PAINTER (GENERAL)

NSQF LEVEL - 4

2nd Year

TRADE THEORY

SECTOR: CONSTRUCTION

(As per revised syllabus July 2022 - 1200 Hrs)

Directorate General of Training

DIRECTORATE GENERAL OF TRAINING
MINISTRY OF SKILL DEVELOPMENT & ENTREPRENEURSHIP
GOVERNMENT OF INDIA

NATIONAL INSTRUCTIONAL MEDIA INSTITUTE, CHENNAI

Post Box No. 3142, CTI Campus, Guindy, Chennai - 600 032

Sector : Construction

Duration : 2 Years

Trades : Painter (General) - Trade Theory - 2nd Year - NSQF Level- 4 (Revised 2022)

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FOREWORD

The Government of India has set an ambitious target of imparting skills to 30 crores people, one out of every four Indians, to help them secure jobs as part of the National Skills Development Policy. Industrial Training Institutes (ITIs) play a vital role in this process especially in terms of providing skilled manpower. Keeping this in mind, and for providing the current industry relevant skill training to Trainees, ITI syllabus has been recently updated with the help of Media Development Committee members of various stakeholders viz. Industries, Entrepreneurs, Academicians and representatives from ITIs.

The National Instructional Media Institute (NIMI), Chennai, has now come up with instructional material to suit the revised curriculum for **Painter (General) - Trade Theory - 2nd Year - NSQF Level - 4 (Revised 2022) - in Construction Sector** in **Annual Pattern.** The NSQF Level - 4 (Revised 2022) Trade Theory will help the trainees to get an international equivalency standard where their skill proficiency and competency will be duly recognized across the globe and this will also increase the scope of recognition of prior learning. NSQF Level - 4 (Revised 2022) trainees will also get the opportunities to promote life long learning and skill development. I have no doubt that with NSQF Level - 4 (Revised 2022) the trainers and trainees of ITIs, and all stakeholders will derive maximum benefits from these Instructional Media Packages IMPs and that NIMI's effort will go a long way in improving the quality of Vocational training in the country.

The Executive Director & Staff of NIMI and members of Media Development Committee deserve appreciation for their contribution in bringing out this publication.

Jai Hind

Additional Secretary/Director General (Training)
Ministry of Skill Development & Entrepreneruship
Government of India.

New Delhi - 110 001

PREFACE

The National Instructional Media Institute (NIMI) was established in 1986 at Chennai by then Directorate General of Employment and Training (D.G.E & T), Ministry of Labour and Employment, (now under Directorate General of Training, Ministry of Skill Development and Entrepreneurship) Government of India, with technical assistance from the Govt. of Federal Republic of Germany. The prime objective of this Institute is to develop and provide instructional materials for various trades as per the prescribed syllabus under the Craftsman and Apprenticeship Training Schemes.

The instructional materials are created keeping in mind, the main objective of Vocational Training under NCVT/NAC in India, which is to help an individual to master skills to do a job. The instructional materials are generated in the form of Instructional Media Packages (IMPs). An IMP consists of Theory book, Practical book, Test and Assignment book, Instructor Guide, Audio Visual Aid (Wall charts and Transparencies) and other support materials.

The trade practical book consists of series of exercises to be completed by the trainees in the workshop. These exercises are designed to ensure that all the skills in the prescribed syllabus are covered. The trade theory book provides related theoretical knowledge required to enable the trainee to do a job. The test and assignments will enable the instructor to give assignments for the evaluation of the performance of a trainee. The wall charts and transparencies are unique, as they not only help the instructor to effectively present a topic but also help him to assess the trainee's understanding. The instructor guide enables the instructor to plan his schedule of instruction, plan the raw material requirements, day to day lessons and demonstrations.

IMPs also deals with the complex skills required to be developed for effective team work. Necessary care has also been taken to include important skill areas of allied trades as prescribed in the syllabus.

The availability of a complete Instructional Media Package in an institute helps both the trainer and management to impart effective training.

The IMPs are the outcome of collective efforts of the staff members of NIMI and the members of the Media Development Committees specially drawn from Public and Private sector industries, various training institutes under the Directorate General of Training (DGT), Government and Private ITIs.

NIMI would like to take this opportunity to convey sincere thanks to the Directors of Employment & Training of various State Governments, Training Departments of Industries both in the Public and Private sectors, Officers of DGT and DGT field institutes, proof readers, individual media developers and coordinators, but for whose active support NIMI would not have been able to bring out this materials.

Chennai - 600 032 **EXECUTIVE DIRECTOR**

ACKNOWLEDGEMENT

National Instructional Media Institute (NIMI) sincerely acknowledges with thanks for the co-operation and contribution extended by the following Media Developers and their sponsoring organisation to bring out this IMP for the trade of **Painter (General) - 2nd Year - Trade Theory - NSQF Level - 4 (Revised 2022)** under the **Construction** Sector for ITIs.

MEDIA DEVELOPMENT COMMITTEE MEMBERS

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Shri. V. Gopalakrishnan	_	Manager NIMI, Chennai - 32.

NIMI records its appreciation of the Data Entry, CAD, DTP Operators for their excellent and devoted services in the process of development of this Instructional Material.

NIMI also acknowledges with thanks, the invaluable efforts rendered by all other staff who have contributed for the development of this Instructional Material.

NIMI is grateful to all others who have directly or indirectly helped in developing this IMP.

INTRODUCTION

TRADE PRACTICAL

The trade practical manual is intented to be used in workshop . It consists of a series of practical exercises to be completed by the trainees during the 2nd year course of the **Painter (General)** under **Construction Sector.** Trade supplemented and supported by instructions/ informations to assist in performing the exercises. These exercises are designed to ensure that all the skills in compliance with NSQF Level - 4 (Revised 2022) syllabus are covered.

This manual is divided into Eight modules. The Eight modules are given as below

Module 1 - **Paper Cutting and Pasting Technology**

Module 2 - **Wooden Surface Preparation and Painting**

Module 3 - **Building Interior and Exterior Wall Painting**

Module 4 - **Building Painting Estimate & Costing**

Module 5 - **Metal Surface Preparation and Paint Coating**

Module 6 - **Painting Equipments and Painting Techniques**

Module 7 - **Painting Process and Types of Paint Defects**

Module 8 - **Paint Coating Designs and Painted Surface Testing**

The skill training in the shop floor is planned through a series of practical exercises centred around some practical project. However, there are few instances where the individual exercise does not form a part of project.

While developing the practical manual a sincere effort was made to prepare each exercise which will be easy to understand and carry out even by below average trainee. However the development team accept that there is a scope for further improvement. NIMI, looks forward to the suggestions from the experienced training faculty for improving the manual.

TRADE THEORY

The manual of trade theory consists of theoretical information for the two years course of the **Painter (General)** Trade Theory NSQF Level - 4 (Revised 2022) under **Construction Sector**. The contents are sequenced according to the practical exercise contained in NSQF Level - 4 (Revised 2022) syllabus on Trade Theory attempt has been made to relate the theoretical aspects with the skill covered in each exercise to the extent possible. This correlation is maintained to help the trainees to develop the perceptional capabilities for performing the skills.

The Trade theory has to be taught and learnt along with the corresponding exercise contained in the manual on trade practical. The indicating about the corresponding practical exercise are given in every sheet of this manual.

It will be preferable to teach/learn the trade theory connected to each exercise atleast one class before performing the related skills in the shop floor. The trade theory is to be treated as an integrated part of each exercise.

The material is not the purpose of self learning and should be considered as supplementary to class room instruction.

CONTENTS

LEARNING / ASSESSABLE OUTCOME

On completion of this book you shall be able to

S.No.	Learning Outcome	Ref. Ex.No.
1	Develop a craft work and artistic work on radium/ vinyl/ thermocol etc. PCS/N9441	2.1.112 - 2.1.116
2	Identity different types of Plywood, MDF & low-quality wood and make wooden surface used various techniques, decorate, paint and make an attractive wooden article. PCS/N5016 PCS/Q5006 PCS/N5004 (PCS/Q5004)	2.2.117 - 2.2.130
3	Develop internal and external Building painting by using different decorative press. PCS/N5016 PCS/Q5006 PCS/N5002 PCS/Q5002	2.3.131 - 2.3.153
4	Choose different pipes as per safety aspect and apply line painting with colour code. PCS/N5110 PCS/N5111 PCS/Q5109	2.4.154 - 2.4.161
5	Process of cleaning and painting on metal surface for preventive coat. PCS/N5110 PCS/N5111 (PCS/Q5109)	2.5.162 - 2.5.180
6	Identify, replace and assemble different pneumatics and paint gun. [Different components– Compressor, Pressure Gauge, Filter Regulator, Valve for hose] PCS/N9442	2.6.181 - 2.6.183
7	Perform Spray Painting technique. (Spray Gun / hose handling, air & paint pressure controlling,) PCS/N9443	2.6.184 - 2.6.185
8	Operate the system of spray booths, Oven, cleaning & their maintenance, application of sealant component on metallic joints. PCS/N5105 PCS/Q5108	2.6.186 - 2.6.188
9	Perform aspect ratio mixing of paint, hardner & solvent. Measure Viscosity of paint. Operate the Spray painting system. PCS/N5004 PCS/Q5002 PCS/N5105 PCS/Q5108	2.6.189 - 2.6.195
10	Identify and apply of spray painting in Home appliances, Agricultural equipment's, Machines, Automotive Bodies etc. PCS/N9444	2.6.196 - 2.7.207
11	Removal of dents & recover the damaged accidental area. Repaint & recovering damaged area. PCS/N9445	2.7.208 - 2.7.218
12	Finish special effects for Modern furniture. PCS/N5002 PCS/Q5002	2.8.219
13	Identify different types of powder coating and apply the Powder coating technique in appropriate place. PCS/N5109 PCS/Q5102	2.8.220 - 2.8.221
14	Integrate quality testing for various Paints & Painted films. PCS/N9902	2.8.222 - 2.8.223

SYLLABUS

2nd Year **Duration: Two years**

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
Professional Skill 42Hrs; Professional Knowledge 13Hrs	Develop a craft work and artistic work on radium/ vinyl/ thermocol etc. **PCS/N9441**	112. Make a manually ornamental design on radium or vinyl. (05 hrs.) 113. Make a symbol or image design by computer in graphics & cut it with plotter. (8 hrs.) 114. Do "Instruction board" on acrylic sheet with help of multi layer radium or vinyl. (13 hrs.) 115. Make a lettering/ image/symbol design for "Instruction board" by computer in graphics, with help of radium or vinyl & cutting it with plotter, pasting on glass/ acrylic/ sun mica or different sheets. (10 hrs.) 116.Create a design for wall decoration by computer in graphics & cut it on multi colour vinyl, paste on wall. (09 hrs.)	Different medium paper for plotter cutting. Manual cutting Instruments & their safety/ care/ precautions, proper pasting procedure, pasting techniques, care & precaution. (13 hrs)
Professional Skill 84 Hrs; Professional Knowledge 27 Hrs .	Identity different types of Plywood, MDF & low-quality wood and make wooden surface used various techniques, decorate, paint & make an attractive wooden article. **P C S / N 5 0 1 6** **P C S / Q 5 0 0 6** **P C S / N 5 0 0 4** **PCS/Q5004**	117. Clean, sanding, knotting, stooping, staining preparation wooden surface properly for polish. (05 hrs.) 118. Make & apply putty for varnishing & polishing. (05 hrs.) 119. Apply polish on prepared wooden surface with cotton rags. (05 hrs.) 120. Clean, sanding, knotting, stooping, staining preparation wooden surface properly for varnish. (05 hrs.) 121. Apply varnish on prepared wooden surface with brush. (05 hrs.) 122. Prepare wooden article& apply varnish with spray. (08hrs.) 123. Prepare wooden article& apply melamine or PU wooden finish with spray. (05hrs.) 124. Make a wooden top with thick layer of melamine polish. (05hrs.)	Polish paper-Types and uses. Putty - Definition, their material types and uses. Method of mixing & its different system of application. Varnish - Definition; types and characteristics of varnish. Process of makingof varnish its importance and contains. Polish- Types and uses. Different application methods. (09 hrs)
		125. Prepare wooden surface properly for painting. (05 hrs.) 126. Apply wood primer by brush (05 hrs.) 127. Make putty for wood finishing. (05 hrs.) 128. Apply putty & prepare wooden surface properly. (05hrs.) 129. Do paint wooden surface properly with brush (05hrs.)	Paint - Definition; classification and use. Pigment, Binders, Solvent, oil,dryers;Additives. Painting- Definition and importance of painting. (09hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		130. Prepare & spray painting on different furniture taking all precautions. (15 hrs.)	Method of wooden surface painting. (09 hrs)
Professional Skill 189 Hrs; Professional Knowledge 60 Hrs	Develop internal and external Building painting by using different decorative press. **PCS/N5016** **PCS/Q5006** **PCS/N5002** **PCS/Q5002**	131. Prepare ceiling surface for lime wash. (05 hrs.) 132. Prepare wall surface for lime wash. (05 hrs.) 133. Apply POP on wall for lime painting. (03 hrs.) 134. Make & mixing of lime & stainer. (02 hrs.) 135. Apply Lime on ceiling & wall with brush properly. (10 hrs.) 136. Prepare ceiling & wall for distemper painting. (05 hrs.) 137. Make wall putty for distempering. (02 hrs.) 138. Apply wall putty with finish & prepare wall surface. (08 hrs.) 139. Mixing & apply a distemper properly for wall. (8 hrs.)	Types, uses of building (wall) paints. Wall primer- Water base / Oil base, types of putty for wall. Mixing, Preparation process of Lime and Distemper. Other required EquipmentsBelow lamp, bucket, plum-bob, putty blender, Paint strainer. Types of Trestle, ladder, scaffolding. (10hrs)
		140. Prepare ceiling & wall surface with putty & Apply interior emulsion paint. Use roller & brush. (20 hrs.) 141. Prepare office & work shop interior wall surface with putty, Apply enamel or luster paint. (20 hrs.)	Colour selection for interior wall painting and use of Paints. Effects; Intention; Purpose of colors. Paint mixing and preparation process. Difference between emulsion paint and Oil paint. (10hrs)
.		142. Make scaffolding for exterior wall painting. (05hrs.) 143. Clean exterior wall aria with cleaning process & water pressure process (05 hrs.) 144. Prepare exterior wall with white cement for painting. (08 hrs.) 145. Paint the prepared wall by brush with cement paint. (08 hrs.) 146. Prepare exterior wall with exterior priming for painting. (8 hrs.) 147. Paint the prepared wall by brush with emulsion paint. (8hrs.) 148. Decorate the projection with dark shade apply special shades of emulsion colour. (04 hrs.)	Color selection for exterior wall painting and use of Paints. Method of paint mixing and preparation. Paint used for exterior wall painting. (11hrs)
		149. Decorate the wall with design roller/ stamp/ stencil. (15 hrs.) 150. Prepare wall & create texture, use different medium, colour& make a different textures. (15 hrs.)	Difference between brush painting and Roller painting. Types of Roller and preparation of texture for wall painting. (18hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		151. Prepare wall & design wall paper pasting on wall (10 hrs.) 152. Find the defect on wall before painting and remove it. (08 hrs.) 153. Find the defect on wall after painting and remove it. (07 hrs.)	Wall defects and defects removal process of wall painting. (9hrs)
Professional Skill 84Hrs; Professional Knowledge 27Hrs	Choose different pipes as per safety aspect and apply line painting with colour code. **PCS/N5110** **PCS/N5111** **PCS/Q5109**	154. Prepare & paint by brush windows, grill, doors, safety doors, gate etc. (16 hrs.) 155. Paint a ceiling and wall with dip-feed roller / pad or airless spray. (16 hrs.)	Building Painting estimate & costing. (14hrs)
		156. Paint the GI pipe, take all precautions while painting. (08 hrs.) 157. Paint the sanitary pipe, take all precautions while painting. (08 hrs.) 158. Paint the MS square & round pipe, take all precautions while painting. (09 hrs.) 159. Paint deferent pipe line with colour code as per ISI. (11 hrs.) 160. Demonstrate knowledge of safety procedures in Industrial pipe line painting (Demo by video & charts). (08 hrs.) 161. Identify colour code wise – Pipe lines, different types of valves. (08 hrs.)	Intention and effects of pipe line painting, Colour Codes of pipe line painting. ISI colour code.(13hrs)
Professional Skill 105Hrs; Professional Knowledge 34Hrs .	Process of cleaning and painting on metal surface for preventive coat. **PCS/N5110** **PCS/N5111** **PCS/Q5109**	162. Scrap thecorrode metal surface. (06hrs.) 163. Clean the metal surface by w ire brush or orbital wire brush. (06 hrs.) 164. Burn the old paint from metal surface by blow lamp or gas flame. (06 hrs.) 165. Do dry sanding with help of emery paper/cloth (06 hrs.) 166. Apply wet sanding on old painted object. (06 hrs.) 167. Clean the metal surface by Sander machine. (06 hrs.) 168. Level different metal surface by portable hand grinder. (06 hrs.)	Corrosion- Definition and classification. Reasons for rusting and effect of climate. Different anti-rusting process. (11hrs)
		169. Apply degreasing process on metal surface. (05 hrs.)	Metal surface - types and selection of sanding paper (polish paper). Metal surface cleaning-

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		170. Apply de-rusting or pickling process on corrode metal. (06 hrs.) 171. Treated phosphating on metal surface with all pre-treatment process. (06 hrs.) 172. Demonstrate practical of Different types of, Industrial Pt system by video. (06 hrs.)	Mechanical and chemical cleaning. (Dry/ wet Sanding, scraping, wire brushing, orbital wire brushing, paint burning, sand and shot- blasting, pickling and phosphating). (07hrs)
		173. Make a proper thin metal primer for brush application. (02 hrs.) 174. Prepare metal surface & apply ready primer on metal surface by brush. (05 hrs.) 175. Apply enamel / polyester putty or filler on primed surface. (08 hrs.) 176. Apply enamel paint on primed metal surface. (05 hrs.)	Metal Primer - Types, Purpose, application and use. Types of surface. Types of solvent or reducers / thinner/ automotive paints (Enamel, NC, Stoving, PU, Epoxy, rubber base sound deadener paint, metallic, pearl, water base automotive paint), lacquer. (07hrs)
		177. Prepare and paint metallic article by brush. (10 hrs.) 178. Prepare & colour making for deep painting. (01 hr) 179. Prepare article for deep painting. (04 hrs.) 180. Demonstrate practical of Electro coat Deeping process & conveyor system by video. (05 hrs.)	Types of painting process- Traditional and modern technology. Ex.- Brushing, Deeping, barreling, Aerosol, roller coating, suction spray, vertical spray, pressure vessel, spray airless, electrostatic, powder coating etc. (09hrs)
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Identify, replace and assemble different pneumatics and paint gun. [Different components – Compressor, Pressure Gauge, Filter Regulator, Valve for hose] **PCS/N9442**	181. Identify pneumatic components – Compressor, pressure gauge, Filter-Regulator-Lubricator (FRL) unit, and Different types of valves and actuators. (05 hrs.) 182. Demonstrate knowledge of safety procedures in spray systems and personal Protective Equipment (PPE) (orally & video). (05 hrs.) 183. Maintenance, troubleshooting, and safety aspects of pneumatic and Painting instruments (The practical for this component may be demonstrated by video) (11 hrs.)	Spray Gun - Principles of spray painting, spray gun accessories and their function different types of spray guns. Holding of spray gun and stroke adjustment. Types of spray painting method. Air compressor for Painting Process. Required instruments for spray painting. (07hrs)
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Perform Spray Painting technique. (Spray Gun / hose handling, air & paint pressure controlling,) **PCS/N9443**	184. Knowledge & Inspect spray gun holding and stroke adjustment, Paint adjustment, air adjustment techniques. (11 hrs.) 185. Spraying practice on the surface like as edges, corner, square, round & curved area. (10 hrs.)	Description of spray painting plant. Types of booth, description of booth, care and maintenance of spray booth. (07hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Operate the system of spray booths, Oven, cleaning & their maintenance, application of sealant component on metallic joints. **PCS/N5105** **PCS/Q5108**	186. Operate, maintenance, troubleshooting, and safety aspects of paint spray booth. (07 hrs.) 187. Operate, and safety aspects of Oven Setting, temperature & timing. (07 hrs.) 188. Apply sealant on metallic joints. (07 hrs.)	Types of oven for painting. Description of oven and its care. Sealant - Definition and description. Purpose of sealant application - edge protection; prevention of water leakage. (Hiding the metal joint/clinch). (07hrs)
Professional Skill 42Hrs; Professional Knowledge 13Hrs	Perform aspect ratio mixing of paint, hardner& solvent. Measure Viscosity of paint. Operate the Spray painting system. **PCS/N5004** **PCS/Q5002** **PCS/N5105** **PCS/Q5108**	189. Paint preparation & mixing for spray painting. (04 hrs.) 190. Practice to Measure the viscosity of paint. (08 hrs.) 191. Spray Painting practice on ornamental objects, with deferent types of paints. (08 hrs.)	Paint viscosity - importance, method of the paint viscosity. Paint preparation & mixing for different application. (07hrs)
		192. Spraying metallic primer on metal surface. (05 hrs.) 193. Apply Car patch, Putty, Filler on metallic surface & prepare it. (08 hrs.) 194. Spraying Surfacer on primed or putty finish surface. (04 hrs.) 195. Spraying finish Top Coat on prepared job. (05 hrs.) * Use enamel/ N.C. paints. (Or latest paints.)	Introduction and uses of Pressure feed. (06hrs)
Professional Skill 84Hrs; Professional Knowledge 27Hrs	Identify and apply of spray painting in Home appliances, Agricultural equipment's, Machines, Automotive Bodies etc. **PCS/N9444**	196. Prepare the surface of home appliances (ex- fan, cooler, fridge, washing machine etc.). (06 hrs.) 197. Priming & surfacing on home appliances. (07 hrs.) 198. Apply finish undercoat &top coat on home appliances. (07 hrs.) * Use enamel/ N.C./ P.U. paints- Solid/ Metallic/ Pearl/.	Airless and Electrostatic Spray painting. (09hrs)
		199. Prepare the surface of machine (ex- lath, drilling, grinding, compressor, suing machine etc.). (06 hrs.) 200. Priming & surfacing on machine. (08 hrs.) 201. Apply finish undercoat & top coat on machine. (08 hrs.) * Use Enamel/ Epoxy/N.C./ P.U. /paints. (Or latest paints.)	Process of article and machine painting. (09hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		202. Prepare the Tow wheeler body and spares surface. (06 hrs.) 203. Priming & surfacing the Tow wheeler body and spares surface. (07 hrs.) 204. Apply finish undercoat & top coat on Tow wheeler body and spares surface. (08 hrs.) Use Automotive paints. Apply Graphic sticker on painted surface properly & apply lacquer coat evenly. Use Enamel/ N.C./ P.U. paints/- Solid/ Metallic. (Or latest paints.) 205. Identify the parts of Electrostatic gun assembly & operate it carefully. (07 hrs.) 206. Identify the parts of Airless gun assembly & operate it carefully. (07 hrs.) 207. Demonstrate practical of Different types of Spray painting, Industrial Painting system by video. (07 hrs.)	Car: Process of repainting. (Removal of dent, car patch, putty process, metal primer, surface, paint) Spray painting. Types of paint defects & its remedies. Importance of polishing, removal defects by polishing. (09hrs)
Professional Skill 84Hrs; Professional Knowledge 27Hrs	Removal of dents & recover the damaged accidental area. Repaint & recovering damaged area. **PCS/N9445**	208. Dissemble essential damage parts, inspect & mark denting aria. Choose & decide process tools for denting. (08 hrs.) 209. Removed dent on marked aria, apply essential method. (12 hrs.) 210. Do sanding or burn on denting area & apply primer & surface. Apply putty layer on necessary area evenly. (12 hrs.) 211. Use wet sanding, level denting surface aria, apply thin coat of surface. (06 hrs.) 212. Masking on unwanted aria properly. (07 hrs.) 213. Match the shade Overlay proper equally on unmask aria. (07 hrs.) 214. Unmasked the mask aria carefully & checkout properly & touch-up it by necessary process. (05 hrs.) 215. Apply final coat rub and wax properly & matched it. (06 hrs.)	Removal of defects by polishing. Removal dented aria on the different surface, types of denting process. (18hrs)
		216. Demonstrate knowledge of Paint defects & its remedies. (video). (05 hrs.)	Types of paint defects & its remedies. Importance of polishing, removal defects by polishing. (09hrs)

Duration	Reference Learning Outcome	Professional Skill (Trade Practical) (With inidcative hour)	Professional Knowledge (Trade Theory)
		217. Check & Find out different paint defects (run down, sagging, pin hole, orange peel, oil & water spot, over/ dry spray, uncover shade variation etc.). (05 hrs.) 218. Mark the defected area, Decide Techniques & apply remedies properly. Make finished surface. (11 hrs.)	
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Finish special effects for Modern furniture. **PCS/N5002** **PCS/Q5002**	219. Process Finish special effects on different furniture & different surface. (like as- colour gradations, malty tones applying, different textures, etc.). (21 hrs.)	Furniture making is a multiple skills, using different applications on one object like Painting, Polishing, Varnishing, Waxing, staining, PU coating textures creating etc. (07hrs)
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Identify different types of powder coating and apply the Powder coating technique in appropriate place. **PCS/N5109** **PCS/Q5102**	220. Prepare & Clean the metallic article in chemical (degreasing, de-rusting, activation, phospheting, passivation & water rainssing as required etc.) (08 hrs.) 221. Proceed powder coating on cleaned article & bake it in oven in appropriate temperature & timing. (13 hrs.)	Operating system of Powder coating technique. Chemical cleaning process, Types of coating powders. (07hrs)
Professional Skill 21Hrs; Professional Knowledge 07Hrs	Integrate quality testing for various Paints & Painted films. **PCS/N9902**	222. Demonstrate knowledge of Paint defects & its remedies. (video). (10 hrs.) 223. Test the quality of paints & Painted surfaces by various method & instruments. (11 hrs.)	Different types of paints & painted surface testing equipments, Types of testing methods. Use & care. (07hrs)

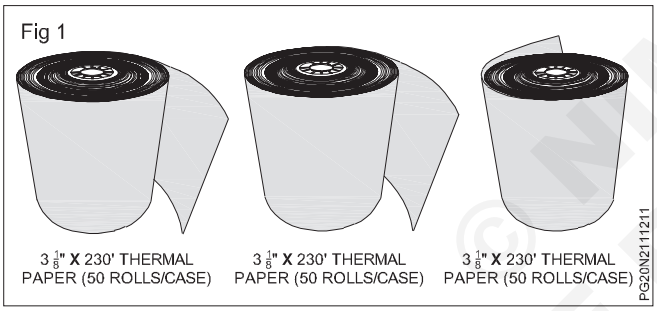
Plotter paper and cutting instruments

Objectives: At the end of this lesson you shall be able to
- **state the types of plotter paper**
- **state the types of paper cutting and manual cutting instruments**
- **state the paper cutting safety precautions**
- **state the procedure of paper pasting and pasting techniques**
- **describe the care and precautions while paper pasting.**

Plotter paper: Plotter paper are output devices that are most commonly used for computer aided design application. Computer output is in large vector designs, which may include architectural blueprints.

Plotter paper is a special kind of paper only used for plotter. A plotter is a computer hardware that works just like a printer and it is used for printing vector type graphics Althrough plotter device works as a printer, the plotter paper printer is much different than regular paper printer. This plotter can print on many surfaces such as shower curtains, cardboard, vinyl, plotter paper and more.

Fig 1



Plotter paper sizes: Types of Xerographic copier or wide format inkjet printer is determine the type of plotter roll and size. Before you take the plunge and order plotter paper, It is essential to understand the plotter paper sizes. Normally plotter paper roll length are measured in feet. Thicker plotter paper roll length is about 150 feet and much shorter than the average plotter paper roll. Which comes in length of 150, 300 and even 500 feet as on customers need, paper length may be change.

Plotter paper width: Plotter paper roll width is measured in inches most of the plotter paper roll width to be either 11, 17, 18, 22, 24, 30, 34, 36, or 42 inches specifications of plotter paper sizes and width is the first number first number listed on the paper roll informative sheet.

Plotter paper weight: The most common weight of papers used in standard printers is 24 lb bond and 60 lb text paper. Select the plotter paper that has a weight needed for specific plotter device.

Core diameter of plotter paper: The diameter of the cardboard tube that the plotter paper is wrapped around is called the core diameter. The inkjet printers are used paper rolls with a core diameter of 2 inches. The larger toner machines use paper rolls with a core diameter of 3 inches.

Plotter: A plotter is a machine that produces vector graphics drawings, plotters draw lines on paper by using pen or some other applications. Knife is used to cut a plotter paper. There are three types of plotter. They are as a drum, plotter flatbed plotter and inkjet plotter are used pens and electrostatic. Plotters do not use the pens.

Cutting plotter: Cutting plotters use the knife to cut into a piece of material (such as paper, mylar film or vinyl film) that is laying on the flat surface area of the plotter. The cutting plotter is connected to a computer, which is equipped with cutting design or drawing computer software programs.

Automate cutting and printing with paper cutting plotter is a cutting plotter. It is designed to house multifunctional knives for cutting and pen for writing and drawing designs.

Drum plotters: This device works by moving a pen on a single axis track, while the paper moves on a cylindrical drum. Typically, the drum moves the pen or pens draw up and down, if use more then one pen, then you have different colors.

Flatbed plotters: Flatbed plotters are output devices. They work by fixing paper on a flat surface, while pens move to draw the image . The pen itself may be attached to an arm allow it to easily move over the paper. They do not use traditional printing heads, nozzles and ink cartridges. The bed itself is a flat vacuum bed or table meant to keep the paper still. This machine makes them an ideal choice to create even larger documents, practically it is used for consistently printing larger architectural or CAD drawings.

Inkjet plotters: This device pushes beads of ink directly on to the surface of whatever printing on. Inkjet plotters typically print in three or four color pallets. The three color injects focus on cyan, magenta, and yellow and they mix colors to create darker shades such as black. Four color inkjet plotters have dedicated black ink. These inks are also often water based, using virtually no Voc's or hydrocarbon based solvents making it an environmentally friendly printing option. These inkjet printers can also reduce the set up time, thus allowing to maximize the productivity.

Plotters tools: Plotter blades, plotters pens, sign making tool, carbide, plotters blade cross cut sheet plotters blade.

Masking paper: Masking film, spray mask and drawings paper clay coated drawings, pounce paper, frist it spray mask stencil. Ruby masking film rolls – 3 mil, white vinyl spray mask stencil 3-2 mil, yellow vinyl spray mask stencil 4 mil.

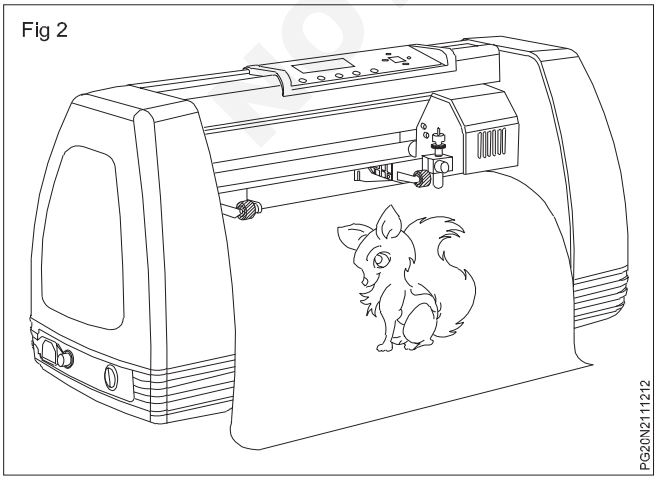
Hand tools: Retractable pocket weeding tool, 1-1½ inch rivet brushes, 20 inch rollers tray to accommodates any size of roll 3 inch rivet brushes, 4 inch speed ball rollers \ applicator, 4.5 inch blue suction cup, 5 inch squeegee – 25 pack, 5 inch super soft felt teflon stripped squeegee – 25 pack, ball tip weeding tool, burnishing tool with needle – 5 pack, curved pointed tip tweezers, double ended vinyl car wrap tool, banner stands.

Applications fluid and adhesive removers: Gold solutions adhesive remover, orange peel adhesive remover, quick stick application fluid is used as a chemical to remove unwanted materials stick on the graphics.

Cut and pasting techniques: Cut and pasting process for ultra – this tape free e-tattoo a removing the liner from commercial tattoo paper, laminating 1.4mm thick transparent PET sheet on the tattoo paper depositing 10mm thick Cr and 100mm – thick. Au on the PET with thermal evaporator, patterning the Au/Cr/PET sheet with a commercial cutter plotter. Peeling off the extraneous parts from the tattoo paper. Applying little water on human skin, pasting e-tattoo on human skin from tattoo paper, spraying liquid bandage over the e-tattoo with the hydrocarbon sensors being covered by stencil.

Cutting plotters use knife to cut into a piece of materials (such as paper, Mylar film, or vinyl film) that is laying on the flat surface area of the plotter. The cutting plotter is connected to a computer, which is equipped with cutting design or drawing computer software programs those computer programs are responsible for sending the necessary cutting dimensions in order to command the cutting knife to produce the correct project cutting needs. This techniques used to card making and scarp booking such as tool allow desired card and decal shapes to be cut very precisely and repeatably.

Fig 2



Static cutting table: This type of cutting plotter used a large flat vacuum table. It is used to cutting a non rigid and porous materials such as textiles, foam or leather that may be too difficult to cut with roll – fed plotters static cutter can also cut much thicker and heavier materials than a typical rollfed or sheet fed plotter is capable of handling.

The surface of the table has a series of multi hole drilled on it materials is placed on the table and a cover sheet of plastic or paper is overlaid on to the material to be cut vacuum pump is turned on and air pressure pushes down on the coversheet to hold the materials in place. The table then operates like a normal vector plotter using various cutting tools to cut holes or slits into the fabric. The cover sheet is also cut, which may lead to a slight loss of vacuum around the edges of the cover sheet.

Vinyl cutter is used to create posters, bill boards signs. T shirt loges and other weather – resistant graphical designs. The vinyl can also be applied car bodies and windows for large bright company advertising and to sail boat transons.

Vinyl cutter hardware is similar to a traditional plotter except that the ink pen is replaced by a very sharp knife to outline each shape and may have a pressure control to adjust how hard the knife presses down into the vinyl film preventing the cuts from also penetrating the backing material. Besides losing relative placement of separate design elements, loose places cut out of the backing materials may fall out and jam the plotter roll feed or the cutter head. After cutting the vinyl materials outside of the design is peeled away leaving the design on the backing materials which can be applied using self Adhesive glue, lamination or a heat press.

The vinyl knife is usually shaped like a potters pen and is also mounted on a swivel head so that the knife edge self-rotates to face the correct direction as the plotters head moves vinyl cutters are primarily used to produce single color line art and lettering multiple color design require cutting separate sheets of vinyl then overlaying then during application but this process quickly becomes counter some for more than a couple of hue.

Sign cutting plotters are in decline in applications such as general bill board designs. Where wide formate inkjet printers that use solvents based inks are employed to print directly onto a variety of materials cutting plotters are still relied upon for precision contour cutting of graphics produced by wide format inkjet printers.

Plotter cutter service tips

- Clean the plotter cutter before and after use.
- Set the machine connections properly.
- Check the plotter cutter accessory fittings.
- Set the friction roller on the machine properly.
- Set the plotter head and adjust it as per instructions given by manufactures.
- Set the backing strip on the machine properly.

- Set the plotter cutter blade size and depth, side view of 45°, 60° angle as you need for your work.
- Insert the blade and set it properly as service manual instructions.
- Load the vinyl roll on the machine and set it properly
- Sensing the roll width through machine software system.
- Set the blade depth vers pressure (Force) depend upon the nature of job.
- Test the plasmatic cutting sample.
- Test the cut overlay and ensure machine is ready for projects work.

Laser cutter: A laser cutter is a cutting device which focuses a high energy laser beam on to a material resulting in high quality and dimensionally accurate cut. These devices can be used to cut, etch, engrave or drill a variety of materials.

Vinyl cutting plotter care and precautions

- Use the adhesive cleaner for vinyl cutters cleaning if you use any other solvent mixture to clean that should not harm the equipment. Choose a mild in odor, non hazardous, hypoallergenic and biodegradable
- You can use paper towel or tissues with rubbing alcohol and a tooth brush or wire brush soak tissue or paper towel in the rubbing alcohol and latch down plotter cutter wheels. Then put the tissue on the wheels and hit the down arrow key. This process will help in the meantime until you get your hands on a proper adhesive fluid remover.
- Once in a week clean the wheels in good working order. This procedure will keep your wheels from getting coated in adhesive, which can cause to have serious tracking problems.
- When you are having tracking problems inspects the quality of work or increase the time It takes to complete projects either way not cleaning off adhesive on your plotter can end up costing, time and money.
- If you have noticed a serious build up of glue, use tweezers or even some adhesive removers to get rid of the build up as soon as possible
- Use the wire brush to scrub grit rollers lightly. Try to work in slow circular motion which will get rid of paper scraper scraps and move without causing any damage.
- Do not interfere with any of the paint while doing the cleaning process on the machines.

Daily maintenance of plotter cutter

- Always clean the machine before start the work
- Check the machine connections and operating switches
- Always lift up the pinch rollers before head out for the day. If leave them down for too long, you could actually create indentations
- If ignoring the above process , plotter will not last as long as, it should to maximize the amount of work you can get out of your plotter.
- Always wipe off any dust with a dry cloth to prevent it form building up dust can end up negatively impacting the ability of adhesive to stick or other materials once they are cut,
- Always make sure that you always keep the tip as free from debris as you can.
- Use the compressed air, for blown on it with a fan or even blast it on a cool setting of a hair dryer for two seconds to send any left over vinyl, dust and dirt flying away.
- Simple solution select the carbide plotter blade cutting angle of 30, 45 and 60 degree as your need of projects work.

Sticker cutter machine care and precautions

- Don't put debris in the operation table of sticker cutter machine such as scissors, ruler pen etc.
- When the sticker cutter machine is running, do not touch the head to avoid injury
- When sticker cutter is not in use, use the alcohol or a vacuum cleaner to remove dust from the adhesive cutting machine to prevent the equipments from aging.
- Ensure the automatic plotter cutter machine function of automatic positioning, automatic cutting automatic feeding and automatic receiving the machine output product.

Vinyl sticker

Objectives: At the end of this lesson you shall be able to
- **state the types of vinyl**
- **state the characteristics of vinyl.**

Vinyl sticker: Vinyl stickers are wall decals and they are cut with a vinyl cutting plotter. These vinyl stickers are also known as tattoos, vinyl or wall stickers. They can be used to decorate a room, for commercial use as a sign to promote a business.

Types of vinyl

There are two basic types of vinyl stickers

1 Adhesive vinyl

2 Heat transfer vinyl

Adhesive vinyl: It is a thin electric material that is advanced to one side and it can be cut to any design.

This can be used on all surfaces which are smooth and rough. It can be used for stickers and other purpose. A special piece of paper is attached to the bake side of it, and after removing the paper you can use it. Some sticking vinyl are permanent and used for interior applications. It is used for permanent interior vinyl signs board or decorative items made of glass for house. Ideal for anytime temporary vinyl wall design sticker, stencils are used for temporary applications.

Heat transfer vinyl: This type of vinyl is being used for clothes T – shirt towels canvas bag and for many other applications. Heat transfer vinyl is applied using heat on press. Heat transfer vinyl is also known as T – shirt vinyl. It is used to heat the surface of the clothes. Using vinyl, it is used to print on the cloth by vinyl print. These two types of vinyl are available in rolls on sheet and its width is normally 12 inches no paper is attached to heat transfer vinyl. This type consist of a clear plastic carrier sheet. which covers the top of the vinyl. Heat transfer vinyl or vinyl on icon is available in many color and styles. It is used on clothes made out of icons.

While selecting HTV you have to primarily about your desired look. Different types of vinyl work well on different clothes. For example, because holographic and metallic vinyl are core, it works best for design made in small pieces rather than in large strips. Like this it works well on stretch vinyl stretching and ploester clothes, all of them fit to be washed.

Other types of vinyl

Reflective vinyl: It is a standard same as vinyl and it can be cut into shape. It can be applied on any smooth and shiny. Its characteristic is that when it shines, vinyl contents lights and shines. The reflective vinyl has got its own smoothers. It is water and weather resistant, it can be used in the interior and exterior of house.

Transculent vinyl: It is a high display, flexible and similar transparent vinyl film. It is suitable for architectural graphic applications involving take light slight board, transparent windows and windows graphics. It is waterproof and weather resistant. So it can be used indoors and outdoors.

Clean vinyl: Clean vinyl is a durable materials and it comes in different thickness. It is like regular vinyl and its white to white. Due to this it provides external security. Printing on it is a bit quickly because it is not socked in ink like regular vinyl. It is used for products labels, windows, commercial advertising, hobbies and many other thing. Its water proof stickers can be cut into any shape and it scratch resistant also

Back vinyl: Back vinyl is a great way to reels your graphics visible at night. After thinking on semi – transparent vinyl banner it is fined on arcrylic box sheet. The light is placed inside the box. Backlit at night makes vinyl graphics clear and attractive when the lights are on.

Cling vinyl: Static cling vinyl is a popular material which is being used for graphics display. Static cling is made from a thin vinyl film that clings various surfaces. Typically, they are displayed on glass windows and doors however they, can also be displayed on smooth plastic or metal.

Sticker: Sticker is a kind of label on its one side paper, plastic vinyl or other materials are printed and on the other side here is a special paper. After removing this paper, you can stick it anywhere. it is used to decorative works and advertisements. This type of stickers are available in various shapes color and designs, they often use stickers to temporarily name tags on advertisements in business schools, homes vehicles and more.

Stickers are widely used when an objects require a logo and words. This products comes from a specific company. The brand sticker for this label is attached to the products. It is also used to describe products that are not clear through simple tests on automobile bumper stickers are permanent, which is called bumper sticker.

Vinyl pasting method

Objectives: At the end of this lesson you shall be able to
- **state the uses of vinyl**
- **state the types of vinyl pasting**
- **state the work of vinyl pasting.**

vinyl pasting: Vinyl is a natural substance, but an artificial man made materials. This type of plastic is made by the combination of ethylene & chlorine in different colors, it is transparent and solid. It is used for baking, paper, ball paper, signboard, nameplate, number plate and other decorative work. The vinyl pasting used on the surface of anything.

Vinyl design or print is called pasting. pasting is two types

1 Dry pasting 2 Wet pasting

Dry pasting: In general dry pasting is used to paste the print or small vinyl design on any place

The vinyl stickers has paper paste on both sides on one side of the vinyl print stickers paper is there. Initially the surface where it is to be applied has to wiped then where you have to paste the design take measurements and then apply the design and remove a strip of abrotape on the top of it. Due to the abrotape applied on the top, the design does not move from the marked area. Then press and rotate the top side of the squeeze design. Ensure that the sticker has stick properly, and then

remove the paper, with a soft cloth gently press on vinyl sticker, if in the design pastings are bubbles, remove it by pricking a hole on the bubbles and press with the help of cloth or, squeeze on outside of vinyl sticker if need dry paint is also done with machine.

Wet pasting: Wet pasting is such as the most popular method for pasting any type and size of vinyl pasting. this method is used to reduce bubbles, if any design on printed design is to be pasted on any surface, tint clear the surface, then spray shampoo mixed with water on it to remove the water under the print, drag it out with the help of squeeze. Due to uniform pressure of squeeze help of squeeze. Due to uniform pressure of squeeze the water and air stored under the vinyl comes out and no bulbs are formed under the vinyl. If bubbles are accidentally applied to a vinyl design on print, then by pin hole with the needle they are pushed to the outside with the help of a cloth or squeeze. Vinyl is applied on flat and smooth surfaces only.

Sanding paper types and their uses

Objectives: At the end of this lesson you shall be able to
- **state the types of sand paper and sand paper grade**
- **state the features and details of polishing papers**
- **state the sand paper grits and usage.**

Sand paper: A perfects sanding work obviously needs at least several grade of sand paper. This sand paper assortment including 12 types of grit cover all you need from art craft, wood work automotive metal, and plastic, applications for buffing and polishing package included. 2x 120 grit sand paper, 2 x 150 grit sandpaper, 2x180 grit sandpaper, 2x240 sandpaper 2x 320, 2x 400 2x60, 0.2x800, 2x1000, 2x1200, 2x1500, 2x2500, 2x3000 grit sand paper.

- 120 to 220 grit for rough sanding and removing scratch.
- 320 to 400 grit for light sanding between coats of finish or to sand metal and other hard surfaces.
- 400 to 800 grit for final finishing before painting
- 1000 to 1500 grit for sanding between coats.
- 2000 to 3000 grit for buffing.

Features and details of polishing papers

- Included all package comes with 2 sheets of each grit in sandpaper 120/ 150/ 180/ 240/ 320/ 400/ 600/ 800/ 1000/ 1500 / 2000/ 2500/ 3000 totaling 28 sheets.
- Suitable for use in art and craft, wood work, automotive, metal and plastic applications for buffing and polishing.
- The sandpaper grits are printed on the back side of sand paper for easy identification.
- Silicon carbide, electro coated, good roughness, good polishing effects, good efficiency, long choose high quality natural abrasive.
- This sand paper kit is perfects for handling all manner of add jobs and little fixes from removing scuffs and abrasive on walls and base boards to smoothing out wood or mold spurs on toys or furniture refinishing hand rails or lawn furniture and even wet sanding blemishes.

Grit number on sand paper: The grit of sand paper is a rating of the size of abrasive materials on the sand paper, the higher grit number is equivalent to a finer abrasive which creates smoother surfaces finishes lower grit numbers represent coarser abrasive that scrape off materials much quicker.

Micro grits are a class of finer abrasive they include higher grit numbers micro grit – sized sand paper commonly used on wood and some on dry wall.

Grade	Description	CAMI	FEPA	Diameter	Used for
Ultra fine	Most delicate abrasives	800 or 1000	P1500, P2000 or P2500	8.4-12.6 micrometers	Final sanding and polishing thick finishes
Super fine	Slightly wipes away patches / small inconsistencies but not strong enough for removal	400. 500 or 600	P800, P1000 or P1200	15.3 to 23.0 micrometers	Final wood finishing
Extra fine	Slightly less and more abrasive than super fine	360 or 320	P400, P500 or P600	25.8 to 36.0 micrometers	Initiative methods for wood polishing
Very fine	The least of the micro abrasives	240	P240, P280, P320 or P360	40.5 to 58.5 micrometer	Sanding finishes between consecutive coats and drywall and wood

Macro grit sandpaper: Macro grit sandpaper are a class of abrasives that range from medium to coarse sand paper calibers. They feature mid to low grit numbers. micro grit - sized sandpaper are commonly used on tougher wood and metals and have a stronger clearance.

Grade	Description	CAMI	FEPA	Diameter	Used for
Very fine	A coarser materials than very fine under the micro abrasives	150, 180 or 220	P150, P180 or P220	190 to 265 micrometers	Sanding on bare wood
Fine	Cannot remove varnish or paint on wood	100 or 120	P100 or P120	115 to 162 micrometers	Preparing wood for finished cleaning plaster and removing water stains on wood
Medium	Medium to coarse surface texture after sanding	80	P60 or P80	190 to 265 micrometers	Sanding bare wood prepare it for removing varnish and final finishing
Coarse	Has the ability to remove material rapidly	40, 50 or P50	P40 orP50	336 to 425 micrometers	Wiping away a layer of debris or finish with minimal efforts
Extra coarse	Quickens the removal of most materials rapidly	P12, P16 P30 or P36		530 to 1815 micrometers	Initial efforts in hardwood floor sanding

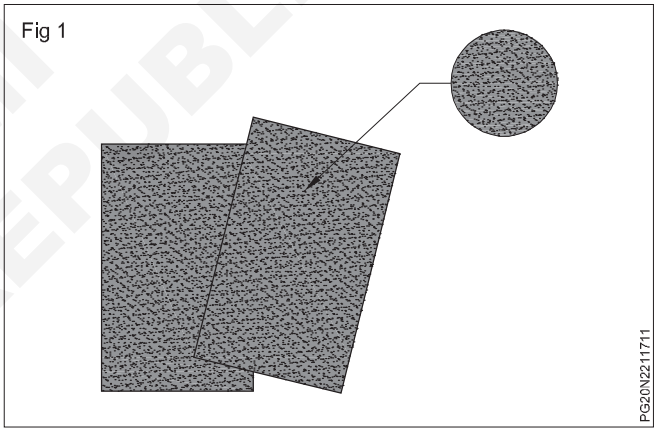
More facts on sandpaper types: Besides the grits and grades, sandpaper is made out of materials that vary chemically. It can be made from the grains of a natural mineral called garnet, or from synthetic ones like aluminum oxide, alumina – zirconia or silicon carbide. Irrespective of the sandpaper you work with, it must have a strong bond between the sandpaper grit and its backing materials, if it doesn't the grit and backing materials may become separated during use, running your application. Backing for sandpaper includes paper, cotton, polyester, rayon, PET, film and rubber. Mylar is used as backing extremely fine grits.

Sand paper grit and sandpaper grades?

Grit size refers to the specific size of the abrasive grain (36, 60, 120, etc.), while grade is a broader term, with each grade including a range of grits. For example, medium grade includes grit sizes between 80 to 150.

Backing: In addition to a paper, backing sandpaper includes cloth (cotton polyester, rayon), pet film fibre, and rubber. Cloth backing is used for sandpaper discs and belts, while mylar is used as backing for extremely fine grits. Fibre or vulcanized fibre is a strong backing materials consisting of many layers of polymer impregnated paper. The weight of the backing is usually designated by a letter. For paper backings, the weight ratings range from 'A to F", with A designating the lightest and F the heaviest. Letter nomenclature follows a different system for cloth backings, with the weight of the backing rated J, X, Y, T, and M, from lightest to heaviest. A flexible backings allows sandpaper to follow irregular contours of a workpiece, relatively inflexible backing is optimal for regular rounded or flat surfaces. sandpaper backings may be glued to the paper or from a separate support structure for moving sandpaper, such as used in sanding belts and discs. Stronger paper or backing increases the ease of sanding wood. The harder the backing materials, the faster the sanding the faster the wear of the paper and the rougher the sanded surface. (Fig 1)

Fig 1



Abrasives

Types of abrasive materials include:

- **Glass:** no longer commonly used.
- **Flint:** no longer commonly used.
- **Garnet:** commonly used in woodworking.
- **Emery:** commonly used to abrade or polish metals.
- **Aluminum oxide:** the most common in modern use, with the widest variety of grits, lowest unit cost: can be used on metal (I,e body shops) or wood.
- **Silicon carbide:** available in very coarse grits all way through to microgrits, common in wet applications.
- **Alumina – zirconia:** (an aluminum oxide – zirconium oxide alloy), it is used for machine grinding applications.
- **Chromium (III) oxide:** used in extremely fine micron grit (micrometer level) papers.

- **Diamond:** It is used for finishing and polishing hard metals, ceramics and glass
- **Ceramic aluminum oxide:** It is used in high pressure applications, used in both coated abrasives, as well as in bonded abrasives.

Sandpaper may be 'stearated' where a dry lubricant loaded to the abrasive. stearated papers are useful in sanding coats of finish and paint as the stearate 'soap' prevents clogging and increases the useful life of the sandpaper.

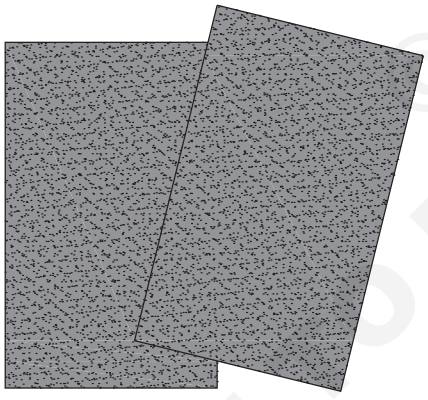
The harder the grit materials , the easier the sanding of harder surfaces like hardwoods such as hickory, pecan, or wenge. the grit materials for polishing granite must be harden than granite. Wet and dry sandpaper is more effective used wet, because clogging is reduced by particles washing away from the grinding surface. Arguably there are also benefits due to lubrication and cooling.

Bonds: Different adhesives are used to bond the abrasive to the paper. Hide glue is still used, but this glue often cannot withstand the heat generated during machine sanding and it is not waterproof. Waterproof sandpapers or wet/sandpaper use a resin bond and a waterproof backing.

Sand paper shapes

- Sheet usually 9 by 11 inches but other sizes may be available. (Fig 2)

Fig 2



SANDPAPER SHEETS

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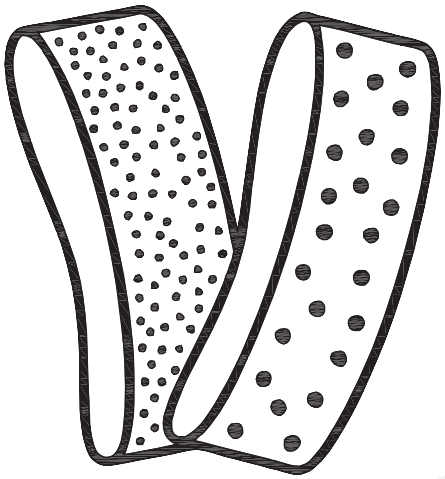
- Belt usually cloth backed, comes in different sizes to fit different belt sanders. (Fig 3)
- Disk made to fit different models of disc and random orbit sanders may be perforated for some models of sanders. attachments includes pressure sensitive adhesive and hook – and – loop (Fig 4)

Fig 3



SANDING BELT

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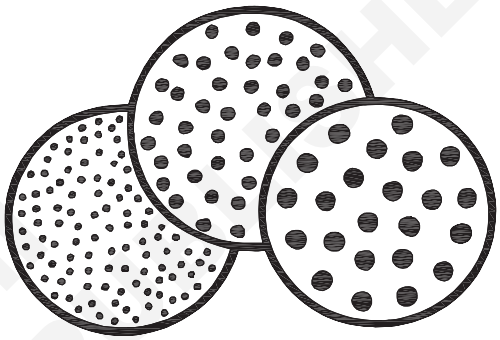
Fig 4



SANDING DISC

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- Rolls known shag rolls
- Sponge–for light place rinsing purpose.

Grit sizes: Sand paper grit size refers to the size of the particles of abrading materials embedded in the sandpaper. These measurements are determined by the amount of the abrasive materials that can fit through square inch filter.

Method of sanding: wet sanding with addition of water to act as a lubricant, is less abrasive than dry sanding and results in a smoother finish. It is best to wet sand final finish for painting.

Dry sanding removes more materials and smoothers rough materials quickly.

Putty material types and uses

Objectives: At the end of this lesson you shall be able to
- **state the putty materials and their uses**
- **state the method of putty mixing**
- **state the method of putty application**
- **state the wood polish types and uses**
- **state the application methods of polish.**

Putty: Putty is a commercial hole filler. It is a stiff paste made to fill small holes and cracks, before applying a clear or opaque finish of wooden surface. Although fillers are made of range of color resembling various common species of wood, at best close match will hardly ever be perfect.

Putty materials types: wooden putty (wood filler) refers to a product wood workers use to ensure their wood surface is smooth and fine finishing wood work. They are made with combination of as filling substance and binding agent hence wood workers use it to patch minuscule damages in wood surface. Putty is used for sealing a large crack and large holes.

Different types of wood fillers: various types of wood fillers used to fill out the cracks, holes and dents on the wood surface after working. They either solvent based filler or water based fillers. The common types of wood fillers as follows.

1 Water based wood fillers

Water based wood fillers are made using organic substance such as cellulose, wood filler and materials. They can dissolve in water easily, hence. They are very useful for wood work, that require a thinner wood filler. Water based wood filler get dried easily in appropriate time of 15 minutes, making the whole process faster and easier. They also have lower amount of volatile organic compounds and so they give of less odor when you work with water based wood fillers. There are two types of water based fillers are used (A) cellulose based wood fillers (B) gypsum based wood fillers.

Fig 1

A Cellulose based wood fillers

It is come as dry powder that is mixable with various solvents to form a useable paste. The solvents can either be water or alcohol based solvents which ever you decide to use can be serve the purpose well.

B Gypsum based filler

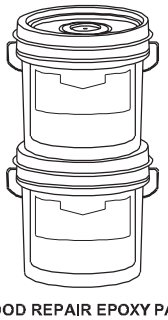
This type of wood fillers contain mineral powders they are soluble in water and forms a solid substance with long lasting capacity. They do not break off quickly once they are getting dried, they possess a crystalline and transparent structure that allows the sand allows the wood fillers to blend correctly with the surrounding wood surface. however this type of wood fillers does not last long, because they get stained easily. For this must add an extra layer of paint to provide the best effects to make them last longer.

2 Latex - based wood fillers

It is equally solvent based wood fillers it is used filling the gaps or small holes in wooden floors, cabinets, furniture etc. Variety of color latex wood fillers are available. This makes it easy to use a wood filler that complements the wood, use the putty knife to apply wood fillers after drying sand the filler to smoother it out. this sort of filler has a advantage through, it has little structural strength after applying this wood filler into a spot avoid using nail or screw in that spot as it can crack it open again

3 Epoxy wood fillers

Fig 2



The epoxy wood filler should be first choice filler with structural strength to fill wider gaps or cracks it comes in two package style either a tube or a can has a clear or colored version depending on what is need careful application is vital because sanding is impossible once dried this type wood filler is stronger than the wood itself

why they get hence you can use a nail or screw on it because of their plastic like appearances. (Fig 2)

Uses of wood fillers

- Wood fillers are used for smoothing wood with wide, long wood grain.
- A wood fillers does the jobs of making the wood surface even out perfectly.
- It is used for fixing furniture, replacing, strength thinning damaged parts of the wood even though it is not recommend this if furniture is a load–bearing one.

Method of putty mixing: Gather the cleaned saw dust into a small pile add wood glue and stir with a craft stick, adding more glue until the mixture is thick putty, roughly texture of cookie dough. Avoid adding so much glue that the mixture becomes runny wood glue hardens relatively quickly so don't take more than 10 minutes of total working time to prepare and applying the fillers.

Form the mixture into a workable dough that you can roll between your fingers. If the dough has already begun to stiffen it will be difficult to apply to the work materials if this happen start with batch and slightly increase the amount of wood glue in the mixture once the proper texture is achieved move immediately to the application of the filler to the work materials.

Apply the wood filler: Push the putty by hand into the gouge, scratch or hole in the work materials, then remove excess by hand working quickly, use a putty knife to flatten the wood filler and scrape away excess let the filler dry completely.

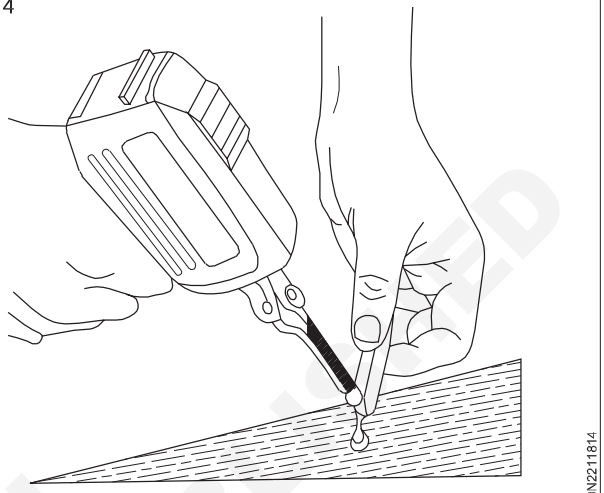
Wash off the putty knife right away with warm water and soap discard un used wood filler it cannot be saved sand the putty filled area very lightly with fine grit sand paper. It will not take much effort to sand the area smooth avoid over sanding which will gouge the patch wipe the sanded area with clean tack cloth.

Fig 3

Melting a shellac stick: Using the tip of a warm soldering iron, melt the shellac, a allowing it to drip onto the blemish. while the shellac is still soft, dip the tip of a chisel in water and use it to press the shellac into the crack or knot. When the shellac is cool and hard, pare it flush, with a chisel then sand it with very fine sand paper.

Filling with a wax stick: Sand the surface of the wood and seal it with shellac before filling with wax. Use a warmed knife blade to soften the wax and to press it into cracks or small holes. As the wax hardened scrape it flush with the knife, then burnish it with the back of a piece of sandpaper.

Fig 4



Varnish: Varnish is type of sprit is used as a solvents is known as spirited varnish or French polish shellac is dissolved in sprit and the products is applied in a thin layer.

Varnish is a clear transparent hard protective coating or film. varnish is primarily used as a wood finish where stained or not the primarily used as a wood finish where intended to be visible varnish finishes are naturally glossy but satin / semi – gloss and flat sheems are available varnish made of varnish oil, resin and thinner.

Types of varnish: There are eight type of varnish used (sprit varnish, Acrylic varnish, Exterior varnish,polyurethene varnish, yacht varnish, oil varnish, alkyd varnish, lacquer varnish).

Sprit varnish: It is known as shellac or French polish, sprit varnish uses shellac dissolved in sprit, which then applied in a thin layer on the wooden surface this type of varnish gives a translucent finish thus making it well suited to materials.

Acrylic varnish: This varnish is quick drying, non toxic and water based it can be used outside as well as inside this is generally available in gloss stain and matte finishes. It is not limited to wood finishing purpose and can be used for other materials. It is more versatile than many varnishes it can just clean up with water.

Exterior varnish: This kind of varnish is used for outdoor spaces, those exposed to extreme weather increased UV protection with this varnish means that the wood beneath is well protected from all kinds of sun damage. This varnish related to yacht varnish in terms of formulation and flexibility this is cure slowly despite being dry to the touch.

Polyurethane varnish: This varnish is tough and long lasting but polyurethane varnish is more often used on floors and other areas, which get a lot of life span. This is heat resistant and will give a clear and tough finish, this type of varnish does not penetrate the wood so primer like an oil based varnish or a shellac solution is applied beforehand. It is excellent harness and durability it is resistant to spills of mild acids, solvents and other chemicals.

Yacht varnish: It is highly flexible varnish that was originally intended for use on boats to prevents water from gradually seeping into the wooden spars of the hull due to weather or just the waves. Yacht varnish is a high gloss finish based on tung oil and phenolic resins and some UV protection.

Oil varnish: It is not varnish as it is just varnish without the rest of the ingredients leaving only the oil because, it is only the oils, they take a long time to dry this is suited for use on exposed surface requiring polishing or frequent cleaning for superior works. It is often used as a varnish and alternative to sprit varnish.

Alkyd varnish: This is a clear wood varnish derived from quality alkyd resin it is used in indoor and outdoor settings. It is provide good protection from variations in temperatures, UV damage from sunlight and water seepage this varnish enhances the wood grain and color. Alkyds are chemically modified vegetable oils that operate well in a wide range of conditions.

Lacquer: Lacquer cannot be considered as a true varnish and is most often used to describe the process of applying a finish by spraying. It is quick drying solvent based finish applied by spraying instead of alcohol as in the case of shellac acetone is the usual solvent base also known as lacquer thinner, once applied lacquer can be removed by using lacquer thinner. It does not cure like a true varnish.

Characteristics of ideal varnish

- It should be give glossy surface
- Should be durable
- It should be dry rapidly after its application
- It should not develop cracks after drying
- It is commonly used on wooden surfaces
- Color of varnish should not fade away with time
- It should not hide natural grain of inner surface of timber.

Process of varnishing: Application of varnish on wood work is carried out in the following steps

1 **Preparation of wood surface:** The wood surface is made smooth by through rubbing it by sand paper or pumice stone.

2 **Knotting:** The process of knotting is carried out exactly in the same way as adopted for painting wood work

3 **Stopping:** Stopping is done by means of hot weak glue size so that pores on the surface are filled up alternately boiled instead of oil can be applied in two coats. The dry surface then be rubbed down with sand paper.

4 **Coat of varnish:** On the cleaned surface, two or more coats of varnish are applied. Next coat is applied only when the previous coat has dried up thoroughly.

Types of wood polish: Mainly two types of wood polish, these are include the surface polish and penetrating polish

Surface wood polish: This polish does not penetrate the interior of the wood. It leaves a strong hard, and thick layer on the floor of the wood. Therefore the hazardous or adverse agent together with moisture will not come in direct contact with the timber surface. This buffing layer may additionally consist of lacquer, wax, varnish, polyurethane, and shellac among others.

Penetrating timber finish: It is an oil based substance that penetrates inside the surface and composition of the wood. The penetrating wood polishes along with linseed oil or Tung oil amongst others. The application of those penetrating finishes is convenient and straight forward.

Popular wood polish types

1) water based wood polish (2) lacquer wood polish (3) polyurethane polish (4) varnish polish (5) shellac polish (6) penetrating or oil based wood polish (7) wax based wood polish

Uses of wood polish

Water based wood polish: This types of wood polish and finish can be used on distinctive types of wood surface. This polish can be used on timber items, handcrafts, and other articles .

Lacquer wood polish: This lacquer finishes are viewed as one of the exceptional types of wood polish, the polish deemed as on all rounder. The finish gives for higher floor protection and also dries up faster. Lacquer wooden end is also easy to remove and a new some different wood polish and can be applied to wood floor each time desired.

Polyurethane polish: This one is regarded to be ideal for kitchen cabinets, cup boards doors, home windows and nearly all sorts of furnishings and even flooring. It has water proof properties. The finish is also durable and positively influences the longevity of timber items. It covers the cracks on the wood surface while applying polyurethane polish on the timber. It is not recommended for outdoor furniture.

Varnish polish: It can be applied to each stained and naked wood, proper cleaning of the wooden surface is required before apply varnish wood polish finish can be utilized. When, applied to a wet surface, the varnish may be also additionally smash it. Hence warning is necessary

Shellac polish: The shellac polish end can dry without difficult and in much less time, and is hard finish. It

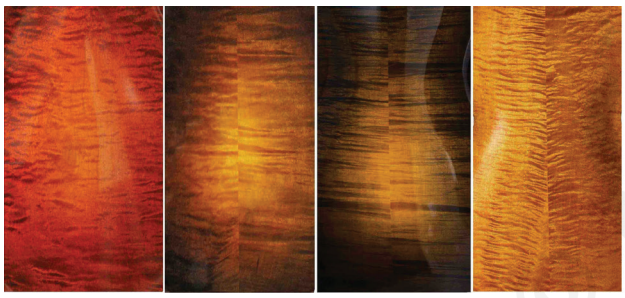
additionally acts as a stain remover and sealer and therefore, it is used on the dry wall and cured plaster French polish is one of the most popular wood polish and ending cloth uses, it is made of alcohol and shellac is more natural looking and it is a stain remover, sealer & safer, dry faster, easier to maintain

French polish: French polish, the most celebrated wood finish of victorian times is still popular today. The polish is made by dissolving shellac, a secretion of the lac insect, in industrial alcohol. It can be burnished to an almost glass–like texture that belies its vulnerability to scratching and its susceptibility to alcohol and water, which itch the surface leaving white stains. Despite these obvious disadvantages, French polish is such an attractive finish that many wood workers are prepared to put in hours of practice in order to master the technique.

French polishes

1 Unfinished mahogany
2 Mahogany finished with button shellac
3 Mahogany finished with garnet shellac
4 White shellac on unable

Fig 5



Types of shellac: 'Orange' and 'white' liquid shellac are widely available commercially, or you can make your own blends by dissolving dry shellac flakes in methylated alcohol. Once mixed, liquid shellac has a limited shelf life, after which it will not dry hard.

Blond shellac: This is the highest grade of shellac flakes, ranging from super – blond, the lightest in color, to various grades known as lemon

Button and garnet shellac: Button – lac was once shellac sold in the form sold in the form of disc or "buttons,"but these have not been available for years. Now the term is used to describe a less – refined grade or shellac flake that is darker in color than the blond and lemon varieties. Garnet is a rich red – brown in color.

Orange shellac: Commercial liquid shellac suited to most wood finishing purposes, with a longer shelf life than commercial white shellac It is usually sold in 3lb cut, or three. pounds of dry shellac mixed with one gallon of alcohol by the manufactures. This is a good rough guideline for mixing dry shellac as well.

White shellac: Bleached white shellac has a short shelf life in dry form. and is therefore always sold premixed its is suitable for use on marquetry or other low – wear applications especially over light – colored woods.

Dewaxed shellac: Natural shellac contains waxes that very slightly dull the appearance of the of the film but also make it more flexible. To achieve finishes of the highest gloss and hardness, manufactures remove the wax.

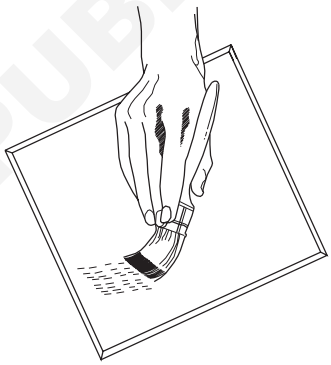
Colored shellacs: Shellacs can be tinted with alcohol – soluble dyes. A green color can be used to tone down raw – red mahogany - a red – brown will enrich dull – brown wood.

Brushing shellac: Traditional French polishing demands skill and practice before results consequently many wood workers prefers to brush slightly thinned shellac on to the wood then rub down between coats rather than apply the polish in the traditional manner.

The technique for brushing shellac is easy to master use a soft brush to an even coat, then after 15 to 20 minutes rub down lightly with self – lubricating silicon carbide paper and apply a second coat. Having applied a third coat in the same way rub it down with 0000 steel wool dipped in wax polish then after five minutes burnish with a soft cloth.

Applying brushing French polish: Use a soft brush to apply an even coat of shellac to the surface. (Fig 6)

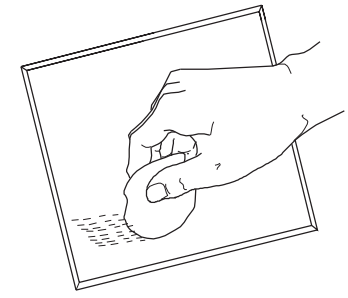
Fig 6



Rubbing brown with steel wool (Fig 7)

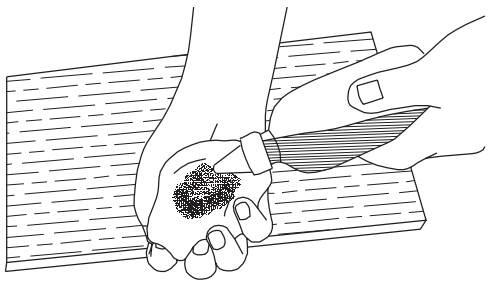
Rub the final coat lightly in the direction of the grain

Fig 7



Charging a rubber: Unfold the line square then holding the rubber in the palm of your shellac polish onto the pad until it is fully charged but not absolutely saturated. Fold the rubber again , as describe left, and press it against a scrap board to squeeze out the polish and distribute it evenly across the sole use your fingertip to apply a drop of linseed oil to sole to act as a lubricant. (Fig 8)

Fig 8



CHARGE THE RUBBER WITH SHELLAC

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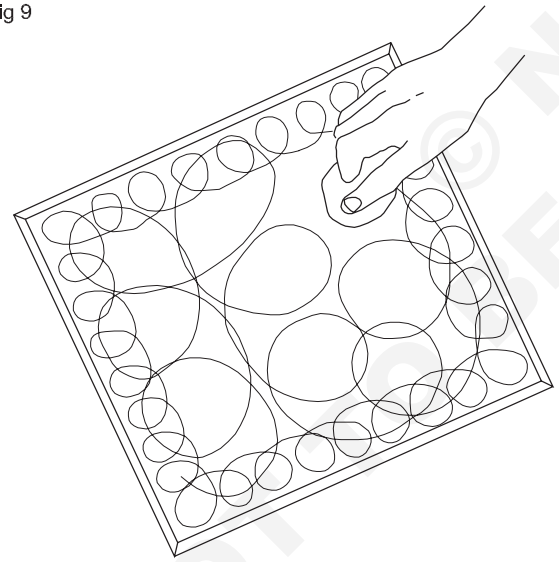
Applying the polish: To apply French polish to a flat surface, first make overlapping circular strokes with the rubber, gradually covering the whole panel with shellac (1). Then go even over the surface again, this time using figure – eight strokes (2) varying the stokes ensures an even coverage. Finish with straight overlapping stroke parallel to the grain. (3) Very little pressure is required with a freshly charged rubber. But gradually increases the pressure as the work proceeds. Always keep the rubber on the move, sweeping it on and off the surface at the beginning and end of each complete coverage if you stop with the rubber in contact with the work, it will stick and scar the polish, in which case you must, let it harden thoroughly before rubbing it down with very fine self – lubricating silicon – carbide paper. recharge your rubber starts to drag. (Figs 9)

Fig 9



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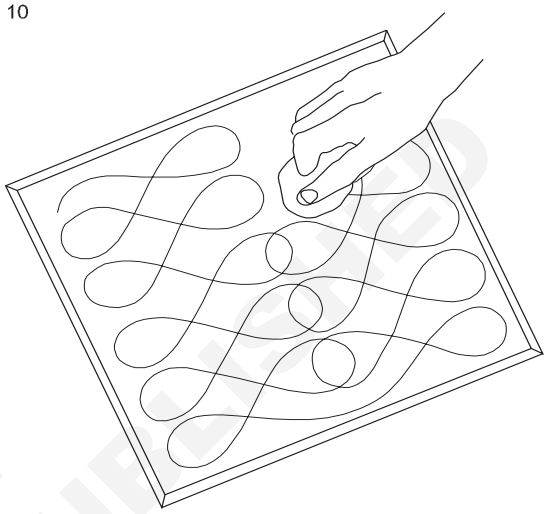
Assuming the first application is free from blemishes leave it dry for about half an hour, then repeat the process build up four or five coats in this way, then leave the shellac to harden overnight. Keep your rubber in a screw – top glass jar while you allow the polish to dry.

The next day, sand out any runs, dust particles or rubber maries with silicon – carbide paper before applying another four to five coats of polish. Judge for yourself when you have built up a protective body of polish with the required depth of color, but 10 to 20 coats will be sufficient.

Polishing moldings and carvings: Panel with large shallow moldings can be polished with a rubber, but use a soft brush to apply slightly thinned shellac to deep moldings or carvings. A squirrel – hair brush from a specialist supplier is ideal, but you can make do with an ordinary good- quality paintbrush, Apply the polish relative quickly and evenly but not too quickly or it will run when the shellac has hardened sprit off with a rubber as describe below, but only burnish lightly or you will remove too much polish from the high points. (Fig 10)

Fig 10



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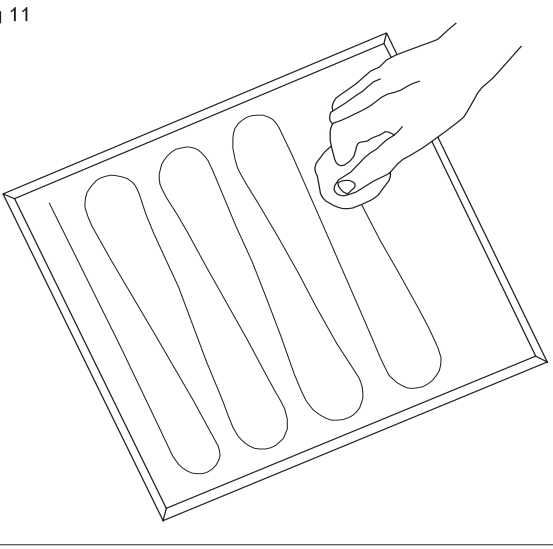
Spiriting – off: The linseed – oil lubricant leaves streaks in the surface of the polish, remove the streaks and burnish the polish to a gloss finish using a rubber practically empty of shellac but with a few drops of methylated alcohol on the sole. Apply rubber to the polished surface using straight parallel stokes only, gliding on all the panel at the beginning and end or each stroke, recharge with more methylated alcohol as soon as the rubber begins to drag. Leave the work for a couple of minutes to see if the streaking disappears. If it doesn't sprit off grain until you have achieved the required finish. After half an hour, burnish the surface with a dry, soft rag, then leave the work to harden completely. (Fig 11)

Fig 11



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Creating a stain finish: If you don't care for a high – gloss finish, matte the fully hardness surface by rubbing it lightly with a ball of 0000 steel wool dipped on soft wax polish. Use straight, parallel, overlapping strokes until the surfaces is dull evenly, then burnish to an attractive stain sheen with a soft cloth, adding a little more wax polish if necessary.

Penetrating or oil based wood polish: It is used for residing room and other home areas or timber handcrafts may require a luxurious and stain look and finish this polish also cover the nicks and scratches and may be applied easily. It is essential to shield the eyes while applying the oil based timber polish it is dry up slowly.

Wax based wood polish: It is available in both paste and liquid forms it gives furniture a silky feel, protects from moisture, protection from stains, suitable for all types of flooring. There are three types of wax used for wood works (1) liquid or cream wax (2) paste wax (3) wood turning wax stick

Wood -finishing oils: Oil is traditionally used to create naturally only woods such as teak and afromasia, which tend to reflect the majority of finishes. but it is equal suitable for hard and soft woods. it is not suitable as finish for interior of drawers and cupboards, where it could strain the contents. There are many types of oil used for wood finishing work. They are as follows (1) linseed oil, (2) Tung oil (3) Danish and teak oil (4) salad or bowl oil.

Linseed oil: Raw linseed oil is suitable for small objects only. it can take up to three days to dry by which time it mat be covered with fluff and dust boiled linseed oil is marginally better since it dries after 24 hours, but neither oil forms a hard, durable finish

Tung oil: Pure tung oil, also known as china wood oil, it is the most durable oil finish. It shrugs off water and is resistant to heat and alcohol. It takes 24 hours to dry, but careful rubbing down with very fine silicon-carbide paper between coats will produce a superb finish. Apply five or six coats in all.

Oil and wax polishes (Fig 12)

1 Danish oil on iroko (Fig 12A)
2 Clear wax on oak (Fig 12B)
3 Antique wax on oak (Fig 12C)

Fig 12

A B C

Danish and teak oils

Tung oil and other vegetable oil usually form the basis of a number of commercially prepared finish as known variously as Danish or teak oils. Driers are incorporated in these oils to shorten the time between application to about six hours. Heat, alcohol and water may temporarily leave white stains on the surface, but they disappear quickly. More permanent blemishes can be effaced with a wipe of fresh oil.

Salad – bowl oil: Most wood–finishing oils contain toxic materials however you can buy non–toxic 'salad–bowl oil' for wooden counter tops chopping blocks and other objects, such as bowls and spoons, that come into contact with food. or if you prefer, use olive oil, or other edible oils, instead.

Waxes: In the past, woodworkers made paste wax by dissolving a mixture of bees wax and hard carnauba wax in turpentine.These raw materials are still. These raw materials are still available,but there are so many excellent ready – made preparations on the market that most woodworkers do not find it necessary to make their own.

Wax makes for an attractive mellow finish that seems to improve with age It is produced in a range of colors, from practically transparent for pale woods to deep brown antique polishes that create the impression of an aged patina and will disguise scratches in a finished surface.

Silicones are added to some polishes to make them easier to buff, but if they penetrate the wood, they are difficult to remove and will repel practically any other finish should the work piece even have to be restored.

Liquid or cream waxes: Liquid or cream waxes are fluid enough to be brushed onto the wood. two or three application are required to build up a protective body of polish.

Paste wax: A paste wax, made to a slightly thicker consistency is ideal for application with a part of very fine steel wool or lint- free rag. on hardening, it can be buffed with a clean soft rag to an impressive luster.

Wood turning wax stick: A stick of wax, hard enough to be used as friction finish, is rubbed against a work piece spinning on a wood turning lathe.

Applying oil: Apply a generous coat of Danish or teak oil to a clean well –prepared surface with a cloth pad or paintbrush leave it to soak into the wood for a few minutes then wipe over the surface with a clean rag to absorb excess oil. six hours later, apply a second coat and leave it to dry overnight. the next day apply one more coat, and buff it to create a sheen.

It takes longer to finish a surface with pure tung oil. After the initial coating applied liberally with a brush and rubbed over as already describe , apply several thinner coasts to allow the oil to dry between applications, if dust particles adhere to the surface during the 24- hour drying period, rub it down lightly with very fine sandpaper in the direction of the grain.

Applying wax: Al through you can apply wax directly to bare wood it is an advantage to seal the surface first with a varnish of, for superior – quality work or oil-stained wood, with two coats of shellac sanding sealer or white French polish , sealing prevents the initial coat of wax from being absorbed too deeply into the grain , especially when you are using a liquid wax. it also prevents dirt from sinking through the wax and permeating the wood over a period of time.

Having flattened the sealer coats with very fine silicon carbide paper , if you are using a liquid wax apply the first liberal coat with a brush or use a soft cloth pad to rub it into the wood with circular strokes first and then straight ones in line with the grain . one hour later, buff up the wax and pad in the direction of the grain only. add a third coat if needed , similarly and buff it as before leave the wax to harden for several hours , then burnish the surface vigorously with as clean soft rag.

If you decide to use a past wax polish , apply it with a pad of 0000 steel wool , rubbing with the grain only and bring it to a shine with a soft cloth.

Paint classification and use

Objectives: At the end of this lesson you shall be able to
- **state the classification of paint and its uses**
- **state the paint pigment, binders, solvent , oil, dryers**
- **state the additives of paint**
- **state the method of painting and its importance.**

Paint: Paint is the general term for liquid that is used to add color to the surface of an objects by covering it with pigmented coating paint is defined as a unique homogeneous mixture of three major ingredients namely binder, pigment, VOC and additives when paint is applied on the any surface as a thin layer that forms a solid dry, adhesive film after oxidation evaporation / polymerization

Types of paint: There are many types of paint used in the field of painting, main type of paints are as follow.

1 **Oil paint:** This kind of paint is available in two finishes such as matt and glossy oil paint is one of the most popular choices and it is easy to apply and clean. It is used for painting on walls, doors, windows and metal objects as well.

2 **Enamel paint:** This kind of paint has lead or zinc to varnish. This is form of a hard and glossy coating and easy to clean. Its life form of is very long lasting, water proof and chemically resistant to offer good coverage and color retention it is used for interior and exterior of walls, wood doors, and flowing, windows, stairs, concrete, plaster, glass, metals but it is flow drying paint and require a titanium coating require before the application.

Emulsion paint: This type of paint used for binding materials such as poly vinyl acetate and polystyrene and contains driers like cobalt and manganese. It is available in different bases such as water or oil and their pigments are used to make different shades of emulsion paints. It dry fast hardened in nature and you clean the surfaces with water, you can use this paints for walls, ceilings and massionary works.

Cement paint: This is one kind of powder form paint. It is easy to mix with water to achieve nice paint consistency. Cement paint has white or colored cement as the base and also contains pigments, accelerators and other additions. It is water proof type and commonly used in rough applications.

Bituminous paint: It is made form dissolved asphalt or tar and available in black color. this paint is water proof and alkali resistant. This paint is used in under water ironworks, concrete foundations, wooden surfaces, and iron pipes to provide rust resistance.

Aluminum paint: It is made by mixing aluminum particles with oil varnish. This paint is corrosion resistant, electricity and water resistant also. Aluminum paint is used on metals and, gas tanks oil tanks, water pipes and radiators.

Anti corrosive paint: This type of paint is chemical resistant and made from linseed oil, zinc chrome, and fine sand. It is used for metallic surfaces and pipes to protect from corrosion and past protection.

Paint components: A liquid paint is an engineered product made of several different ingredients that mix to create a specific product with its own unique properties. The selection of components used to paint stability, application, characteristics handling, clean up, disposal, and importantly, the performance of the paint on which it is applied. Paint formulas include the following 1) binder (resin) 2) pigments, (3) solvents 4) additives.

Binders (Resin): The binder is the film forming components that identifies the paint different of resin and polymers are used in paints. Paint binders may be referred as convertible and nonconvertible types, convertible binders include oils, oleoresinous varnishes, alkyds, amino resins, epoxy resins phenolic resins, polyurethane resins and thermosetting acrylics,

Nonconvertible resins such as cellulose nitrocellulose, chlorinated rubber, and vinyl resins will not be covered in the text because they are usually used in low solid high solvents content coatings.

Oil and oleoresinous varnishes: Oils were commonly used in paint formulation but have declined as improved polymers were developed that could be used for a broader variety of coatings, with expection of limited use of refined linseed oil and linseed stand oil certain type of primers for steel timbers, oils are rarely used as the binder in an industrial paint. Oil modified alkyd resin, one of the most widely used binders in modern technology for example linseed oil and tung oil are referred to as drying oils, because they will readily dry when they exposed to oxygen. Another group of oils that includes soybean oil is called semidrying oils, because they do not dry quickly the drying process is a complex oxidation reaction involving the centers of instauration in the carbon chains of the fatty acid triglycerides of the drying oil. The reaction is referred to as oxidative polymerization or auto – oxidation. Its rate of reaction is slow and so it is usually accelerated by the addition of driers such as cobalt or lead naphthenates.

Alkyd resins: Alkyd resins are modified with a number of oils including soya, linseed, dehydrated castor and

coconut. Alkyd can be prepared directly from oil, a polyol, or an acid drying and semidrying alkyds cure by auto oxidation so they are good resins to use in formulation of air dry coatings non dryings oil alkyds, particularly the short oil resins require expose to heat for curing.

Polyester resins: Polyester resins are typically used in heat cured coatings that need to be high in paint solids and low in solvents content. They have extremely good color retention that provides good oven- bake protection and very good UV resistance and they can be applied using a wide range of spray equipment.

Acrylic resins: Acrylic resins provided toughness, good weathering ability, and resistance to abrasion and chemical attack acrylic lacquers are used for both ferrous and nonferrous substrates lacquer are solution of resin in organic solvents that harden as the results of the evaporation of the solvent this can be forced with heat.

Acrylic polymers: Acrylic polymers are used for decorative and protective functions for decorative applications they provide high gloss, good pigment binding characteristics and clarity. For protective applications, they provide good adhesive, hardness and durability.

Amino resins: It is generally used in baked coating as cross linking agents. they are used in proportion upto 50% of the total vechicle binder. They can be used with alkyds, polyestery epoxies, thermosetting acrylics, phenlice and other heat reactive resins.

Epoxy resins: Epoxy resins is a excellent corrosion and chemical resistance it is used as primer for exterior applications the epoxy resin is usually cross linked with melamine or urea resin at curing temperature of 250°-425°F. Epoxy coatings are characterized by excellent adhesives a high degree of impact and abrasive resistance and resistance to chemicals and solvents. Epoxy resins can also be used in epoxy acrylic thermosetting systems to provide a combination of film hardness, mar resistance, gloss and color retention, and chemical resistance.

Urethane resins: Urethane resins are very popular, with formulations providing a combination of chemical resistance, toughness and abrasive resistance, and exterior durability effective application on plastic has led to substantial growth in urethane technology. The properties of the various resins are compared in following table.

Resins Properties

Exterior durability	Alkyd	Alkyd amino	Backing polyester	Modified (styrenated) Alkyd	Acrylic	Cellulose (Lacquer)	Catalyzed epoxy	Urethane
Salt spray	E	E	E	G	E	E	G	E
Alkali	E	G	G	G	E	E	E	E
Resistance	P	F	G	G	G	P	E	F
Solvent aliphatic	G	E	E	F	F	F	E	E
Solvent ketone	P	P	G	P	P	P	G	E
Flexibility	E	G	E	G	E	E	F	E
Impact	G	E	E	G	E	E	G	E
Heat resistance	G	G	E	G	G	P	G	G
Color retention	G	G	E	G	E	E	F	E
Gloss retention	E	G	E	F	E	G	P	E
E= Excellent G= Good F=Fair P=Poor								

Pigments: Pigments are particulate solids that are dispersed in paints to provide certain characteristics to them including color, opacity, durability, mechanical strength, and corrosion protection for substrates pigments may be organic and inorganic materials. Organic pigments are used primarily for decorative purpose. While inorganic materials have traditionally been added for protective properties. Extenders are used in conjunction with pigments to modify the properties of the paint. Pigments particle size also effect the finished gloss, setting of the pigment during storage and wetting by the binder. When the paint is mixed, the pigment are incorporated mechanically in a mill. The pigment has to be able to withstand the milling process.

A wide variety of coloring agents can be used to provide a considerable range of colors and shades. The number of pigments used and the amount of each is related to color hiding and many other film properties. Some common pigments are given below.

White pigments: All paint formulas include some white pigments to adjust the lightness, darkness of the final color some of common white pigment as follows (a) titanium dioxide (b) zinc oxide (c) antimony oxide (d) white lead

a **Titanium dioxide:** It is wide used nontoxic, stable synthetic pigments used for both protective and decorative paints it comes in two different crystalline forms, rutile and anatase .The rutile crystalline form is more compact and has a higher specific gravity, greater refractive index enhanced stability and enhanced durability. Rutile titanium dioxide is photo chemically insert and the pigment protects paint films degradation by scattering absorbed light. The anatase grade is used mainly for interior applications due to it is a cleaner white color.

b **Zinc oxide:** A synthetic based pigments that will inhibit mold growth, if present in high levels. The basic nature of zinc oxide leads to interaction with paints of high acid value with the formulation of zinc soaps. These can mechanically reinforce the film, but can cause embrittlement on exterior exposure.

c **Antimony oxide:** A synthetic based inert pigment often used with chlorine containing binders in the formulation of fire retardant paints, when exposed to flames, the antimony choloride vapor, that is released is heavier than air and acts as a blanket to the fire. This pigment also has good opacifying characteristics.

d **white lead:** White lead will react with acidic paints to form lead soaps, which will enhance film elasticity usefill for timber primes, however the pigment has a high chalking rate and a tendency to darken in polluted atmospheres due to the formation of lead sulfide.

Yellow pigments: Yellow pigments are used to adjust the yellow – blue axis of the color spectrum. there are two types of yellow pigment (a) yellow dyes (b) benzidine yellows (c) lead chromates (d) zinc chromates (e) yellow iron oxides (f) cadmium yellow

a **Yellow dyes:** Yellow dyes are soluble inketones, esters and aromatic solvents, but they have poor solubility in aliphatic solvents. This makes them suitable for use in air dry coatings that contain aliphatic hydrocarbons or in emulsion systems. this provides good opacity and are nontoxic, so they are often used instead of lead chromates.

b **Benzidine yellow:** It have good opacity and are insduble in most solvents used in paint formulation. They can withstand temperature upto 300°F. It is restricted to interior applications.

c **Lead chromates:** A wide of synthetic pigments, ranging from pale yellow to deep orange in colour. Have been used in paint formulation. Lead chromes have high tint strengths good light fastness and opacity. But they also darken in polluted air and they will black in the presence of sulfur dioxide. Lead chromates interact with alkaline substrates resulting in colour loss. Never used this for undercoats and finishing systems.

d **Zinc chromate:** Three forms of zinc chromate are used for pigmentation of paints. The pigment grades have good light fastness and are stable in polluted air, but they are of low opacity. The zinc chromates are slightly basic and will react with acid paints, leading to a thickening of the paint during storage. The form of zinc chrome used for corrosion – protection must be free from residual chloride, which is usually present in pigment grades. A third form of zinc chromate, the tetroxichromate, is used in metal pretreatment primers.

e **Yellow iron oxides:** Yellow iron oxides, ranging in color from dull yellow to dark yellow – brown, but more restricted in the range of color shades than synthetically prepared oxides. Natural oxides have cleaner and greater purity. Both natural and synthetic oxides are resistant to alkalis and organic acids, but they can be discolored by mineral acids. Shade variations can occur at elevated temperatures. Iron oxides will absorb UV radiation and have a protective effect in exterior paints.

f **Cadmium yellow:** Synthetic pigments varying in color from primrose to orange, the shade being determined by manufacturing process conditions. They are stable at high temperature. It may be used on a variety of substance, especially where alkali resistance or temperature resistance is required. Cadmium likes chrome and lead, was a staple in the formulation of paint. Especially performance coating for many years.

Green pigments: Green pigments are used to adjust the blue – yellow axis of the color. It has following types (a) phthalo green (b) chromium oxide (c) lead chrome green.

a **Phthalo green:** It is not purely organic in nature. phthalocyanine green pigment has a blue – green color with good opacity in paints. It has good

resistance to solvents, heat, and alkalis, but it can be decomposed by acids. It is widely used in decorative finishes.

b **Chromium oxide:** Chromium oxide is a dull green, synthetic pigment with good stability to light heat, acids, and alkalinity, but it provides poor opacity. Chrome oxide is also used as a pigment for concrete and cement.

c **Lead chrome greens:** Synthetic pigments ranging from grass green to deep green in color, the shade being controlled by the prussian blue admixed with the lead chrome yellow. They have good opacity, but they tend discolor in polluted air. They also tend to float in paint formulations, owing to toxicity, these products are not often used today.

Blue pigments: Blue pigments are used to adjust the blue – yellow axis of the color. They are as following types (a) phthalocyanine blues, (b) Prussian blue (c) ultramarine blue

a **Phthalocyanine blue:** It is vary in color from reddish – blue to yellowish – green; this is to have high tint strength and high opacity along with very good light fastness. It is a nontoxic temperature stable, and resistant to most solvents and chemicals expect strong acids. These pigments are used in a great many paint and finishes.

b **Prussian blue:** This is a bright blue synthetic pigment having high staining power but low opacity. It is lightfast and acid resistant, but it can decompose to iron oxide by exposure to alkalinity and elevated temperature.

c **Ultramarine blue:** A complex synthetic alumino silicate pigment, it occurs naturally as the semiprecious stone lapislazuli. The pigment has coarse texture and is subjects to hard settling but it has good light fastness, heat resistance, and alkali resistance, it will decompose in an acid.

Red pigments: Red pigments are used to adjust the red – green axis of the color. It has three types as a toluidine reds , arylamide reds red iron oxide

Toluidine reds: It is characterized by bright, clean colors, good lightfastness, and high opacities although the color stability is reduced when they are mixed with white pigments. Toluidine reds have good color stability, are resistant to acids and alkalis, and heat up to 350°F for short periods. They are soluble in aromatic solvents and slightly soluble and alcohols.

Arylamide reds: This is ranging in color from orange to red they have good lighfastness even if reduced with pigments and they are temperature stable up to 300° F. Arylamide reds are slightly soluble in solvents.They are resistant to acids and alkalis and are used in many decorative exterior applications.

Red iron oxide: Red iron oxide is mined as hematite ore, and synthetic red iron oxides are used as pigments. The presence of impurities together with the variation in the iron oxide content provides pigments with colors ranging from orange – red to deep brown. The natural oxides are used in timber stains and low- cost metal primers.

Synthetic oxides have soften texture and greater purity, giving brighter, cleaner, and greater tinting strength. It has absorb UV radiation and increase the resistance of paint films to fading.

Black pigments: Black pigments are present in many paint formulas to adjust the lightness – darkness of the coating.

Black iron oxide: A synthetic pigment of low tinting strength, mainly used as a colorant for fillers, primers, and undercoats. The pigment is reddened by heat, but otherwise the oxide has good chemical resistance.

Carbon blacks: Pigments that are produced by the carbonization of hydrocarbon minerals, plants, and animals. Carbon blacks are lightfast, insoluble in acids and alkalis, and are resistant to solvents. They provides good opacity, even at low addition levels.

Metallic pigments: Metallic pigments are very popular for paints that will be used on products such as automobiles, motorcycles, metal office furniture, and other products that require exceptional appearance characteristics. While aluminum is the most commonly used metallic pigments, stainless steel, lead, and zinc have also been used in paint formulation.

Aluminum pigments: A pure metal that is rendered resistant to many aggressive agents by the presence of a surface film of alumina. It is available in two powdered forms, leafing and non leafing grades.

Particles of the leafing grades which are used coated with stearic acid or a similar surface – active agents, tend to float toward the surface of a paint film and become oriented parallel to the plane of the film. The close packed of aluminum platelets provides the film with a reasonably efficient moisture barrier and functions as a protective pigment. Normally, low levels of aluminum are used, often with no other pigments. The aluminum may also prevent corrosion by being a sacrificial anode when the surface of the coating has been damaged.

The nonleafing grades does not migrate to the surface of the coating but is more randomly distributed throughout the film, again, low levels of the nonleafing aluminum are used and the pigment s main function is to provide a sparkle effect to the film.

Mica: Mica naturally occurring potassium alumino – silicate used in the form of fine platelets the lamellar structure of mica results in a leafing effect like that in leafing – grades aluminum that reduces water permeability in the paint film. The incorporation of mica improves weathering resistance in paint by reducing the tendency to fail by cracking and checking. These properties permits mica to be used in exterior decorative coatings.

Solvents: A solvent is a pure or mixed liquid that is used to make the paint flowable prior to its applications. In practice, the term solvents, solvents blend, a thinner are often used interchangeably. solvents are chemical substances that can dissolve, suspend, or extract other materials, usually without chemically changing either the solvents or the other materials.solvents make if possible to process, apply, clean, or sepatate materials.

Some important terms relating to solvents are as follows:

- **True solvents** – A liquid that can dissolve the binder.
- **Diluent** – A liquid that cannot dissolve the binder by itself but can be added to a solution to increase its capacity for the binder.
- **Latent solvent** – A liquid that cannot dissolve the binder by itself but increases the binder s tolerance for a diluents.
- **Thinner** – Any pure or mixed liquid added to a paint to reduce its viscosity (make it more flowable)
- **Front** – End solvent – A fast evaporating solvents that leaves the paint very soon after application, usually before the part reaches the oven.
- **Exempt solvent** – Solvents that do not react with sunlight to form smog and whose use is not considered exempt as well acetone and methyl acetate, review of the status of solvents in ongoing.
- **Middle solvents** – A medium evaporating rate solvents that leaves the paint primarily during flash – off and oven warm – up
- **Tail – end solvents** – A slow evaporating solvent added to paint primarily during the baking cycle.
- **Retarder** – A slow evaporation solvent added to paint to prolong the drying time. Typically used to reduce orange peel or blushing.
- **Solvent blend** – The particular mixture of liquids that gives paint the desired flow or evaporation properties. Skillful solvents' blending allows a paint shop to adjust purchased paint for local variation in temperature, humidity, line speed, application equipment, and so forth. The selection of a solvent system is often a complex task, best handled by the paint vendor. Important considerations in blending solvents are solvency, viscosity, evaporation rate, safety, and cost.
- **Solvency** – The ability of the solvents to dissolve the binder. the solvent must be able to keep the binder in solution..
- **Evaporation rate** – The solvent must evaporate within the time allowed by the curing schedule. Available oven length and temperature, as well as production volume is important. if the solvents is a mixture of two or more liquids , their individual evaporation rates become very important , for example, if the solvent remaining on the work piece should become excessively rich in diluents , the binder might come out of the solution as small sticky lumps , rather than the smoother even film that is desired.
- **Viscosity** – The fluidity or flow – ability of the paint viscosity is adjusted to provide good atomization and flow – out

The proper solvents for a given task will depend on the required properties of the formula and other considerations such as safety and cost.

Safety issues affect the solvents chosen for formulation. for example, naphtha like hydrocarbons are very flammable and chlorinated hydrocarbons are very toxic, so they must be used with extreme care.

Solvents are volatile liquids added to paints to dissolve the binder (the resin components) and / or to modify the paint viscosity. the paint viscosity must be compatible with the storage and application methods.

The solvents must have an evaporation rate that works well in the application environmental ideally, the solvent should also be nontoxic, of low cost, and have an acceptable odor.

The particular solvents that may work in a given formula will depend on their solubility characteristics. there are three classes of solubility: strongly hydrogen bonded, moderately hydrogen bonded, and weakly hydrogen bonded.

Resins used as paint binders have a range of parameter values that affect solvent selection. the solvent and the binder must be compatible. epoxy resins, which have a range of 8-13, are soluble in ketones, ethers, and esters but insoluble in hydrocarbons and alcohols because the values are zero.

Usually, when selecting solvents for a particular resin, the solubility parameters of the solvents have to lie within the range of the resin. other selection criteria include cost, paint viscosity, and drying time. a blend of diluents with the primary solvents will usually create a mixture with a mean that is within the mid – 80% of the resin solubility range.

The evaporation rate of solvents is partially important for nonconvertible coatings. slow – evaporating solvents may cause long drying times and creates problems in batch coatings operations or excessive flow and sag of the wet film. High evaporation rates may cause problems with flow and film intergrity. Selection is affected by the method of application. Typically, slower evaporation rates are required for brush applied coatings while faster rates are used for spray methods. Some properties of some common solvents are given in table.

Table

Properties of some solvents

Solvent	Specific gravity	Boling point(C°)	Evaporation rate	Flash point (C°)
Acetone	O.79	56	944	-18
Butyl acetate	0.88	125	100	23
Butyl alcohol	0.881	118	36	35
Ethyl acetate	0.90	77	480	-4.4
Ethyl alcohol	0.79	79	253	12
Ethylene glycol monoethylether (2 ethoxyethanol)	0.93	135	24	49
Methyl ethyl ketone	0.81	80	572	-7
Methyl isobutyl ketone	0.83	116	164	13
Toluene	0.87	111	214	4.4
Mineral sprits	0.80	150-200	-18	38(min)
Xylene	0.87	138-144	73	17-25

1 Hydrocarbon Solvents

Aliphatic and aromatic hydrocarbons are commonly used to formulate and reduce a paint material. They are complex mixture of different compounds with different flash points, density, and other properties.

a Toluene: Toluence is an aromatic hydrocarbon used in solvent blends for air-drying vinyl and chlorinated rubber coatings as well as diluent in nitrocellulose paints.

b Mineral spirits: Mineral spirits are largely aliphatic (but containing 15 – 18% aromatics) blend of paraffin of variable composition. They are slow evaporating and dissolve most natural resins, oleresinous varnishes, and medium and long oil alkyd resins. Mineral spirit is commonly used as the main solvent for brush applied decorative and protective paints based on these binders. it is also used as a cleaning and degreasing solvent.

c Xylene: Xylene is an aromatic hydrocarbon widely used as a solvent for short- oil alkyd, chlorinated rubber, and polyurethane resins. The good solvating power and moderate evaporation rate permit xylene to be used for sag- resistant spray – applied coatings as well as for backing – cured coatings.

2 Oxygenated solvents

Oxygenated solvents include alcohols , glycol ethers, ketones, esters, and glycol ether esters that are synthesized from other chemicals to form a desired solvent that is typically 99 % pure.

a Butyl alcohol: Butyl alcohol is usually solvents for a wide variety of oils and resins, particularly amino and acrylic resins and also, in solvent combinations for nitrocellulose regins.

b Ethyl alcohol: Ethyl alcohol is usually admixed with methyl alcohol, dyes, and toxins in the form of industrial alcohol (methylated spirits) ethyl alcohol, a fast evaporating solvents, is used for poly (vinyl butyryl) as well as with other solvents nitrocellulose.

c Ethylene glycol monoethyl: Glycolether Ethyl alcohol is a slow- evaporating solvent for many resins, which is often added to brush applied formulations that cannot incorporate aliphatic hydrocarbons such as white spirit. The high boiling ethers are widely used as coalescing aids (solvents) in emulsion paints.

d Acetone: Acetone is a fast evaporating powerful solvents used for vinyl copolymers and nitrocellulose. It is also blended (at low addition levels) with many other solvents, when its high solvating power and evaporation rate modify the properties of the liquid paint and the film.

3 Methyl ethyl kentone (MEK): MEK is a powerful solvent with a fast evaporation rate. Widely used for vinyl copolymers, epoxy, and polyurethane systems. it is often blended with less powerful solvents to modify the film- forming properties and application characteristics of coatings.

4 Methyl isobutyl ketone: Methyl isobutyl ketone is a fast – evaporating powerful solvents used in similar applications as MEK but where a somewhat slower evaporation rate is require. it is also used at low addition levels in solvents blends where its fast evaporation rate and high solvents power will benefit the properties of the liquid paint film forming characteristics.

5 **Butyl acetate:** Butyl acetate is a easter solvents with moderately fast evaporation rate, of general applicability. formerly butyl acetate was the major solvents for nitrocellulose coatings , it is now used for a wide variety of synethetic resins but it is less powerful than the ketone solvents.

6 **Ethyl acetate:** Ethyl acetate is another ester solvents with rapid evaporation rate. the major applications of ethyl acetate was formerly in nitrocellulose coatings, but it now has a somewhat wider application .it has a lower solvating power than the ketone solvents.

Additives: Additives are chemicals added to paint , usually in small quantities, to achieve special effects. Although additives have been used in paints for centuries, it is not always understood how they operate. Typical paint may be classified by their effect on the properties of liquid or dry paint.

Additives can affect the paint materials characteristics and the finished film properties. Example of properties that can be adjusted with paint additives include viscosity, foaming, skinning, pigment dispersion, stability, flexibility/ hardness, gloss, UV resistance, fire resistance, bacteria resistance, and many more.

Paint driers: Driers are various compounds added to paints and coatings intended to decrease the drying time of the paint or coating. Driers help corrosive paints improve their drying characteristics even at low temperatures, an in humid environments. Driers improve a coatings dryings capability and other properties to some extent

A paint is mixture of three major ingredient known as, binders, pigments and volatile organic compounds and additives, when paint is applied on any surface forms a thin solid coat layer after oxidation or evaporation

Advantages of using driers are

- The driers are completely soluble in the paint or coating at room temperature.
- They are added in very small quantities
- They are added shortly before use
- Only on drier should be used at a time considering the purpose of the application

Some common paint driers are iron octoate, calcium octoate, cobalt octoate, zinc, octoate, barium octoate and lead octoate.

For example

Cobalt octoate is used as a drier in oil based paints, lead octoate drier is used in anti- corrosion coatings, varnish, dispersion agents for pigments and a grinding aid for coatings.

Oil used in paints: Linseed oil is most commonly used, but poppy, sunflower, safflower soyabean and walnut oils can also been used. The advantage of slow drying quality of oil paint is that an artist can develop a painting gradually making changes or correction if necessary.

Importance of painting

- Painting increase cultural appreciation
- Paintings help people learn history
- Paintings boosts creativity
- Painting can improve your focus
- Painting can improve problem solving skills
- Paintings helps communicate emotions
- Painting improve self estimate
- Looking at painting increases blood flow to the brain
- Painting can improve mental health
- Painting can improve older years memories

Painting: Painting is the practice of applying paint, pigments, color or other medium to a solid surface. The medium is commonly applied to the base with a brush , but other implements, such as knives, sponges, and airbrushes can be used in art, the term painting describes both the act and the result of the action.

Method of wooden surfaces painting

Objectives: At the end of this lesson you shall be able to
- **prepare the wooden surface for painting**
- **prepare the paint and painting the wooden surface.**

Wooden surface preparation (Figs 1, 2, 3 & 4): There are three types of method used to prepare the surface of the wood as a final stop before finishing (wide belt sanding, 2) random orbit sanding 3) brush sanding. wide belt sanding to 220 – 240 grit sandpaper works well for flat panel work and where a liner scratch pattern with the grain of wood is acceptable.

Random orbit sanding is used as a final stop to remove minor defects and provides a scratch pattern that is invisible after finish is applied. Brush sander is used to strips of abrasive and are backed by different types of brush media to force the abrasive strips into corners and recessed profiles of the substrate brush sanding has become one of the most viable technologies to become lean and improves profitability in finishing the benefits of finish quality cannot be over when using right brush sanding procedure. The uniformity of stain colors, depth of finish and the clarity of the finish will dramatically improve the visual perception of the products.

Before painting new wood sand all surface and edges lightly to smooth the grain. Then remove the sanding dust and apply a suitable primer prepare previously painted wood, strip off cracking, flaking or chipping paint, sand the surface with, 180 grit sandpaper , remove the dust , and wipe with damp sponge . another thing you should do is to look for soft, crumbly wood, which could indicate the presence of dry or wet rot, typically occurring in hot damp climates. While small areas of rotten wood can be scrapped off, cleaned out and treated with fungicides, badly damaged sections should be replaced with new wood. Each type of wood preservative has different uses and risks.

Fig 1

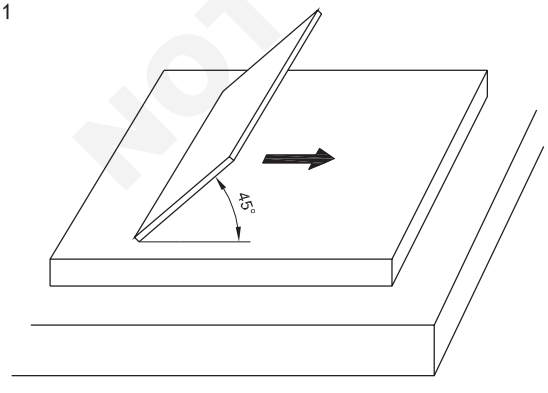


Fig 2

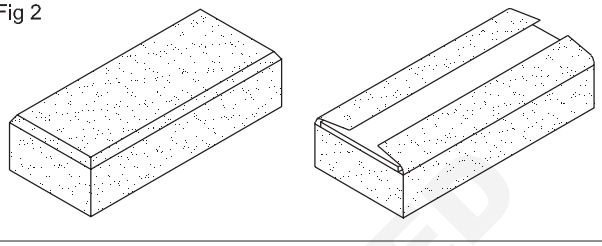


Fig 3

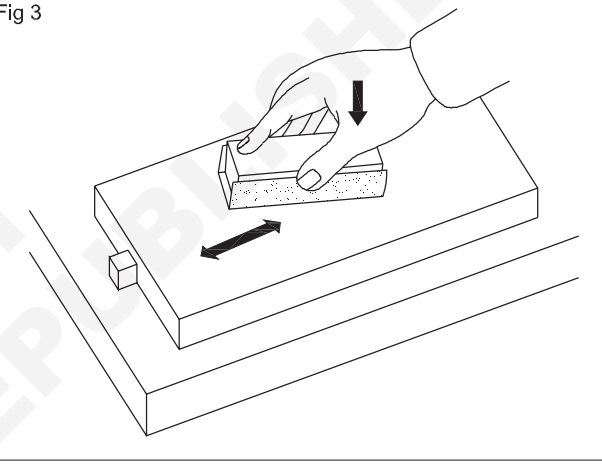
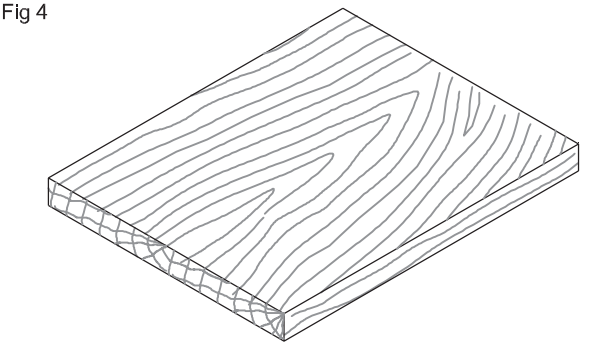


Fig 4

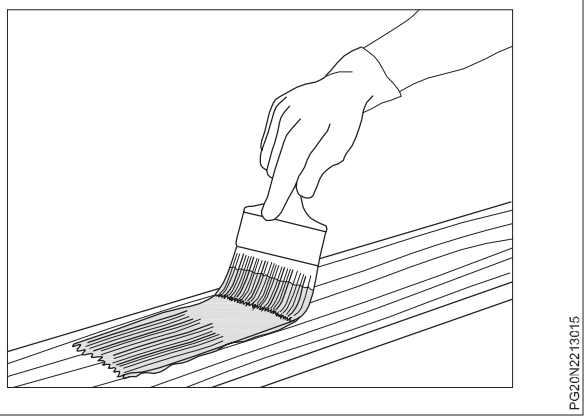


Patching holes, dents and cracks: Variety of wood repainting products, ranging from oil based fillers and epoxies to colored wood patch materials and paint table latest caulks when choosing wood repair compounded consider, whether it is designed for interior or exterior wood repair if you intended to exterior wood repair. If you intended to apply a stain or varnish make sure that you choose a filler that would not be visible through final finish and also fill the gaps between wood works and walls and sand all repair areas for a smoother appearance.

Priming: Choosing the right primer and applying it correctly will ensure a uniform, smooth long lasting paint job. The right primer can prevent flashing and

block the strains that may seep through the top coat. when priming follow the manufactures recommended mixing and application techniques, drying times etc. to get smooth surface , resand it lightly before applying paint. (Fig 5)

Fig 5



Painting the wooden surface: Before paint the wooden surface sanding and clean the primed surface with clean cloth. Ensure the wooden surfaces is ready for the paint. select the paint which is to be painted on the wooden surfaces mixing the paint with ingredient whether the paint is resin based or thixotropic based. If the paint is water based, use the brush to apply paint on the wooden surface or if the paint is thixotropic, use the paint spray gun to apply paint on the wooden surface. or if the paint on the wooden surface. The final top coat paint provides a wipe clean surface of the required color and texture. Opaque paints are intended for finishing cheep hard wood and texture as well as soft wood. and manmade boards water based paints will raise the grain if used to finish wood.

Method of applying paint: Solvent based paints are applied like varnish, brushing then out to provide an even cover on the wooden surface, then laying off with parallel strokes of the brush. However there is no need to brushing out on thixotropic based paints instead, apply a fairly liberal coat of paint brushing with virtually parallel strokes only and leave the brush marks to flow out naturally.

Allow enough time for each coat of paint to dry according to the manufactures instructions, then rub down with fine silicon carbide paper and wipe the surface clean with a rag. leave the final top coat to dry overnight in a dust free environment.

Fig 6

Unfinished Wood | Primer | Undercoat | Top Coat

Types of building paint materials and their uses

Objectives: At the end of this lesson you shall be able to
- **state the different type of building paint materials**
- **state the process of lime and distemper mixing and preparation**
- **state the different wall painting tools and equipments.**

Building paint materials: Different types of building paint material are used for decorate the building interior and exterior walls. They are as follow 1) Wall primer, (water base/ oil base), 2) Wall care putty, 3) Paints (lime and distemper, water based paint and oil based paint), 4) Paint strainer, 5) Putty blender etc.

Paint: Paint is a liquid or powder that is used to a add colour to the any surface of an object by covering it with a pigmented coating. There are three type of paints are used for wall painting. 1) Water colour (lime and distemper), 2) Acrylics, 3) Oil paint. Paints are four basic sheens flat, satin, semi gloss, medium gloss, high gloss.

Paint is made of pigments, binders, solvents and additives. Pigments provide colour and hide, while binders work to bind the pigments together and create the paint film. Paint provide a protective coating that will preserve the interior or exterior surface of building wall. It enables such area to with stand wear and tear while protecting walls from damaging effects of extreme weather condition improving building wall by applying paint will slow down the process of wear and tear.

Wall putty: Wall putty is a fine powder made of white cement, which is mixed with water and other additives to create a solution that is applied to the wall. If you apply the solution properly it fills the cracks imperfections and gaps in the wall to create an even base for your paint.

Wall putty can be used on plastered walls, concreate brick works and asbestos. Wall putty colour also white. It is derived from the white cement, which allows is to apply any paint combination on the wall.

Types of wall putty: There are two types of wall putty. Acrylic putty and powder base putty. Powder based wall putty consists of white cement mixed with polymers and minerals. As it is white cement based, it can be used on interior walls and exterior walls for its powerful binding capabilities Acrylic wall putty is a putty with smooth paste like consistency and based on acrylics. It is used for interior wall surface preparation.

Acrylic wall putty: It is available only in white shade. Acrylic putty smoothens and levels the bare walls by covering their cracks and dents and cavities if the acrylic wall care putty is used then a primer coat is recommended before and after application of the putty in case of cement based putty or polymer putty is a coat of primer helps in binding the putty to the wall.

Preparation of wall putty: Select the wall putty and pour it in a bucket, add water with putty powder as per manufacturers instruction mix 2 parts of water and 1 part of putty and stir it until it's smooth. If you use small holes and cracks use putty knife to apply putty on the wall surface.

Sanding the putty: After putty applied let it allow to dry approximately 3-4 hours. Sanding after putty dry, it helps to level the surface.

Wall primer: A wall primer liquid provides a smooth and even surface for the paint layer to go on the top. Wall primer helps the paint adhere to the wall better and improves the durability and longevity of the paint coat. Apply primer after sanding the putter. This is not mandatory for repainting of existing colour. This is mostly applicable for fresh painting or colour change.

Water paints: Water based paints (latex paints) consist of a pigment and binder with water used as a carrier. They are the most common and environmentally responsible paint option. They provide great colour retention over time, dry faster than alternatives and produce fewer odors. Once it is dry the paint is permanent durable and weather proof and will not be washed off.

Oil based paint: Oil based paints contain either natural oils, like linseed oil, or a synthetic alkyd. They consist of a pigment and a resin in a solvent thinner. When thinner evaporates, the resin forms a hard coating. Oil based paints are extremely durable and can with stand routine contact, making them ideal for moldings and trims. The oil based paints creates hard coating that is not breathable this option resist strains and rust over time. Oil based paint have stronger odor than water based paints and take more time to dry. They are also harder to clean too use the paint thinner, mineral sprits and turpentine to mixing with oil paints to bring standard paint viscosity.

Preparation process of lime: The easiest way to make a lime wash is to simply start by mixing equal amounts of lime putty (powder) and water eg 10 liters of water with 10 liters of lime putty you can then add more water until you reach suitable consistency to achieve a thin paint consistency like single cream. If you want to add colour to the lime wash, use the natural powdered pigments mix the pigments with a small amount of warm water to creak a smooth pasts, ensuring that all of the pigments is wet and then add the coloured pasts to lime wash to 1 part pigments paste is recommended. Coloured

lime wash will be dark on application and will finish is not lighter. It is important to continually stir the lime wash during application, as the lime particles will have tendency to quickly settle to the bottom of the container. Use a good paintbrush to apply the lime wash as using paint roller can create rough uneven surface. Paint with lime wash when the weather is not too dry or too wet. Too dry will getting dust with lime wash mix and to wet is no good, however you do want a little dampness on the wall before painting so use a hand spray to spritz the wall as customer choice.

For lime wash to stick it relies on suction between itself and the walls surface.

Distemper paint preparation process

- Mix the whiting and water, set aside
- Follow the directions on the pack to prepare glue
- Mix and well shack the whiting and mix the glue with whiting
- Select the colour and colour with tint
- Filter through fine muslin
- Apply distemper to wall or celling with suitable brush
- Stand back and admire

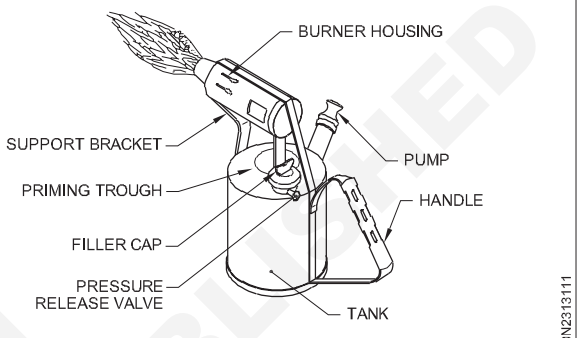
The process of painting walls with distemper paint is easier and quicker as applied directly to cemented walls without the need of primer.

Painting tools and equipments: Different types of painting tools are used for wall painting it is used for adequate paint preparation and careful work. Painting tools and equipments will help with necessary wall repairs. The following tools are used for wall painting and repair works.

- Wall cleaner
- Painters tape
- Brushes
- Rollers
- Cloth drop cloths
- Paint brush cleaner
- Plastic bucket
- Roller trays
- Roller extension pot
- Sturdy ladder
- Touch up tools
- Premixed spackling
- Putty knife and tapping knife
- Fiber mesh tape
- Flexible sanding sponge
- Paint key
- Tube to cover a wet roller
- Tray liners
- Paint pads
- Paint handle

Blow lamp: Blow lamp is pumped the kerosene to pressurized pass through pre heated tubes, thus becoming vaporized the kerosene vapour continues through a nozzle, that producing a forceful flame. The flame with in the housing provides the heat to maintain vaporization of the kerosene. The free flame at the nozzle outlet is used to heat the painted wall to burn and remove the old paint from the wall. Blow lamp is a portable heating appliance used as a direct source of heat for wall paint burn or remove. (Fig 1)

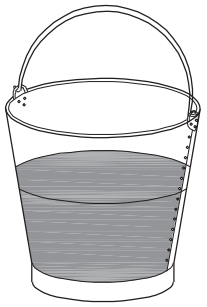
Fig 1



BLOW LAMP

Plastic bucket: It is easier to pour paint into these containers that to work from a quart or gallon. It is used mix the wall painting materials proper ratio and thickness of paint, lime wash distemper, wall care primer and wall care putty etc. (Fig 2)

Fig 2

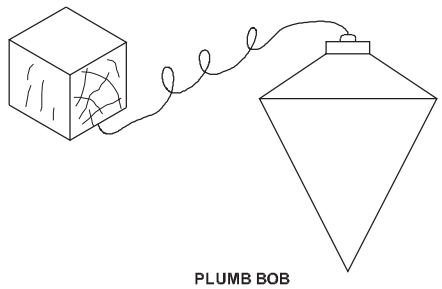


PAINT BUCKET

Plum bob: A plum bob level is a weight, usually with a pointed tip on the bottom, suspended from a string and used as vertical reference line or plumb line it is used to establish a vertical datum

- Measure two to three few inches away from the top of the wall and make a mark
- Set a nail in the mark
- Hang the plumb bob on the nail, letting gravity draw a vertical reference line for you
- When the plumb bob is done oscillating measure the distance from the wall. (Fig 3)

Fig 3



PLUMB BOB

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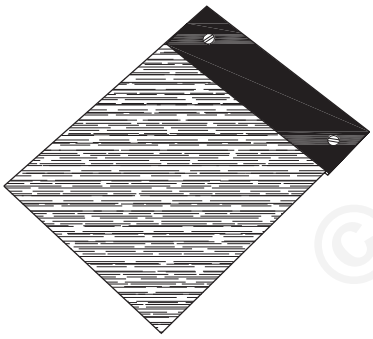
Putty blender (Putty Blade): Putty blade is made of high quality material to ensure corrosion resistance while providing a sharp edge that will not dull or break. These are the ultimate tool for dry wall, putty mixing and leveling, decals, wall paper baking, patching and painting precise flex for better finish and faster application rates.

It can be used for applying filler materials like wood filler, dry wall taping compound, scraping residue and any number of other applications. This blade is designed with the perfect amount of flex making it strong durable and versatile and perfect for paint scraper and apply wall putty. (Fig 4)

Fig 4



PUTTY BLENDER

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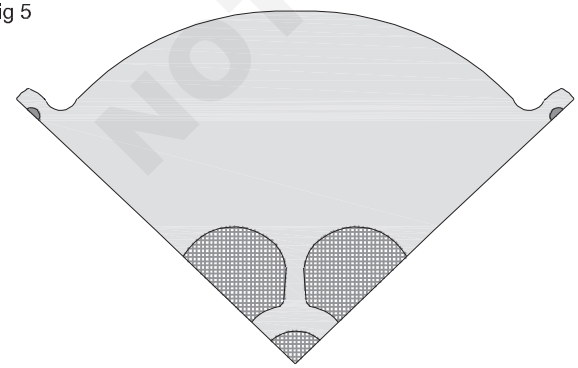
Paint strainer: Paint strainers are disposable painting products designed with fine mesh material. The purpose of a paint strainer is to remove all impurities (clumps, dirt, dust, dried flakes etc) from the paint prior to a paint job. (Fig 5)

Fig 5



PAINT STAINER

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Paint strainer from small, funnel shaped fine mesh strainers to larger 5- gallon bag strainers, there is a wide range of options and sizes for any paint job type. Strainer are mainly three types of bag type, cone type, pump type bag type is used for all types of paint, strains, varnish, and all liquid type paints, cone type strainer is used for filter the later paint and oil based paint impurities it is also known as paper paint strainer. Pump strainers are used to filter unwanted super fine particles from the paint before use in spray gun.

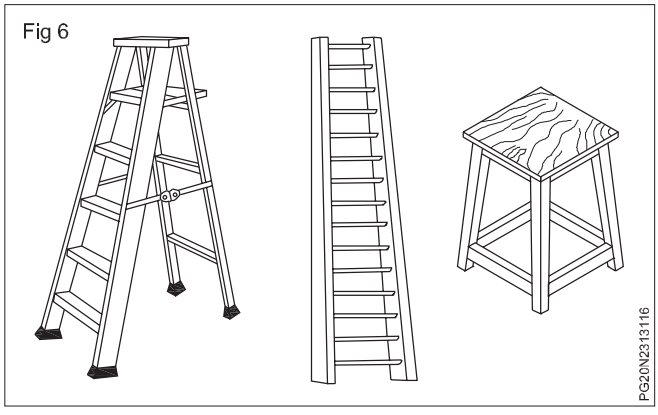
Trestle: Trestle is a frame work consisting of a horizontal beam supported two pairs of sloping legs, used in pairs to support a flat surface such as a table top.

Types of trestle

- Timber trestle
- Coel trestle
- Wooden trestle
- Wood raid board trestle
- Stone trestle
- Iron trestle
- Cast, iron trestle
- Wrought iron trestle
- Steel trestle
- Concrete trestle

Ladder: Ladders are designed expressly with the painter in mind are available in fiberglass, aluminum, steel or wood, with aluminum being the most common for its light weight and strength there are also folding, telescoping, extending and wheeled ladders that are ideal for easy portability. (Fig 6)

Fig 6



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Scaffolding: Scaffolding is a temporary rigid structure having platforms raised up as the building increases in height. Scaffolding enables the painting work at different stages of a building and to hoist the materials for the immediate use at various heights.

Types of scaffolding

1 wall support
2 painter scaffold
3 steel or tubular scaffold
4 needle scaffold
5 wooden scaffold

Wall support scaffold: They are provided on the building side of the standards and are secured in position by rope rashings. They are provided to support the working platform. (Fig 7)

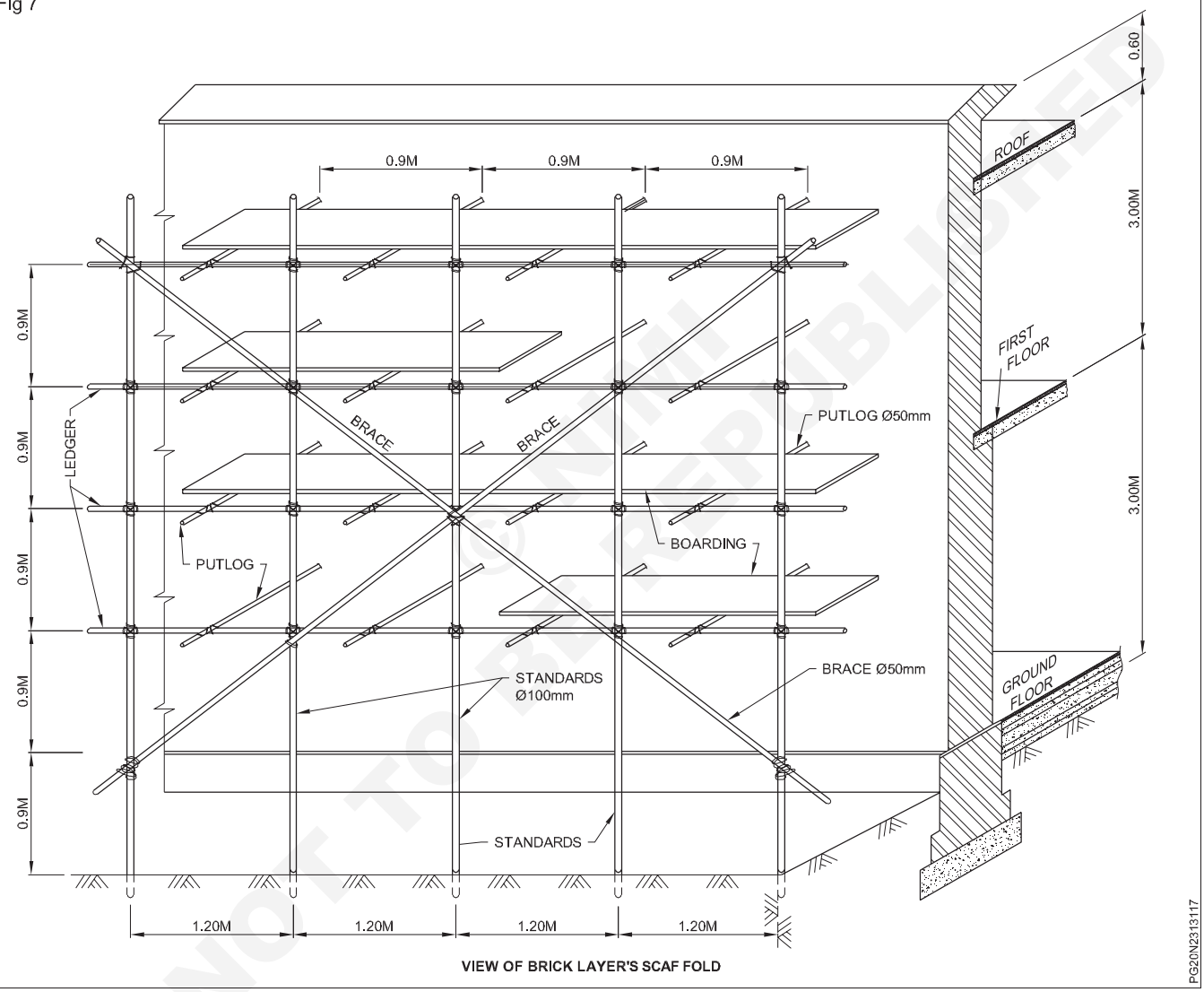
Painter scaffold: They are supported to carry the loads of heavy blocks of paint make and the stresses produced on account of the lifting device and hence they are made stronger by placing the standards at fairly close distance apart.

Steel or tubular scaffold: Tubular scaffold has several advantages over the timber scaffolding such as rapid erection and dismantling, greater strength and durability and higher fire resisting value, it proves to be economical in the long run and hence it is being extensively used these days.

Needle scaffold: When scaffolding is to be provided for a building on the side of a busy street where the construction of ordinary scaffolding will obstruct the traffic on road, needle scaffold is used.

Wooden scaffold: Wooden scaffold is also known as gantrier. This is needed for providing a working platform above ground level and leaving the space below free from obstruction.

Fig 7



VIEW OF BRICK LAYER'S SCAF FOLD

Colour selection for interior wall painting

Objectives: At the end of this lesson you shall be able to
- **colour selection of paint for interior walls**
- **state the paint mixing and paint preparation process**
- **state the difference between emulsion paint and oil paint.**

Colours: Colours have pivotal role and gravitate towards colour from choosing a home interior wall painting we express ourselves through colour, so it is fine to be demanding and particular in choosing interior wall paint colour. Colour can make or break a space depending on the combinations you prefer worst combinations of paint colour never paint for home interior walls. Paint manufactures are recommended best interior wall colour combination as follows.

Pastel colours: Pink, mauve and baby blue, lacking strong shade are called as pastel colour. This colour will give a distinct look and feel to your home it is the best interior wall painting colour combination for children's room.

Purple and gunmetal grey colour: Purple mixed with grey make your home interior look more dignified and sophisticated. Nature of purple rightly blended with natural gray will come across as distinguished wall paint colour combination. This combination is suitable for living room. This colour combination will be a new trend that everyone will love.

Soft pink and turquoise: Soft pink and turquoise shade is a bold colour combination for your home interiors. The combination renders a bright and lustrous look to interior walls it is one of the versatile colour combinations for walls, as it works well with a number of design styles and it the good for ladies staying room.

Aquarium blue and grape: This unique colour combination for interior walls infuses vibrant and playful energy. This colour illuminates even a lightless space in your home. This playful and bright combination for home entrance. Aqua and grape are best combination for home entrance hall interior walls painting.

Blue and yellow: Blue and yellow makes an electric pairing. The mix of vivid blue and warm yellow colour makes your home interiors look more exciting and dynamic. Dramatic blue walls get a splash contrast from yellow and mellow the mood of your home. This colour more suitable for study room as yellow enhances memory.

Orange with white colour: Orange is the colour of laughter and celebration. Orange mixed with white combination paint is suitable and best choice for bed room. This is one of the fascinating interior wall paint colour combinations.

Navy blue and white: This colour combination is the most minimalistic interior wall paint colour combination. This colour interior wall painting makes interior looks clean and elegant. This colour combination is suitable for kitchen of your home.

Cream and aqua: The combination of aqua and cream spreads a cool and breezy mood in home. This combination on interior walls will create a relaxed and peaceful ambience this is go to interior wall colour combination for beach houses and guest houses.

Brown and green: This brown and green paint combination applied to the combination of earthy brown and green in interior walls. This combination makes fresh and append a natural ambience to home interior.

Grey on grey: Although a monochrome palette, shades of grey build texture in interior walls. Grey being a natural colour will give a pleasant and placed feel to your interiors. The shades of grey in interior wall, add a classy and majestic look to your building interior. This makes grey the best two colour combination for bed room walls.

Paint: Paint play an important role in interior and exterior design, appearance and beauty of wall. A wide range of paint is available such as emulsion paint, oil based paint distemper paint, latex paint etc. let us discuss the difference between emulsion paint and oil based paint

The emulsion paint is the water based paint with various non-volatile substances such as alkyd or acrylic resin as the binder.

The oil based paint is consist of particular particles of pigment suspended in a drying oil, commonly linseed oil is used in all based paints.

Difference between emulsion paint and oil based paint

S.No	Emulsion paint	Oil based paint
1	Thinner no need for paint	Thinner (turpentine, naphtha white sprit) is used
2	Emulsion has less odour	Oil based paint has a strong odour.
3	Emulsion paint is more durable than other paints	Less durable than emulsion paint
4	It may not turn to yellow and crack with in short time	It may turn yellow and crack with short time
5	It has finishes options such as mat, smooth, eggshell, semi – glossy and glossy	It has finishes options such as high gloss, smooth and opaque
6	Emulsion paint dries quickly	It take more time than emulsion paint
7	More hardness than oil based paint	Less hardness compared to emulsion paint
8	It covers more area in one liter	It covers less area in one liter compared with emulsion paint
9	Emulsion paints are flexible	Oil based paints are less flexible
10	Emulsion paints are water proof	Oil based paints are not water proof
11	Emulsion paint will not easily crack due to temperature variations	Oil based paints are easily crack due to temperature variations
12	It is suitable for interior and exterior painting	It is not suitable for external surface painting
13	Alkyd resin, acrylic resin, epoxy are used as emulsion binder	Linseed oil, Tung oil, poppy oil, nut oil are used as binder
14	Water is used as solvent in emulsion paint	No need for a solvent
15	Emulsion paint not flammable	Oil based paints are flammable
16	Emulsifiers are used as wetting agent	Oil based paint it self wetting agent
17	Emulsion paints are made with non-toxic material	Oil based paint made with toxic materials
18	It is safe for human health irritation,	It affect the painter eyes, lung and skin headache and weakness
19	Emulsion paints are available in 1,4,10,20 liters packs	Oil based paints are 500ml,1,4,10,20 liters pack
20	Emulsion paints can be applied on metal wood, glass and concrete surface	Oil based paints can be applied on metal aluminum surface
21	More expensive than other paints	Less expensive than emulsion paint

Emulsion paint mixing and preparation process:

The major raw materials used for the emulsion paint, water, titanium, oxide, calcium, carbonate, kaolin, aerosol, biocide, PVA, ammonia deformer kerosene, yellow iron oxide and red iron oxide. The pigments are in powder formed with the pigment components held together in clusters during the premixing these are turned to smaller dusters and homogeneously distributed through out the binder. The tinting strength of the paint is now relatively low, but this will increase as the pigment is ground finer in the triple roll mill the pigment clusters are ground further to the desired fitness. The difference in speed of roller helps to grind the pigment lumps and the paint goes from one roller to other. The paint is finally removed by using a scraper then paints are filled in tubes, bottles, and tins and labeled. The final step is to check that packing contains the right amount of paint.

The acrylic polymer emulsions are a water based polymer that can be produced from methyl methacrylate, butyl acrylate, ethythexyl acrylate, acrylic acid, methyl acryl ate etc. polymers with specific attributes for a variety of applications or uses can be produced by choosing appropriate hard and soft monomers.

Interior wall painting process

- Prepare the wall surface by using sand paper or other scraping tools to remove any particles that may affect the paint finish such as loose flaking paint, dirt, grease and dust
- Apply water neutralizing cement, universal white or thinkable cement primer depending on area to be paint allow it to dry 6 to 8 hours and than spot prime the nail holes and wall cracks
- When the primer has dried apply putty to get rid of uneven wall surface area. Allow it dry off for 6 hours sand the putty pasted area to make it even with rest of wall using 180/ 320 grit emery paper then wipe off the putty dust.
- Select the interior paint and thin out interior emulsion paint at a ratio of 3:5 or 7:10 with water for softer and more depth sheen, mix water and emulsion paint at a ratio of 1:5 or 3:10 mix and apply 2 to 3 top coats of interior emulsion paint with in a paint period time of 6 hours. After paint applied protect the painted area from the dust particles until wall paint dry.

Colour selection for exterior wall painting

Objectives: At the end of this lesson you shall be able to
- **select colour for exterior wall painting**
- **state the method of paint mixing and preparation.**

Paint colour selection: Paint colour scheme brings cohesiveness of building appearance. Normally paint colour is very personal and emotionally charged paint colour, can make feel calim or energized, happy the mood of building wall paint colour. The import part of choosing home colour schemes is finding for your building, keep in mind that soft and earth tone shades are beautiful neutrals of a more intense primary colour match the exterior wall paint colour with paint colour palette. Colour palette should consist of three colours a light, medium and dark colour.

Colours and its effect:

White colour: White represents cleanliness it creates a cool and refinishing feeling. A warmer shade of white can help make a room feel cooler white is more formal feeling.

Black colour: Black represents elegance, mystery and power.

Red colour: Red represents the most psychologically stimulating of colours. It is the colour of confidence and creates excitement and energy. It brings to mind danger.

Brown colour: Broun represents earth, security and contaminant it gives a sense of simplicity and comfort.

Orange colour: It is represent whole some and fruitful. It symbolizes balance, warmth, enthusiasm, vibrancy and demands attention orange stimulates a dining area.

Yellow colour: Yellow represents happiness, optimism, inspiration and summer. Pole yellow brings a sunny feel to space without bring over whelming.

Green colour: It is represents the colour of nature – calm and relaxing. It is often described as the colour of joy, harmony, life energy, the environment and money.

Blue colour: Blue colour is calming and cool it is the most popular colour because it symbolizes the sky and heaven because of its calming power blue works well

Purple colour: It is represents the imagination. It is the colour of royalty, luxury and wealth. Purple colour tend to be creative wise and romantic

Pink colour: Pink is the part of red colour, but much more delicate. Pink colour perceived to be feminine, romantic, innocent.

Gray colour: It is represent a classic, intelligent and displaced

Silver colour: Silver colour represents money prosperity and wealth this colour silver can create a feeling of make richness.

Use of exterior wall paints: Exterior wall paint protects the building wall by giving it an extra layer against harsh weather animals, and other things that can invade the penetrate the walls. Exterior paint can also protect the wall siding against the wind and sun to preserve the life of exterior walls. For a perfect exterior wall paint. Finish use satin and eggshell. It is best choice as they have high durability and easier to clean. These finishes also exterior paint colour ideas

How to choose the exterior wall paint: Choose the colour combinations for exterior wall paint colours as more colour on exteriors appear cluttered.

- Choose one of the best exterior paint colour idea is to avoid black and other dark colours.
- High gloss paints are not be fitted for exterior wall paints even though it has the highest durability. For perfect exterior wall paint finish satin and eggshell are the best choices as they have high durability and easier to clean.
- Whatever colour and finish use to your exterior walls, it will look natural. The exterior wall paint should go with the mood and climatic of their surroundings and back drop. Cool colours are best house painting in hilly regions as it suits the climate and the greeneries surrounding the house
- The exterior wall painting should be attract the eyes instantly. The bright colours induce an extra appeal to exterior walls in the first blink. Bright colour can catch attention from fair distance
- Create a theme on your exterior wall painting with fixed theme in your mind will bring about some unique exterior paint colour ideas and it also will make your entire house look like one.
- Just like interiors, the exterior paint colours also need to be enhanced with some furnishing out side of the house. The furniture used must perfectly match with the colour theme of the exterior wall paint colour.
- The exterior paints have a longer life span if they are painted in some particular seasons irrespective of the quality, type and colour the exterior wall paints require a minimum temperature to be painted. Exterior paints are best painted during the summer season as there will be enough temperature for paint to dry properly. Painting your exteriors during the winter season and rainy season will make you redo the paint regularly.

Exterior wall paint colour: The following paint colours are suitable for Indian claimates

- Golden brown + white + grey
- Dark brown and light brown orange
- Orange and grey
- Brick and grey
- Grey and white

Exterior wall paint mixing method

Add water to dulux paint putting it right use a coat of dulux emulsion thinned 10 – 20% with clean water once this is dried you can apply a full coat of dulux emulsion. Follow the following steps to prepare the exterior wall paints.

- Pour the paint into the bucket
- Add ½ cup of clean water for every gallon of paint
- Mix thoroughly
- Check the thickness by running the paint through the funnel. If it flows freely through funnel, you can know the paint is thinned enough

Exterior wall preparation for painting

Wash the exterior wall with cleaning solvent. You can hand apply the solution with sponge, which will take forever and many trips up and down the ladder or hire a pro to pressure wash siding, with help of compressed pressure water spray.

- Use the scraper to scrape off loose paint. To work lead safe wear a mask and type suit, spray water on the paint as you scrape and collect the debris.
- Sand the rough spots – a pad sander or random – orbit fitted with 80 grit sand paper will smooth out any remaining rough spots take care not to push, so hard that you leave sander marks in the wall.
- Fill and repair – after washing, scraping and sanding and inspect the wall for cracks, holes, dings and chips. Prepare the wall putty and fill the damaged spot by apply on it if any major damage repair mason to be repair the damaged wall with cement and sand mixture. After putty dry off sand the putty applied area to match surface with remaining wall surface.
- Clean the wall before apply the wall care primer. Select the correct wall primer and prepare the primer to apply on the wall. Apply primer by brush or spray gun at even thickness. Let allow to dry off for 6 hours. After dry the primer use the 180 or 320 grit sand paper to smoothen the wall surface, then wipe with dry clean cloth.
- If any marks on the walls, apply magic acrylic wall putty or wall guard to even out the areas. Allow the putty to dry for 6 hours, level the pasted surface with recommended sand paper grit size.
- Wipe out the any remaining dust on the wall.
- Select the paint materials and prepare it as per manufactures instructions. Thin professional exterior emulsion with clean water at a ratio of 2:5 or 1:2 by volume. Apply 2 to 3 coats of professional exterior emulsion paint and allow it 6 hours to dry off. If you want a darker shade apply more coats of paint. Wall painting is one of the most affordable solutions to esthetic appealing link for interior and exterior walls.

Brush painting and roller painting

Objectives: At the end of this lesson you shall be able to
- **state the difference between brush painting and roller painting**
- **state the different type of rollers**
- **state the preparation of texture for wall painting.**

Painting tools: The painters use a range of techniques and tools to get the job done most of the painter have used different types of painting brushes and rollers in action. Even though painting method is difference between brushes and rollers these paint applicators serve distinct functional roles for both building wall interior and exterior painting job. Depending on the situation at hand a brush might be more useful and efficient than a roller.

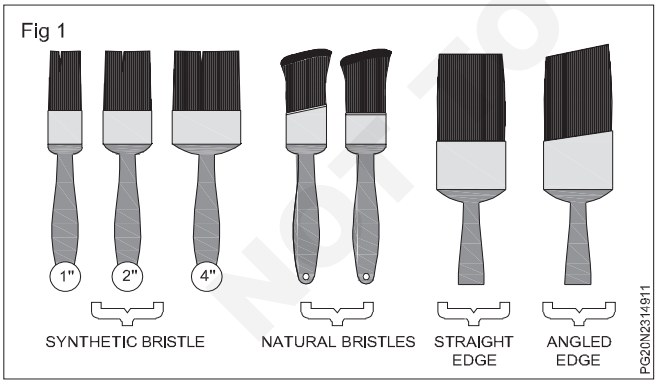
Benefits of paint brushes

It is used to cut in and out of smaller and more detailed areas including trims, corners and edges (2) brushes are small and flexible and they work well when controlling paint (3) brushes are used to create a textured effect with brush strokes (4) nylon or polyester brushes are perfect for latex (water based) paints and natural brushes are good for oil based paints, varnishes and stains.

The paint brush and paint roller have two very different functions, this means that selecting the right tool for the job is very important

Paint brush: The different types of paint brushes are used for painting work and choosing the right ones for paint application can make a big difference in the final outcome consider which type of brush is suitable for your painting work in general. There are twelve different types of paint brushes used for wall painting (Fig 1) they are as follows

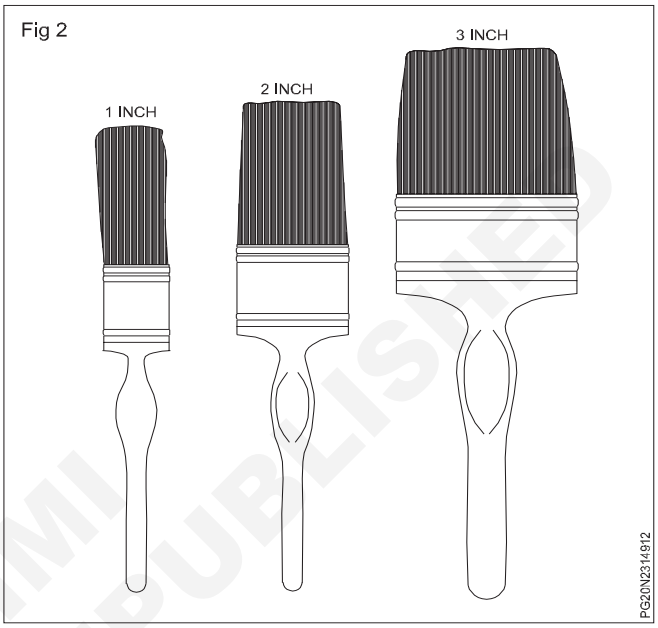
Fig 1



1 **Small paint brush:** Small paint brushes are tiny and delicate smaller paint brushes from one inch to two and half inches in size. This type of brushes are used for walls to paint tight areas, such as corners, trim and window areas.

2 **Medium size:** These types of paint brushes are not too big and not too small, so they are right size for a variety of projects normally its, size is 3 inches. (Fig 2)

Fig 2



3 **Large paint brush:** For large areas such as walls and ceilings the best paint brush to use is a large one. This brushes size is 4 inches to 6 inches used for painting applications

4 **Natural brushes:** Natural brushes are made from animal hair such as badger or hog hair. They tend to hold more paint and ultimately create a smoother finish. It is suitable for applying an oil-based paint, polyurethane, top coats, shellac, varnish, enamel or decorative chalk paint. It is a used for applying furniture wax also. Natural brushes should not be used for water based paints.

5 **Synthetic paint brush:** It is made from high quality polyester or nylon/Polyester blend. It is used for water based paint

6 **Angle sash paint brush:** Its bristles are cut on a sharp slant, which creates clean lines. This type of paint brush is short handled angled it offers great stability and maneuverability

7 **Round sash paint brush:** This type of brushes can range from 20 to 44mm in size and feature a blunt, tapered end with soft edges. It is used for decorative painting.

8 **Square cut paint brush:** It is a standard type of paint brushes for walls. It is bristles are square cut making it ideal for flat surfaces such as interior and exterior walls, siding pending and flat doors

9 **Finishing brushes:** This type of brushes are softer than normal ox hair bristles. It is used for paint jobs like banisters and kitchen cabinet doors or any space requires a smooth finish of wall.

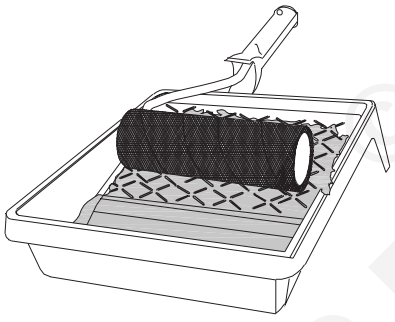
10 **Flagged bristle paint brushes:** This type of brush bristles are split at the ends which allows them to hold more paint and ultimately provide more coverage plus the paint tends to be released more smoothly. This type of brush useage can create a clean painting finish.

11 **Foam brushes:** It is specially designed for use with paint, stain and urethane to produce a smooth finish. This type of brush used for furniture, cabinetry and trim work.

12 **Stencil brushes:** This type of brush is only used for create stencil work on the walls. They differ from paint brushes because they are round and have more bristle together. The bristles are same length as other brushes.

Paint rollers and their uses: There are ten different types of paint rollers are used for interior and exterior wall painting painter should be select the correct roller for a particular type of wall painting. If you choose the wrong roller and you could have a paint job requiring a redo. Painter should know the which paint rollers to use for their jobs. The different types of roller and its use is given below. (Fig 3)

Fig 3



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1 **Manual paint rollers:** A manual paint roller is used to apply paint for walls and ceilings. The extended length of their handles make them convenient for painting in high surfaces. When it is using on high surface, it is likely to drip paint down below.

2 **Pad paint rollers:** Pad rollers are designed for use on trim and edging. They are highly absorbent and flat and are meant to be used in straight and even strokes you may notice using other types of rollers that they tend to splatter paint as they cover a surface. A pad roller lies completely flat which eliminates any opportunity for splattering or dripping. The flat design pad roller also make the pad roller easier to hold and carry paint. This roller is suitable for intend to paint surface two or more colours.

3 **Textured paint rollers:** Textured rollers are used to transfer onto a surface with texture. The special foam covers complete with patterns etched into them, this is quickest and most accurate way to apply paint in a way that creates an artificial finish. They make textured rollers simulating wood grain, brick, stone, tile and similar interior design patterns textured rollers are used for large surfaces, such as walls and ceiling

4 **Mini hot dog paint rollers:** Mini hot dog rollers are miniature paint rollers are shaped it is reach difficult areas that a regular manual rollers can't reach mini hot dog rollers are effective in painting behind fixtures. They are used to paint cupboard, shelving and rolling doors.This type of roller can also apply paint to trim and edging with easy. The only draw back to this type of roller is, very handy and it is easy to pick up too much paint and then with that comes splatter.

5 **specialty paint rollers:** This type of rollers are often used for applying textured paints. They tend to cut down on splatter and it is very absorbent and transfer paints like suede, stone and light plaster with ease.

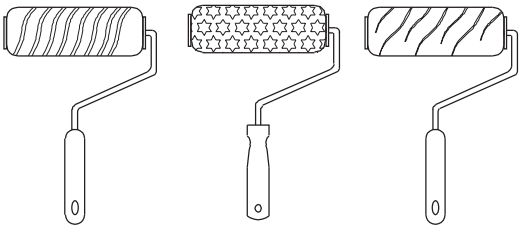
6 **Thick nap paint rollers:** Thick nap rollers are best for use on stucco, decking materials, bricks and ceilings dry wall. This type of roller carry more paint and can get into crevices that a thinner nap cannot thick nap paint roller size is ¾ and 3/8 inches.

7 **Thin nap paint rollers:** A thin nap paint roller uses either a ¼" nap or a flat foam nap. It is used most often on materials for smoothest finish. Thin nap paint rollers used for wall painting. don't use the thin nap roller on surface where thick nap roller is recommended.

8 **Microfiber paint roller:** Microfiber rollers are eco friendly used and it is hold onto paint better than average paint roller resulting in minimal splatter and an overall smooth application of paint. Microfiber rollers should only be used for smooth, consistent application is desired.

9 **Long paint rollers:** Long paint rollers are used for painting a walls and ceilings use the industry standard 9 inch long roller. Choose this type of paint roller for paint a large surface. This gives enough area to soak in the right amount of paint without abundance and provides the size to get right job done as fast. (Fig 4)

Fig 4



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10 **Small paint rollers:** Small paint roller size is 4 inch it is used for paint the doors, furniture and cabinets. If you fail difficulty depending on a materials size and texture to resolve this alternative type of roller may need to be used in conjunction with the four inch frame.

Advantages of paint rollers: Paint rollers are ideal for bigger ideas such as, walls, ceilings and large furniture and the porous surface of the roller holds much more paint them a brush and distributes an even layer of paint much faster different types of finishes can achieved with above mentioned different types of rollers. Rollers with a smooth surface will produce a smooth finishes. The rollers with a thick or fluffy surface will create a more textured finish.

Rollers materials: The paint rollers cover made of following materials

- Foam rubber
- Felt
- Velor
- Fur of different materials
- Mohair
- Vestan, polyester and other polymers

Difference between brush painting and roller painting

S.No	Brush painting	Roller painting
1	Paint brush covered small area of paint stroke	Roller covered the one pass can be equaled to a hundred brush strokes
2	Less convenient to paint on rough surface	More convenient to paint the floor
3	Paint brush stroke cover very small area	Rollers painting stroke covers very large area than brush stroke
4	Paint brush painting will take more time	Paint rollers painting will take less time
5	Painting work will be slow	Painting work will be faster
6	Paint brush covers the surface unevenly	Paint roller covers the surface evenly
7	Brushes are not designed to work with a large number of finishing materials	Rollers are have a huge selection of the of invoice of paint or other decorative Coatings
8	Less cost of brushes than cost of quality rollers	Cost of a quality roller is higher than cost of a brush
9	Paint brushes can be used for corners, joints corners and joints and other small surfaces	Rollers can not be used for painting on small surface
10	Brushes are perfect for minor painting tasks large, open, uninterrupted areas	Rollers are designed to efficiently cover large surface
11	Brushes can hold small amount of paint volume than rollers	Paint rollers can hold onto a greater volume of paint brush
12	More effort and time need to achieve smoother,	Rollers provide smoother, more even results with less effort than brushes.

Few tips to make the right choice:

- The paint brush and paint roller have two different functions so that selecting the right tool for the job is very important
- The lager the area the higher the efficiency when using the roller.
- The roller can paint the surface almost without leaving the place. Brush requires simplified access to the working surface.
- The roller requires a special tray and containers for storing the paint. This is not only an additional expense, but also an inconvenience for the painter, who should instead of one brush keep several items at once while working.
- The bristles rarely falls out of the roller, which is very important when working with ‘‘light’’ paints, which are laid by the thinnest layer.
- With a large brush, it is convenient to bleach the ceiling and walls with lime, but it is difficult to work with this material.
- Brush is an indispensable tool for working with comers. It is also necessary for painting window frames, pipes, radiators.
- Roller is often used to work with stencils. Roller paint over the stencil.

Preparation of texture for wall painting

Objective: At the end of this lesson you shall be able to
- **state the preparation of texture for wall painting.**

Wall Texture: Wall texture is after applied as building owner would choose a smooth, glass like texture for their building walls and ceiling. For texture, smooth wall or ceiling surfaces help paint colour stand out better. Because there are no bumps to create a shadow effect, the surface appears brighter.

Wall texture does have the distinct advantage of being a quick method of finishing walls without the seemingly endless cycles of mudding, and sanding dry wall compounds. Wall texture can cover up imperfect dry wall or moulding work and it dries rapidly enough that you can begin painting just few hours later. Wall texturing also known as wall stippling texture can be painted with a roller and other materials that are easy to obtain the texture designs.

Materials required for wall texture (Fig 1)

- Painter's tape
- Dry wall compound
- Primer
- Sponge paint
- Dry wall joint
- Cleaning rag

Fig 1

Painter's tape | Dry wall compound | Primer

Sponge paint | Dry wall joint | Cleaning rag

Equipment / Tools need for textures (Fig 2)

- Drop cloths
- Plastic sheeting
- Dry wall knife
- 5 gallon bucket
- Drill and paint mixer attachment
- Paint roller and cover
- Paint brush
- Paint tray
- Texture sprayer
- Faux finish applicators
- Handy paint cup.

Fig 2

Drop cloths | Plastic sheeting | Dry wall knife

5 gallon bucket | Drill and paint mixer attachment | Paint roller and cover

Paint brush | Paint tray | Texture sprayer

Faux finish applicators | Handy paint cup

Preparation of texture for wall painting

Texturing with joint compound or textured paint.

- Clean the walls and allow them to dry completely
- Combine the joint compound with water according to manufacture instructions
- Pour the joint compound into a paint tray, then use a paint roller to roll it onto the wall.
- Wait for the joint compound on the wall to partially dry. Then roll over the wall again. Doing so well pull up the partially dried compound to create a pleasing 3 dimensional texture.

- Use a brush to textures corners. Use the small angled brushes to work better, while smaller ones may work better for hard to reach places. The angled shape of the brush helps to create a crisper line and it comes to filling all the nooks cranies along the edge of the walls.
- Once the compound has completely dried after 24 hours you can paint the walls.
- When using textured paint check the paints manufacturers instructions to see, if it recommends just single coat.
- For more defined texture use a thick-nap roller cover.

Texturing with paint for a faux finish

- Prepare and clean the walls as you normally would for painting
- Paint a base colour and allow it to dry
- Using either a thick nap roller cover or a stencil roller roll a complementary glaze or second paint colour over the coat.

Tips for painting texture wall: Painted textured walls can be quite change, will all those peaks and valleys preventing you from getting even coverage and crisp lines.

- Fill the holes and scratches of textured walls hide mask use putty knife to spread spackle holes then allow to dry imperfect.
- Vacuum and wipe down walls with a damp cloth before start.
- Remove outlet and switch covers.
- Tape base boards and transition areas by using painter's tape applying correctly goes a long way to getting clean crisp lines on textured walls.
- Use right painting tools, which is included with roller tray and paint cup combined into one convenient handled pail.
- Apply second coat paint after dry the first coat paint.
- Clean up the painted area once paint is dry remove the tape. Checkout that perfectly clean link at corner clean the tape applied area with soapy water by bristle brush.
- Inspect the newly painted textured walls

Application of a texture paint: The textured paints are simple to apply. Texture paint can be applied by the use of spray, paintbrushes, and paint rollers. If you are planning to paint your home on your own then obey the "DIY'' instruction on the manufacturer's pamphlets.

The premixed texture paints are "ready for usage'' accessible in the market and can be immediately applied to the surface. The premixed texture paint contains mineral aggregate, lace, marble stone, sandstone, ribbon, leather, etc.

Varieties of tools are similarly created for obtaining various finishes in texture paint. These tools contain sponges, spatula, styluses, specialized paintbrushes, and the paint roller.

The texture paints can similarly be applied to old as well as the recently plastered surface.

Type of textures: Texture is used to give a different effect to a wall in building paint. Textures means that the design is done on a surface with a apecific tool or material.

They are two types of texture

A Plain texture

B Relief texture

Plain texture: In this method, different design effect are brought out by painting on a flat surface. This effect design is made using nail, sponges, woollen fibres, coconut bristles, brushes, bathroom brush stamps, and other materials to create textures, This texture is not felt but 3D feel is there. In relief type by colour, effect can be shown only on texture without using any other material. Use a colour darken than the wall colour to create a bay texture.

Relief Texture: After painting the wall smooth, the fashion has come to give a different effect on any wall. Showing the separate existence of a wall and on it you can file showpiece, photo, painting, other materials by which you get attracted to this wall. If the putty is wet, then tab it with a putty knife. Draw lines with a comb, scratch with the coconut husk, and using other materials bulge texture is created.

You can see this bulge texture and it can be felt by hand. To do this texture, materials and tools are available in the market. Relief texture is also done by using putty material on plastic by of pneumatic gun by short blasting.

This is a thin rubber stamp of 4 to 5 inches, which can be held by hand. This is used to give a texture on the walls surface. After finishing the putty of the surface a special colour is given to it, when it is completely dried, a layer of silver, golden or other colour is applied with a roller. When the layer is wet with a spatula tool draw striper on it. As result the same amount of water is erased, and the inner colour is visible and pulling several times creates a swirling texture of the bands and the walls become attractive.

Tools for wall texture:

Spatula tool: This is a thin rubber strap of 4 to 5 inches, which can be held by hand. This is used to give a texture on the walls surface. After finishing the putty of the surface a special colour is given to it, when it is completely dried, a layer of silver, golden or other colour is applied with a roller. When the layer is wet with a spatula tool. Draw straps on it. As a result, the same amount of colour is erased, and the inner colour is visible and pulling several times creates a swirling texture of the bands and the walls become attractive.

Texture roller: To give a unique finish to the walls and roots texture roller cover is selected. These rollers are used to provide a specific pattern. It is used to hide the defects in old walls. Texture roller can remove any part of the wet paints and now a days many types of rollers are available in market.

Timber tool: It is carried with thick rubber blocks from small hemisphere to large hemispherical lines. This tool is used to create the effect of wooden sticks on the surface. On the surface the colour is given like devdar or other wooden colours. When the paint fully dries, other recommended dark colours are applied. The timber tool is noticed as desired when the paint is wet. The top colour is erased according to the lines of instrument and you can see the inner colour.

These lines appear on the surface as wooden rod. This tool is available in various shapes in market.

Comb tool: This is an triangular or rectangular shaped rubber band is which line comb thin and thick teeth are there. The comb tool can be rotated as desired on the surface. After the tool is rotated, the top colour is erased and we can see the lines of inner colour. We see attractive designs on the surface. This type of texture design can be made with the help of comb tool. This tool is available in different shapes in the market.

Ragging tool: Ragging tool is a type of texture roller and whose roller cover is made by less or more designed clothes. When the surface is finished by putty, on it is a special colour is given and when it is dried, completely with the help of a roller a layer of silver, gold or other colour is given. Due to this colour just fades away and interior colour can be seen. On the coloured surface with the ragging is used in both ways.

Denim brush: This brush tool shape is like a bathroom brush. Its bristles are made from plastic on nylon wires. Denim brushes wire bundles are filled in its handle. The handle is made from plastic. This tool is used to give texture to the walls surface. It is used to make denim cloth design on walls. A special paint is applied on the putty's applied surface. When this paint dries up completely, shade of another paint applied. The denim tool is rotated on it when the paint is wet. Due to this the paint top layer is removed and interior paint lines or seen. Due to this it has an denim cloth effect on the surface.

Mudra tool: This is a type of stencil which is used for design printing on walls and different surface computerized design is made on thick plastic paper and it is art by a plotter cutter. On the surface with design sponge roller is printed. This stamp is called mudra. The wall looks very beautiful and attractive if you repeat the walls stencil of the design.

Types of texture paint techniques: There are many types of texture painting techniques are used for texturing the building walls and ceilings. Commonly used textured paint techniques are given below

- Silica sand texture paint
- Roll-on texture paint
- Knock down texture paint
- Smoothly texture paint
- Popcorn texture paint
- Orange peel texture paint
- Hawax and trowel skip trowel
- Slap brush texture
- Skip trowel texture paint

Types of textured paint: Texture grades range from very fine to coarse. While many textured paints can be used on both walls and ceilings below are the types of textured styles.

1 **Smooth texture paint:** It has a light texture, that is much subtler than other types texture paints it does not contain sand or other materials to create a rough grains appearance smooth texture paint needs to be applied with a trowel or putty knife. (Fig 3)

Fig 3

2 **Sand texture paint:** Sand texture paint features an extra heavy bodied finish that can be used to add a gritty texture to both walls and ceilings. (Fig 4)

Fig 4

3 **Knock down texture:** You can create a knockdown texture by applying joint compound to walls and ceilings and then smoothing the stalactite like peeks down with a knife. The result is a marbled texture that can then be painted any colour.(Fig 5)

Fig 5

- **Popcorn texture:** Popcorn texture is a heavy putty ceiling texture that deadens sound it created using a joint compound mixed with large texturing pieces made from materials such as Styrofoam once applied popcorn texture is different to remove. (Fig 6)

Fig 6

- **Orange peel texture:** Orange peel texture is a subtle splatter texture created by spraying plaster onto dry wall. The layer of plaster makes the walls more durable against cracks and dents.(Fig 7)

Fig 7

Coarse Paint: Coarse paint contained coarse grains (such as sand, gypsum) Leather, lace, ribbon, metal etc. Water based paint used for developing a rough structure impact on the dry wall. (Fig 8)

Fig 8

Wall defects and defects removal process of wall painting

Objectives: At the end of this lesson you shall be able to
- **state the wall defects and wall painting defects**
- **state the wall painting defects removal process.**

Wall Painting and defects: Wall painting not only gives a good appearance to a structure but also provides protection various infiltrative actions such as corrosion, decaying, weathering etc. The paint film also gets deteriorated by above mentioned actions building wall paint should be selected based on many factors such as type of wall /ceiling surface type of environment and type of usage.

Painted wall defects are occurred due to various causes. General paint defects are developed due to poor workmanship and bad painting techniques used and negligent to follow the paint manufactures (Painting) instructions. While wall / ceiling painting. The various paint defects and preventing method is given blow.

Wall paint defects are as follows

Paint defects: Repair any small identifications that are still evedent after painting by using compound. Apply compound with a putty knife wipping and sanding it with fine grit sand paper and wipe away any dust with a damp microfiber cloth.

Type of paint defects

1 **Skinning:** skinning defects is caused by the formation of a layer of skin on the surface of the paint it can be prevented by keep the container airtight and don't open it until in use. If skin has appeared, then remove it and stir the remaining paint before use it.

2 **Brush marks:** Brush marks are caused by under thinning of paints or due to poor application of the final coat of paint or due to poor quality brush. It can prevent by ensure that a paint with right viscosity is applied with a good brush.

3 **Crawling:** This type of defects leads to uneven film thickness and occurs mainly due to improper cleaning of wall surface it can prevent by ensure to have a sand, dirt or dust free surface

4 **Cracking:** Small cracks are formed in the coating. This can occur on re-coat or if coating is applied to solvent sensitive substrates it can prevent by use proper solvents after consulting with experts to prevent cracking.

5 **Loss of gloss:** Loss of gloss may be caused due to poor surface preparation presence of oil or due to over thing of paint. It can prevent by use appropriate thinner on clean surfaces and proper humidity control while painting.

6 **Blistering and peeling:** Blistering and peeling are defects in which swelling of the paint film accurse. The swelling caused by the formation of an air bubble under the paint film due to the presence of moisture or oil or grease matter then it is called blistering.

Blistering and peeling occur due to the imperfect seasoning of timber, usage of excess base coat and final coat, imprisoned gases between paint coats, etc. These defects can be eliminated by porous paints like emulsion paints instead of non-porous paints such as oil paints, enamel paints, etc. (Fig 1)

Fig 1

7 **Fading:** Fading is the discoloration of the paint surface. This is mainly due to atmospheric agencies such as sunlight, moisture, etc. To prevent fading or discoloration, weathering resistance pigments should be used in the paint. (Fig 2)

Fig 2

8 **Grinning:** The paint film should be opaque enough to cover the background surface. The visibility background due to insufficient opacity of paint film even after the final coat is called as grinning. (Fig 3)

9 **Chalking:** Chalking is the formation of powder on the painted surface. This is due to the use of insufficient oil in the primer. It can be prevented by using sufficient oil in the primer, applying paint at recommended spreading rate, etc. (Fig 4)

Fig 3

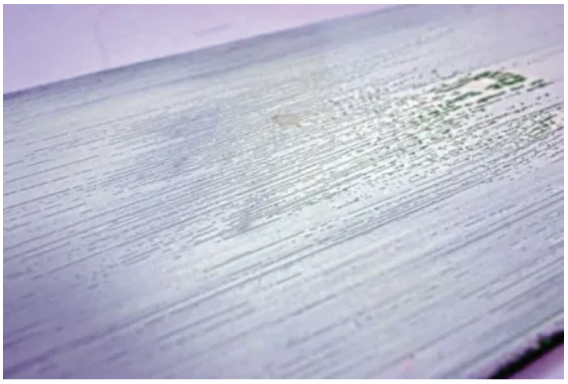


Fig 4

10 Running: When a thin layer of paint is coating on a glossy and smooth surface the paint may run back and sometimes leaves small areas of surface uncovered. This defect is called running it can be prevent by using correct viscosity of paint. (Fig 5)

Fig 5

11 Sagging: When a surface is to be painted with a thick layer of paint, the thick paint film may run downwards and forms sagging of paint. It similar to running but here the sag of pint is very thick. This type of defects occurs when you paint surface with paint spray gun. It can prevent by use the proper viscosity of paint and maintain the specified distance from spray gun nozzle up to wall surface. (Fig 6)

12 Flaking: The detachment of paint film from the surface is called flaking. It occurs when the bond between surface and paint film is poor. It can even by, the surface should be cleaned and rubbed with abrasive paper before applying paint. (Fig 7)

Fig 6

Fig 7

13 Blooming: Blooming is the defect caused due to improper ventilation, weathering, defective paint, etc. in this case, dull patches are formed on the painted surface. It can prevented by providing proper ventilation weathering with use of correct quality wall paint (water based or oil based paint) (Fig 8)

Fig 8

14 Wrinkling: Wrinkling occurs when a thick layer of paint is to be coated on the surface. In this case, the paint film gets shrinks and develops on the surface as shown in the picture. It can be prevented by allowing the undercoat to dry completely prior to the application to final coat. (Fig 9)

Fig 9

15 Flashing: The formation of glossy patches on the painted surface is called flashing. This caused due to the poor quality of paint, weathering and, poor workmanship, etc. it can be prevented by using correct quality of paint and weathering action and painting techniques as per paint manufacturers instructions. (Fig 10)

Fig 10

16 Saponification: Saponification of paints occurred when the painted surface is exposed to chemicals such as alkalis. In this defect, soap patches a formed on the paint surface and paint film gets off from the surface. It can be prevented by before use the good quality of paint for wall painting. (Fig 11)

Fig 11

17 Alligatoring: Alligatoring is pattern cracking similar to the scales of an alligator. It occurs when the hard coat of paint is over the coat existing coat of paint. To prevent this, a high-quality oil based primer should be used as a prime coat. (Fig 12)

18 Checking: Checking occurs when ultra violet rays cause the paint binder to disintegrate it can happen when interior paint are used for exterior surface it can prevent by remove any unstable paint films allow the wall to dry thoroughly and repaint with a recommended paint or make sure the paint is not adulterate with foreign materials. (Fig 13)

Fig 12

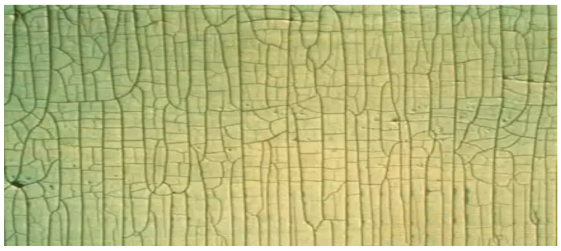
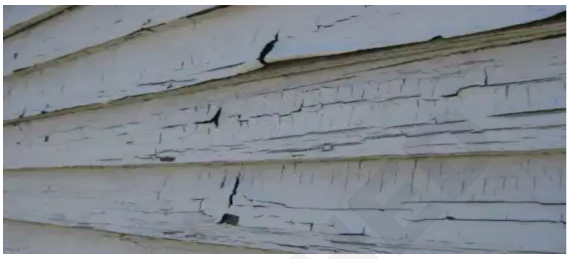


Fig 13



19 Mildew: Mildew is a form of fungus which grows well in warm, moist and dark places. It places. It grows rapidly and develops the grey coloured pat the painted surface. It also affects the bond between paint coats. It can be prevented by keeping the surface dry and clean before applying paint. If there is any trace of mildew growth, then wash the surface with solution of bleach. (Fig 14)

Fig 14

Preventive measures for painting defects

- Employ good surface preparation before the application of paint. Ensure that substrate should be free from sand, dirt or any dust.
- Moisture content on the painting surface should not exceed 6% as it helps to avoid efflorescence
- Apply adequate primer to seal the surface before going for under coat and top coat.
- Use appropriate coating and select colours that are more stable to avoid deterioration.
- Use environmental situations for areas exposed to extreme weather resistance paints.
- Protect and treat all metal parts to avoid rust stains or corrosion.
- Avoid details with very rough textures and use algae. Resistant paint to prevent algae and fungi growth.

Building painting estimate and costing

Objective: At the end of this lesson you shall be able to
- **prepare the building painting estimate & costing.**

Factors that affect the painting cost: The operation of the building paint system has many variables that affect the painting cost, effective control of these variables will provide the best quality of painting at the lowest cost. The painting cost variables are part of the paint and texture designs, part of the operation and others are related to decisions on how to run the painting system. Each cost variable has to be considers to know the system cost to operate and how much to charge for painting part and painting materials.

Painting system designs: The painting system design is long and could fill a book of it own. There are few guide lines for selection that are mostly common sense

- Design the system large enough for future volumes
- Pay close attention to features that can lead to cost saving, safety or efficiency and be willing to spend extra money for them
- Consider operating cost as closely as capital cost
- Use durable paint materials (wall cleaner, surfacer, putty, primer wall sealer, water based paint, oil based paint etc.)
- Consider manpower and painting equipment issues, and paint retouch up

Quality of painting: The required quality of building wall, ceiling and other parts refinishing has a directs influence on the cost of painting. The desired level of quality will affect the pre-treatment, process, the application process and the amount of rework or touch up required. The quality of building exterior finish is quite different from the quality of interior painting finish. A high quality standard will require a better system, better controls, more inspection and possibly more rework. Its costs more to produce a better finish

Substrate condition: The condition of building wall/ coiling and other building part is also a major factor in the cost of the paint finish. Simple wall/ ceiling, door, windows high volume damages cracks, oil/ grease layer on the wall are heavy, that need to be removed prior to paint application.

The substrate building wall/ceiling door windows damages are special consideration will impact the cost of wall surface preparation. The painting surface must be completely free of contamination before it can be painted

Racking: Another cost consideration is racking. Custom paint racks designed for a new built building can be very expensive.

Rework: Rework and scrap must be accounted for in determining the cost of paint operation. Applying a second coat to building is expensive. A second coat will add thickness that may not be acceptable. Some building parts may need to stripped and in some cases, the part cannot be salvaged at all. The percentage of defects and the method for correcting them is an important cost issue.

Colour change: Colour change time for liquid spray or brush systems impact on cost colour change requires time and wastes material. Gaps in the wall joints line, cleaning solvents and wasted paint are part of the total cost to paint the building.

Applied cost of paint: The applied cost per square foot of a paint material can be calculated to determine the actual cost of painting the wall, special considerations like taping film thickness requirements and special wall/ ceiling and other part surface preparation should be factored in to the total cost.

The cost of coating application is related to the material and efficiency of the paint application process. The following formula provide a method of developing estimated coating per square foot. Actual cost of any process depend on the variables of the materials utilization labour and so forth

Cost per square foot of liquid spray coating: The number 1604 is used as a starting point (the coverage in square feet of 1 gal of paint that is 100% solids, at a film thickness of 1mil and 100% efficiency) To determine the coverage of a gallon of paint, the first piece of information that is factored in the percentage of solids. The solids content of the paint will provide the film, while the solvent and water content will evaporate.

% of solids X 1604 = Theoretical coverage at 100% efficiency (ft2/gal, 1mill thick)

The actual film thickness and transfer for efficiency is then added to calculation

(Theoretical coverage/ film thickness)
X transfer efficiency = actual coverage ft^2 / gal

After the actual coverage is determined, it is a simple step to calculate the applied cost

Cost/gal/actual coverage = applied cost/ft^2

Labour and maintenance costs: The labour cost to run a system will vary with the size of the system, the level of quality expected hours of production frequency of colour change and many other, variables.

Procedure for prepare the building painting estimate costing:

The cost of painting a building interior and exterior estimate cost will be vary from building to building and state to state, place to place and it will also be depend on other factors state to like size of room wall ceiling, wall textures, height of the ceiling, condition of the wall surface, price of paint colour of paint, number of paint coating, living room paint designs, modular kitchen painting designs, space saving furniture, custom wardrobe design weather condition and materials quality etc.

Follow the steps to prepare the painting estimate

- Do a site vist and inspect the building interior and exterior
- Estimate the required paint and calculate the paint cost
- Estimate the cost of materials like-surface preparation materials wall care putty, primer, sealer, masking paper/tape etc.
- Estimate the cost of labour like surface preparation, primer and putty application, paint application, paint repair work, wall cleaning and sludge disposal etc.
- Estimate the cost of rent materials like ladder, sprayer scaffolder, paint bucket , agitator, pump, air compressor and other material rent cost.
- Estimate the paint cost for each coat separately.
- Estimate the different paint colours and quantity separately.
- Decide the margin amount
- Calculate the painting rate for per square foot rate material + labour + paint cost+ time taken= Estimate cost
- Calculate the door, window, modular kitchen painting wall and ceiling calculation separately
- Analyses the paint cost of different paint manufactures and select particular brand of paint and materials and then calculate total paint required to complete the building painting including interior and exterior

For example

Required paint for building interior and exterior

Interior – 50 liter X Rs.200 per liter = 10,000/-
Exterior – 70 liter X Rs. 250 per liter = 17500/-
Kitchen – 5 liter X Rs. 300 per liter = 1500/-
Door painting – 5 liter X Rs. 200 per liter = 1100/-
Windows painting – 4 liter X Rs. 200 per liter = 800/-
Decorative paint – 7 liter X Rs.150 per liter = 1050/-
Furniture paint – 6 liter X Rs. 230 per liter = 1380/-
Primer – 20 liter X Rs. 100 per liter = 2000/-
Wall putty – 2kg X Rs. 150 per kg = 300/-
Total paint cost = Rs.35630/-

As mentioned above example calculate the remaining works and then add the all total cost to find the estimate cote of building and then add the margin amount with estimate cost of building. Total Estimate Cost = Paint Cost + Material Cost+ Actual Labour Cost + Material Rent Cost + Electrical Cost + Supervission Cost + Margin Amount

Calculation of building height and width:

Calculation of ceiling = each room length X width (Fig 1)

Room wall calculation = (number of wall X width X length X height) - (door of window cub board length X width)(number of each one) (Fig 2)

Fig 1

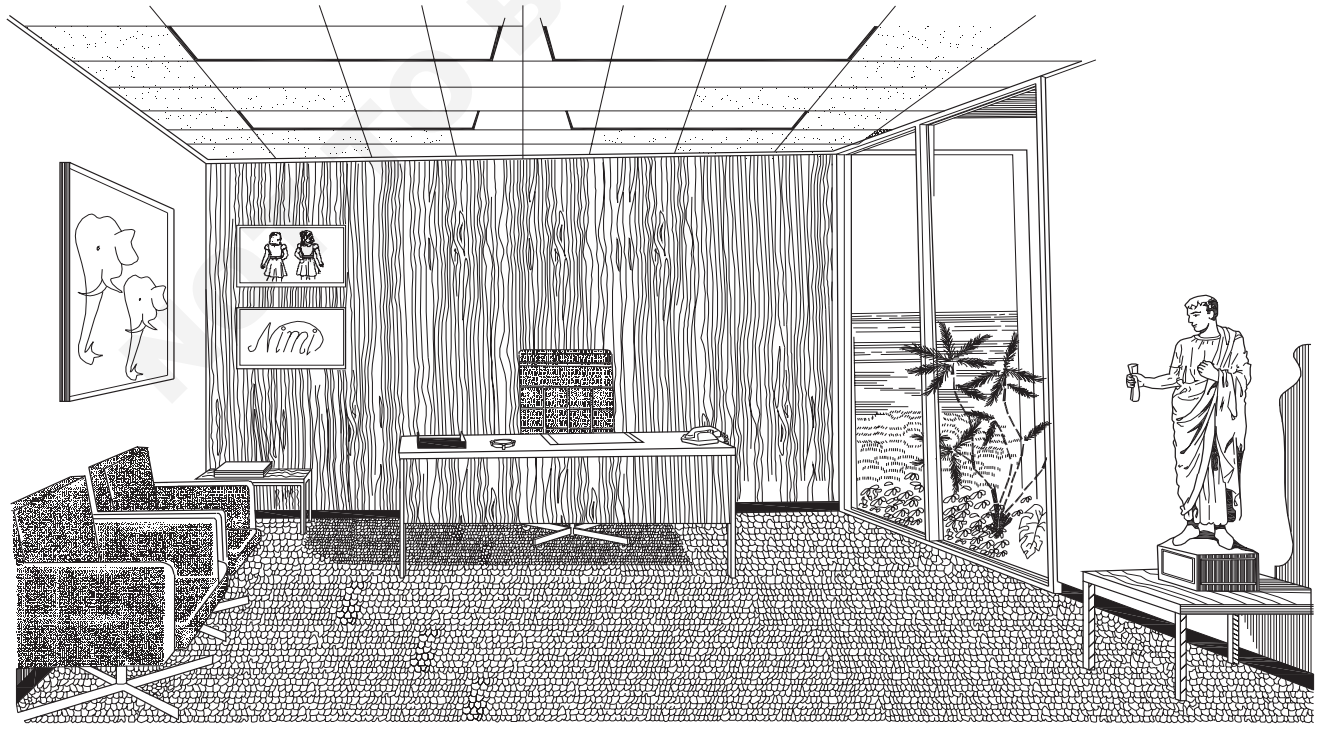
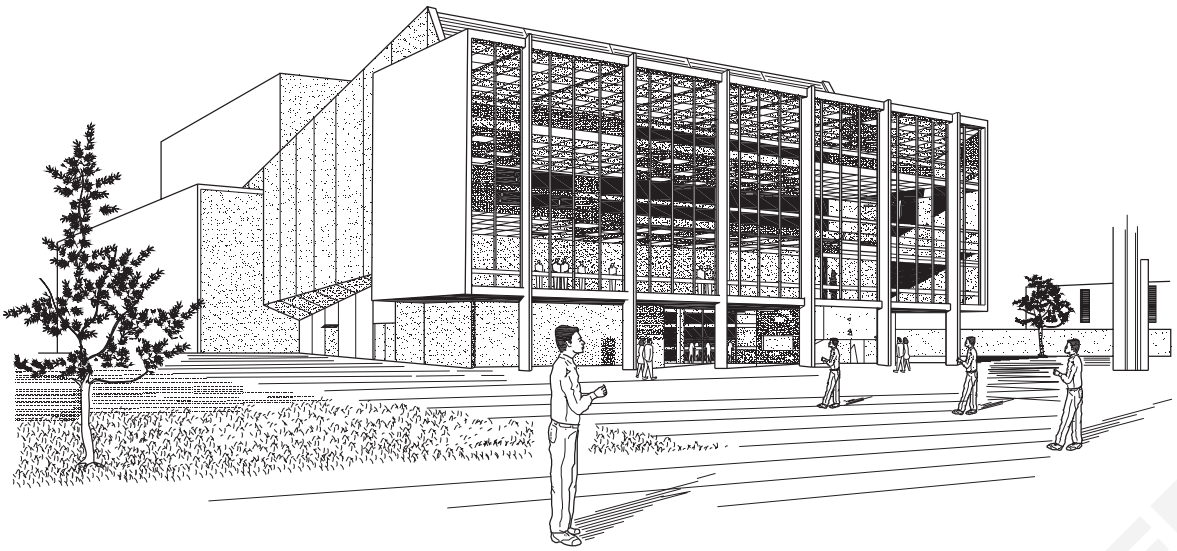


Fig 2



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Pipe line painting and ISI colour code

Objectives: At the end of this lesson you shall be able to
- **state the intention and effects of pipe line painting**
- **state the ISI colour code for pipe lines.**

Effects of pipe line painting: Pipe line painting may be carried out with certain cautions deviations from these requirements such as painting without stipulated surface preparation, painting includes surface preparation clean up and application of painting. The steps of painting instructions are printed on the paint packing label by the paint manufactures. The paint manufacturers detailed information about their paint effectiveness and durability of the paint system. Scope of pipe line painting covered in this specification shall include but not limited to the following.

- Surface preparation
- Selection and application of painting on piping
- Follow the instruction for storage
- Surface preparation prior to painting
- Paint mixing and thinning
- Application of paints and recommended limit on time intervals between coats

Surface preparation: Metallic pipe line that are usually given practice coating are heavily contaminated and require, at least some cleaning treatment before the coating is applied. The importance of surface preparation cannot be over emphasized as many investigations have shown convincingly that the performance and durability of any protective coatings are to a large extent governed by the thoroughness of surface preparation careful cleaning and preparation of the surface is more important then the quality of the protective coating.

Pipe line surface contamination in the form of rust scale oil grease and dirt must be removed before painting. Invisible contamination may also be present and represents, on the whole a greater hazard

Use the following methods to pipe line surface preparation

- White metal blast or near white metal blast
- Acid pickling
- Brush blast
- Flame cleaning and power sanding
- Power tool cleaning
- Chip and hand wire brush
- Solvent wipe

Note: sand blast is not allowed in refinery Mot inspect the sanded surface before painting.

Paint application: The purpose of painting/coating application is to develop a continuous highly adherent film with an even thickness over the pipe line to achieve this various factors have to be considered such as type of coating application methods.

Paint application restrictions: For all painting cases, paint manufacturers guidelines shall be followed the following restrictions are given as recommended practices

1 coating application shall not be permitted during fog, mist or rain

2 coating application shall not permitted, when the relative humidity is 85% or above.

- Coating application shall not be permitted when the steel surface temperature and/or ambient temperature is below 10 degrees centigrade (50°F)
- Coating application shall not permitted when steel surface temperature is less than 3°C(5°F) above the dew point.
- Coating application shall not be permitted, when the steel surface temperature and/or ambient temperature is above 50°C(120°F)
- Humidity and dew point readings shall be taken by contractor with a sling psychometric meter and calculated using psychometric tables. Reading shall be taken prior to coating operation commencing and at least every four hours while paint coating application is on going
- Coating shall not be applied before the surface has been inspected and the preparatory work approved
- All sharp projection shall be ground to min 2mm radial and a thick stripe coat shall be applied at sharp edges.
- Fresh water blasting or fresh water mopping shall be carried out on salt spray area before application of primer to remove the salts deposited on metal surface mopping can be repeated before application of other coats to remove salts deposited on previous coats if such deposits are suspected. The permissible chloride content for water used shall be 50 ppm maximum.

Inspection and testing of painting pipes

- Inspect the painted pipe line, paint colour, thickness, and paint defects on the pipe line surface inspect the each stages of painting
- Surface preparation
- Metal conditioner application
- Primer application
- Dry film thickness
- Each coat of paint
- Wet film thickness.

Need of pipe line painting: High quality painting of piping equipment is essential to prevent corrosion. It helps insure longevity of constructed installation and low maintenance costs.

Paint coatings reduce corrosion. Corrosion can result on the inside and outside of pipe due to corrosive components of the liquid/gas being transported. The pipe paint coating reduces corrosion. Paint coating need to be carefully applied and maintained in order to effectively prevent corrosion.

Select an enamel or oil based metal paint and primer make sure both products are compatible with the type of pipe painting. Generally, metal paint and primer comes in both spray on and paint on varieties, that work on almost any type of metal surface. PVC pipe line paint and that is to use specific paints designed for PVC and plastic. Latex or acrylic ideally used to paint PVC.

Pipe line colour code: Pipe line colour coding provides important information about the hazard presented by the pipe's contents. The text identifies the pipe's contents by name and may also indicate temperature or pressure.

The pipe lines are used in facilities to transport liquids and gases from one place to another place, both short and long distances. Most facilities have dozens of pipes moving substance, from place to place and because of this, it is important to be able to keep track of the contents in each pipe as well as its destination. The following pipe colour coding is extremely helpful for obtaining crucial information about a pipe paint colour standards and formates vary from country to country contents. So, refer the particular countries pipe line ISI colour code.

Pipe line ISI colour code: The Indian Standard covers the colour scheme for the identification of the contents of pipelines carrying fluids in domestic and public buildings, such industrial installation where a specific colour code does not exist. For the purpose of this standard, piping systems shall include pipes of any kind and in additional fittings, valves and pipe coverings. Pipe line supports and brackets or other accessories are specifically excluded from application of this standard. This colour code standard is not applicable to pipeline buried underground or used for electrical services.

A scheme consisting of colour code or lettering or word or a combination of both intended for the identification of the contents of the pipelines.

Pipe line paints: Appropriate quality conforming to relevant Indian Standards, shall be used for colour marking. This pipe line colour code excludes media used for the pneumatic conveyance of solids. Recommended pipe line paints used should be produce a glossy finish in order to identify the contents of the pipe lines, a large number of colour shades are required. The system of colour coding consists of a ground colour and colour bands super imposed on it.

Ground colours: The ground colour identifies the basic nature of the fluid carried and also distinguishes one fluid from another (Fig 1). The various ground colours are indicated in Table 1.The ground colour shall be applied throughout the entire length for uninsulated pipes.

Fig 1

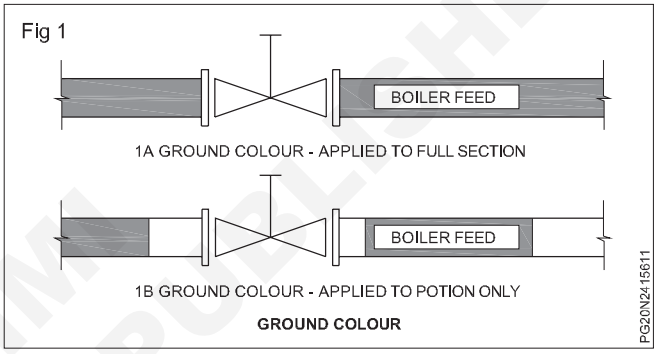


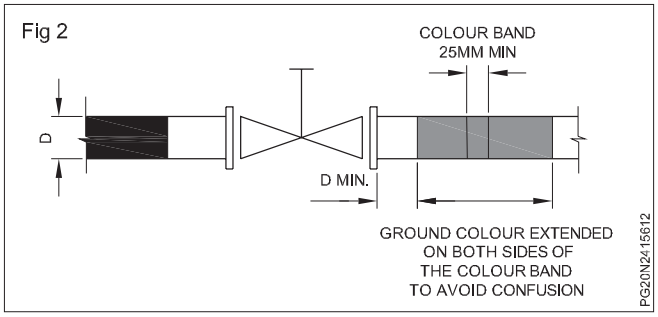
Table 1

Substance	Colour
Water	Sea green
Steam	Aluminium to IS 2339
Mideral, Vegetables and animal oils, combossible liquids	Light
Acids	Dark violet
Air	Air blue
Gases	Canary yellow
Alkalilcs	Smoke grey
Other liquids gases which do not need identifcation	Black
Hydrocarbon organic compounds	Dark admirality grey

Colour bands: Colour bands are super imposed on the ground colour to distinguish. (Fig 2)

Pipe line colour application: Ground colours are as given Table 1 shall be applied in one of the following ways.

- Throughout the entire length of pipe. (Fig 1A)
- As a colour coating of adequate length. (Fig 1B)
- As a colour panel



- On a label attached to the pipe or by the use of coloured adhesive tapes of suitable materials.

Whenever the ground colour is not applied throughout the entire length it shall be applied near valves, functions joints services appliances bulkheads, walls etc. (Fig 3)

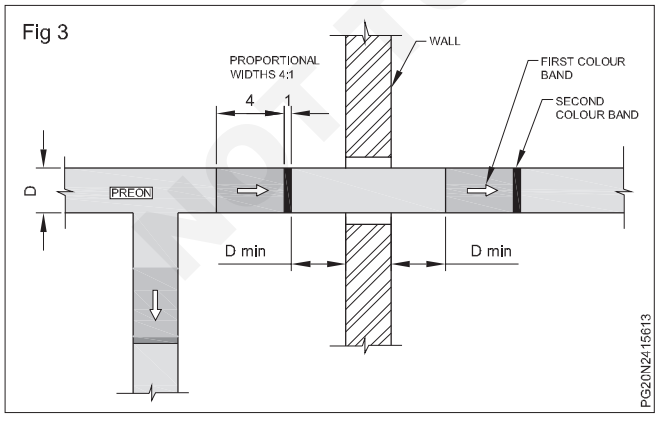
When colour bands are superimposed on the ground colour the ground colour shall extend sufficiently on both sides of the colour bands to avoid confusion (Figs 2 & 3)

Colour bands: They shall be superimposed on ground colour at the following location:

- At battery limit points
- Intersection point and change of direction point in piping ways:
- Other points such as midway of each piping way near valves junction joints of service appliances, walls on either side of pipe culverts.
- For long stretch yard piping at 50 m interval: and
- At start and terminating points.

Colour bands shall be arranged in the sequence shown in tables 2 to 5, and the sequence follows the direction of flow (Fig 3) for example, Fig 3 shows the colour code for a pipe carrying from where the light grey and dark violet colour bands have sequence numbers 1 and 2.

The relative proportional widths of the first colour hand to the subsequence bands shall be 4: 1 (See Fig 3)



As a rule minimum width of colour band shall confirm to the following table.

Normal pipe size	Width L (mm)
80 NB and below	25
Over 100 NB up to 150 NB	50
Over 200 NB up to 300 NB	75
Over 350 NB	100

For insulated pipes nominal pipe size means the outside diameter of insulation

Valve shall be painted with the same colour as the main pipelines except when the pipeline has been provided with the safety colour , the valves shall be painted red, for fire fighting : yellow with black diagonal stripes , for warning of danger : and French blue in conjunction with the green basic colour , to denote pipes carrying fresh water, either potable or non – potable.

The colour coding as prescribe in this standard and as applicable to pipelines for general services, pipelines conveying industrial gases hydrocarbons and naphtha and pipelines conveying medical gases are given in tables 2, 3, 4 and 5 respectively.

All uninsulated pipes having temperatures above 100 C (Heat resistant Aluminium painted) need not be identified with colour bands. As special case if required with colour bands may be applied using Teflon Tape.

Hazards: When it is desired to indicate that a pipeline carries a hazardous material, a panel of colour of suitable width (minimum 100 mm) as given below shall be superimposed on the ground colour at suitable intervals:

- Slightly radioactive Hazards – a base colour of jasmine yellow with black dots suitably superimposed (see Fig 4A)
- Highly radioactive hazards – a base colour of light orange with cross diagonal swipes of black colour, suitably superimposed (see Fig 4B); and
- Other Hazards – Equal diagonal stripes of black and golden yellow colours (see Fig 4C). Different legends for various types of hazards other than radioactivity like that for flammable or explosive materials, chemically active or toxic materials, etc, may be indicated by lettering.

Table 2 - Colour Code for General Services Contents

Contents	Ground Colour	First Colour Band	Second Colour Band
WATER:			
Cooling	Sea green	French blue	-
Boiler feed water	Sea green	Gulf red	-
Condensate	Sea green	Light brown	-
Drinking	Sea green	French blue	Signal red
Treated	Sea green	Light orange	-
Fire water	Fire red	Crimson red	-
Central heating below 60°C	Sea green	Canary yellow	-
Central heating 60°C to 100°C	Sea green	Dark violet	-
Central heating above 100°C	Sea green	Dark violet	Signal red
Cold water down service from storage tanks	Sea green	French blue	Canary yellow
Domestic, hot	Sea green	Light grey	-
Hydraulic power	Sea green	Black	-
Sea, river, untreated	Sea green	White	-
Filtered water	Sea green	Light brown	-
Soft water	Sea green	Light brown	Signal red
Warm water	Sea green	Light grey	Canary yellow
Chilled water	Sea green	Black	Canary yellow
Sprinkle and hydrant water	Sea green	White	Signal red
Waste water	Sea green	Canary yellow	Signal red
Demineralized water	Sea green	Gulf red	-
Process water	Sea green	Oxied red	-
Wash water	Sea green	Canary yellow	-
Quench	Sea green	Dark grey	-
AIR:			
Compressed, up to and including 15 kg/cm	Sky blue	-	-
Compressed to over 15 kg/cm	Sky blue	Sky red	-
Plant air	Sky blue	Silver grey	-
Instrument air	Sky blue	French blue	-
Dry Vacuum	White	-	-
Wet vacuum	White	Dark violet	-
Very high pressure steam	Aluminium to IS 2339	Signal red	-
High pressure steam	Aluminium to IS 2339	French blue	-
Medium pressure steam	Aluminium to IS 2339	Gulf red	-
Low pressure steam	Aluminium to IS 2339	Canary yellow	-
Drainage	Black	-	-
Town gas	Canary yellow	-	-
OILS:			
Light diesel fuel	Light brown	Brilliant green	-
High speed diesel fuel	Light brown	-	-
Paraffin oil	Light brown	Signal red	-
Quenching oil	Light brown	Canary yellow	-
Furnace fuel	Light brown	French blue	-
Lubricating oil	Light brown	Light grey	-
Hydraulic power	Light brown	Dark violet	-
Transformer oil	Light brown	Light orange	-

Table 3 - Colour Code for Industrial Gases

Contents	Ground Colour	First Colour Band	Second Colour Band
Ammonia	Canary yellow	Dark violet	-
Chlorine	Canary yellow	Dark violet	Light orange
Hydrocyanic acid	Canary yellow	Dark violet	Post office red
Phenole	Canary yellow	Dark violet	Smoke grey
Sulphur dioxide	Canary yellow	Dark violet	Gloden brown
Acetylene	Canary yellow	Service brown	-
Flare gases	Canary yellow	-	-
Hydrogen sulphide	Canary yellow	Gulf red	-
Argon	Canary yellow	French blue	-
Benzole	Canary yellow	Dark violet	French blue
Blast furnace gas	Canary yellow	Signal red	Light grey
Butane	Canary yellow	Signal red	-
Coal gas	Canary yellow	Signal red	Brilliant green
Carbon dioxide (temperate)	Canary yellow	Light grey	-
Carbon monoxide	Canary yellow	Signal red	White
Coke oven gas	Canary yellow	Signal red	Dark violet
Ethylchloride (inflammable)	Canary yellow	Light grey	Signal red
Ethylchloride (non-inflammable)	Canary yellow	Light grey	White
Ethylene	Canary yellow	Dark violet	Signal red
Ethylene oxide	Canary yellow	Dark violet	Brilliant green
Freon (chlorofluoro derivative of methane and ethane)	Canary yellow	Light grey	Dark violet
Helium	Canary yellow	Light brown	-
Hydrogen	Canary yellow	Signal red	French blue
Methane	Canary yellow	Signal red	Light brown
Methylbromide	Canary yellow	French blue	Black
Methylchloride (inflammable)	Canary yellow	Brilliant green	Signal red
Methylchloride (non-inflammable)	Canary yellow	Brilliant green	French blue
Neon	Canary yellow	Light brown	Black
Nitrogen	Canary yellow	Black	-
Oxygen	Canary yellow	White	-
Propane	Canary yellow	Signal red	Black
Phosgene	Canary yellow	Black	White
Fuel gas and sour gas	Canary yellow	Grey	Dark violet
Sweet gas	Canary yellow	Grey	-
Residue gas, LPG	Canary yellow	Oxide red	White
Charge gas	Canary yellow	Signal red	French blue
Aromatic gasoline	Dark Admiralty grey	Brilliant green	Canary yellow
Pyrolysis gasoline	Dark Admiralty grey	Brilliant green	Black

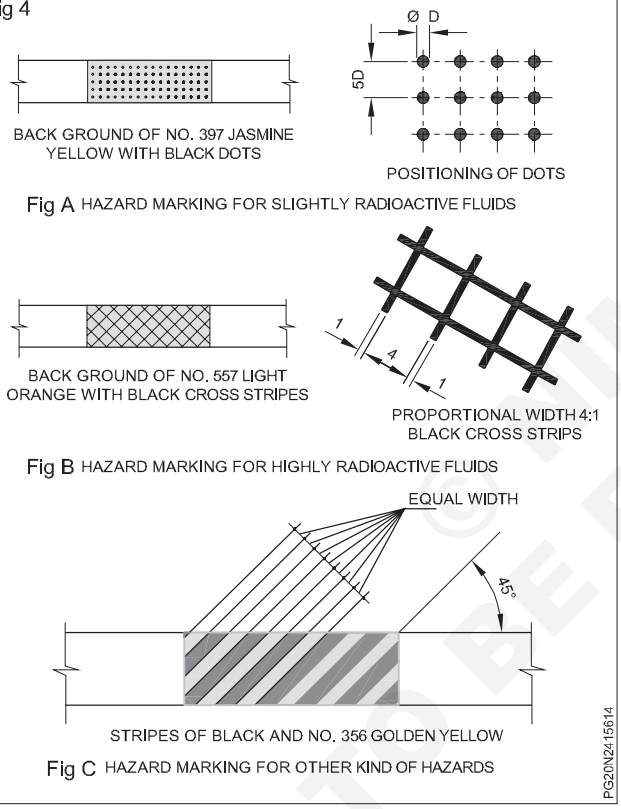
Table 4 - Colour Code for Hydrocarbons and Naptha

Contents	Ground Colour	First Colour Band	Second Colour Band
Propylene F.P. (Liquid)	Dark admirality grey	Brilliant green	-
Propylene (C.G.) (Liquid)	Dark admirality grey	Brilliant green	Smoke grey
Ethylene glycol	Dark admirality grey	Brilliant green	Gulf red
Ethylene Di-chloride	Dark admirality grey	Gulf red	-
Benzene	Dark admirality grey	Canary yellow	-
Butadina	Dark admirality grey	Black	-
Acetone	Dark admirality grey	Black	-
Methanol	Dark admirality grey	Deep buff	Canary yellow
Naptha	Dark admirality grey	Light brown	Black
Ethane (Liquid)	Dark admirality grey	Light grey	French blue
Propylene (Liquid)	Dark admirality grey	Signal red	Black
Kerosene	Light brown	Brilliant green	Dark violet
LPG (Liquid)	Dark admirality grey	Brilliant green	Dark violet
ACIDS			
Phosphoric acid	Dark violet	Silver grey	-
Hydrofluoric acid	Dark violet	Signal red	French blue
Sulphuric acid	Dark violet	Brilliant green	Light orange
Nitric acid	Dark violet	French blue	Light orange
Hydrochloric acid	Dark violet	Signal red	Light orange
Acetic acid	Dark violet	Silver grey	-
CHEMICAL & ALLIED PRODUCTS			
Brine	Black	White	-
Caustic solution	Smoke grey	Light orange	-
Classified	Black	Canary yellow	-
Spinbath concentrative sulphuric acid	Dark violet	Brilliant green	Canary yellow
Dissolving	-	Light orange	White
Causted	Dark violet	Light orange	-
Evaporated spinbath	Black	Canary yellow	Brilliant green
Fleculent solution	Black	Brilliant green	-
Lime	Smoke grey	White	Canary yellow
Mercury	Black	White	Brilliant green
Rum-off caustic	Smoke grey	White	-
Recovered caustic	Smoke grey	Signal red	White
Carbon disulphide	Black	Light orange	-
Strong caustic	Smoke grey	French blue	White
Steeping caustic	Smoke grey	Goldern yellow	-
Sodium sulfide	Black	Brilliant green	Canary yellow
Soap solution	Black	Light orange	White
Spinbath supply	Black	White	Canary yellow
Spinbath return	Black	Goldern yellow	-
Sodium carbonate solution	Dark violet	Jasmine yellow	-
Waste caustic	Dark violet	White	Canary yellow
Waste spinbath	Black	Jasmine yellow	-
Viscose	Black	Goldern yellow	Brilliant green

Table 5 - Colour Code for Medical Gases

Gas	Ground Colour Band	First Colour Band	Second Colour Band
Air	Sky blue	White	Black
	Canary Yellow	Light orange	
Carbon oxide	Canary Yellow	Light grey	
Ethyens	Canary Yellow	Dart Yellow	Signal red
Helium	Canary Yellow	Light brown	
Oxygen	Canary Yellow	White	
Oxygen and carbon oxide mixture			
Oxgyen and helium mixture	Canary Yellow	White	Light grey
Nitrous oxide	Canary Yellow	White	Light bronw
Nitrogen	Canary Yellow	French blue	Signal red
Vacuum	Canary Yellow	Black	
	Sky blue	Black	

Fig 4

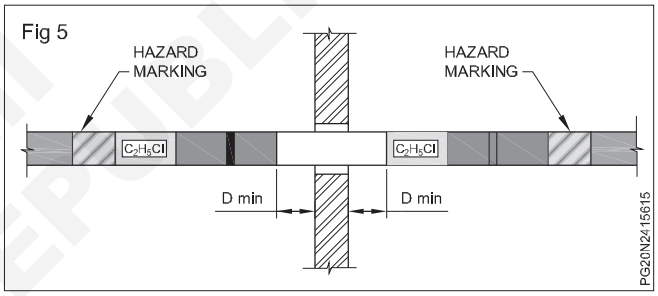


Additional identification: When further identification is required to supplement the colour code this may be done by the particular industry for its own use.

Lettering: Lettering is recommended for chemical industry (see Fig 3 and 5), for the products not covered in tables 2 to 5. For steam, temperature and pressure shall be indicated after colour indication, by lettering. The recommended size of lettering for pipes of different diameters is given below:

Outside Diameter of pipe or covering	size of Legend
mm	mm
20 to 30	10
Above 30 to 50	20
Above 50 to 80	30
Above 80 to 150	40
Above 150 to 250	90
Over 250	

Fig 5



Direction of Flow: Where it is required to indicate of flow, arrows or letters may be painted near valves junctions, walls, etc, and at suitable intervals alone the pipe, in a manner best suited to local conditions. (See Fig 3)

These shall be black or white in colour and in contrast to the colour on which they are superimposed. If a label or badge with a codified indication is attached to the pipe, the direction of flow may be indicated by the pointed end of the label or badge.

Sizes of arrow shall be as given in Fig 6.

For central heating systems or other closed circuits where it is necessary to indicate separately, the flow and return pipes, this shall be done by the use of the word 'FLOW' or the letter 'F' on the one pipe and the word ' RETURN' or the letter 'R' on the other.

Visibility of markings: Attention shall be given to the visibility of colour marking and the lettering. Where the pipelines are located above the normal line of vision of the operator, the lettering shall be placed below the horizontal line of the pipes, as shown in Fig 7.

Preferably colouring shall be all around the pipe wherever possible, if not, the extent of colouring along the circumference is to be decided by purchase Engineer in charge depending upon direction of visibility at site.

Fig 6

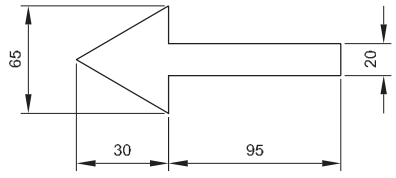


Fig A - FOR PIPES DN 200 AND BELOW

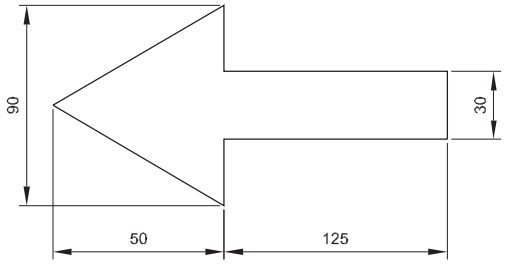


Fig B - FOR PIPES ABOVE DN 200

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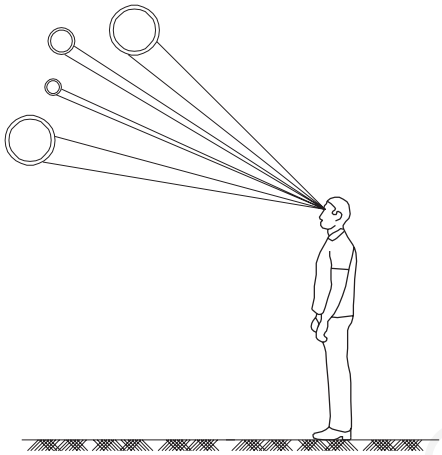
Fig 7



POSITIONING OF MARKING FOR VISIBILITY

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The electrical illumination of plant in the night should be such that the shades of colours are not affected to ensure proper visibility in the night. Wherever legends and colour bands are indicated, their location should be such that they are easily visible from floor/ ground level during day time and extra illumination should be provided over them for night time or wherever visibility is poor.

Pipe colour coding is not a complicated process there are many standards out there from a variety of sources but by for the most popular is the ANSI/ASME A13.1,B18 standard. This standard explains colour, text, size, and placements of pipe marking labels the standard colour-coding make it easy to identify the pipes. Pipe line standard colours examples given as blow

Pipe line colours

Yellow	-	Flammable and oxidizing fluids
Red	-	Fire quenching fluids
Orange	-	Toxic and corrosive fluids
Green	-	All water (potable, boiler etc.)
Blue	-	All air (compressed, lab etc.)
Brown	-	Combustible fluids
White	-	All types of water

Colour, words and symbols: It is indicates all necessary information stamped on the label. The colour of pipe line label is one of the most important features because, label can be able to see it from a distance.

Words: writing out the contents of the pipe is important these words should be easy to read so choose a simple font.

Symbols: Most pipe markings will also have symbols a label can also have common warning symbols to alert people to potential dangers in many countries.

Corrosion

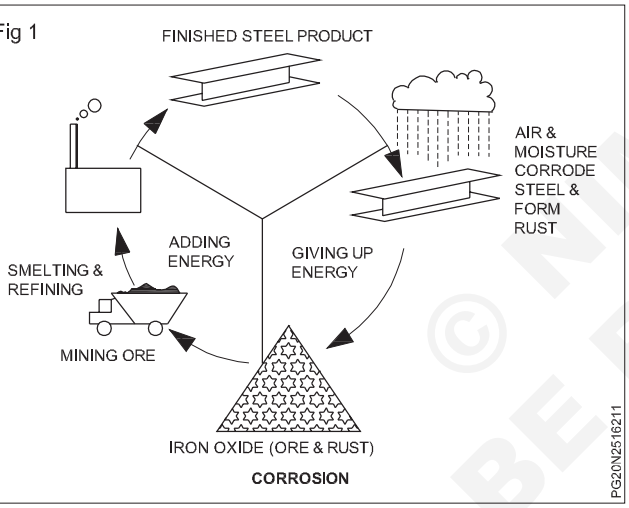
Objectives: At the end of this lesson you shall be able to
- **state the corrosion definition and classification**
- **state the cause for rusting and effect of climate**
- **state the anti-rusting process.**

Corrosion: Corrosion is when a refined metal is naturally converted to more stable from such as its oxide, hydroxide, or sulphide state this leads to deterioration of the material.

Cause for corrosion: Obviously, the most common type of corrosion is the formation of rust or iron oxide on the surface of metals containing iron, when acidic substances. Come in contact with metals such as iron and steel. Rust begins to form. Even dirt and bacteria.

Corrosion also happen when metals like steel are placed too much stress causing the material to crack. (Fig 1)

Fig 1



There are two types of corrosion

Chemical corrosion

Atmospheric corrosion

And other types of corrosion

1 Uniform Corrosion
2 Two Metal Corrosion
3 Crevice Corrosion
4 Pitting
5 Inter Granular Corrosion
6 Selective Leaching
7 Erosion Corrosion
8 Stress Corrosion Cracking
9 Galvanic Corrosion

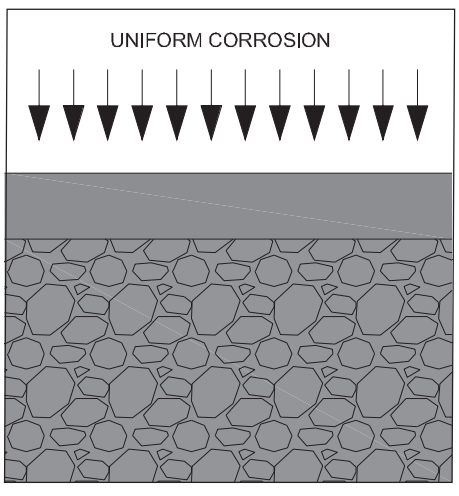
Anti Corrosion Materials: Anti Corrosion refers to the protection of metal surfaces from corroding in high risk environments. When metallic materials are put into corrosive environments, they tend to have chemical reactions with the air or water. The effects of corrosion become evident on the surfaces of these materials.

- Epoxy resins
- Painting materials
- Adhesives
- Laminates
- Nickel or chrome, electroplate
- Composites
- Potting
- (Encapsulank) for semiconductors
- Insulating material for electrical
- Silicones and phosphorus based compound
- Aluminium and zinc coating

Corrosion of iron: The most type of iron corrosion occurs, when it is exposed to oxygen and the presence of water which creates a red, iron oxide commonly called rust. Rust can also effects iron alloys such as steel. The rusting of iron can also occur, when iron reacts with chloride in an oxygen deprived environment while green rust, which is another type of corrosion, can formed directly from metallic or iron hydroxide.

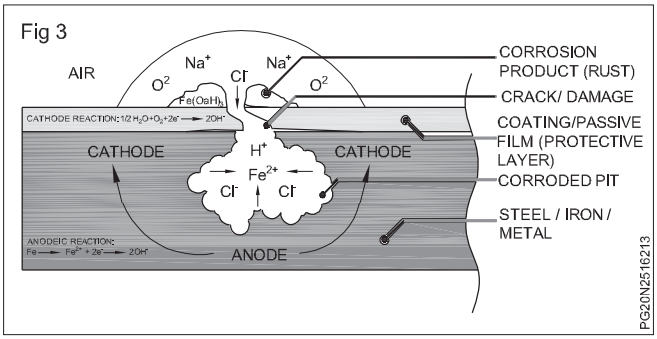
Uniform Corrosion: - It is a common form of corrosion which usually takes place evenly over large of a materials surface (Fig 2)

Fig 2



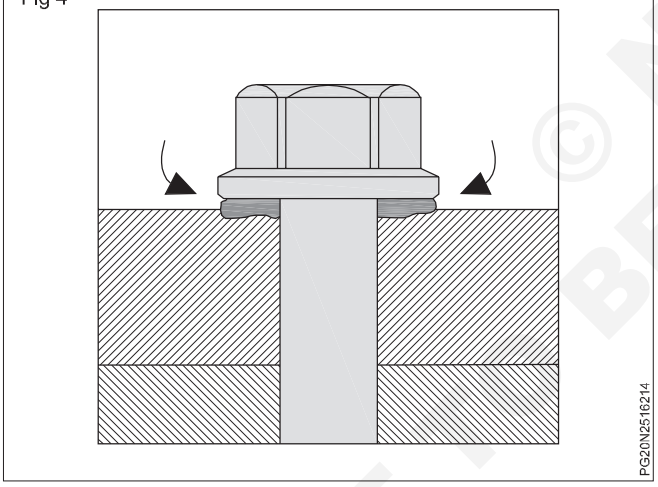
Pitting Corrosion: Pitting corrosion can be hard to predict detect or characterised it is happen when a local anodic or cathodic point forms a corrosion cell with the surrounding surface. This pit can create a hole or cavity. This type of corrosion penetrates the material in a vertical direction down from the surface. Pitting corrosion can be causes by damage or a break in the oxide film and also be caused through non-uniformities in the structure of the metal. (Fig 3)

Fig 3



Crevice Corrosion: This form of corrosion occurs in areas where oxygen is restricted such as under washers or bolts heads it usually results from a difference in the iron concentration between two areas of metal crevice corrosion can take place at lower temperature than pitting corrosion but can be minimised by proper joint design. (Fig 4)

Fig 4

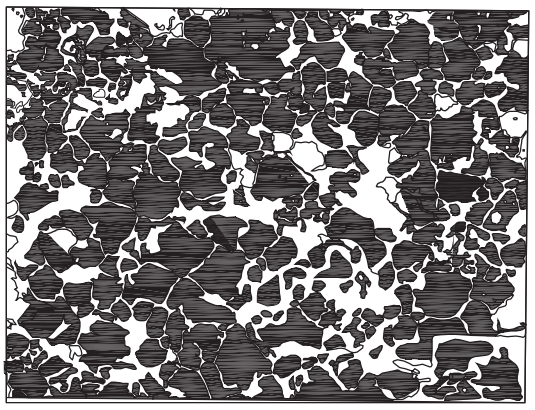


Granular Corrosion: It is occurs when impurities are present at the grain boundaries which form during solidification of an alloy. This type of corrosion occurs along or adjacent to the grains, affecting the mechanical properties of the metal despite the bulk of the material being unaffected. (Fig 5)

Stress Corrosion Cracking: It refers to the growth of cracks due to a corrosive environment, which can be lead to the failure of ductile metals when subjected to tensile stress particularly at high temperatures.

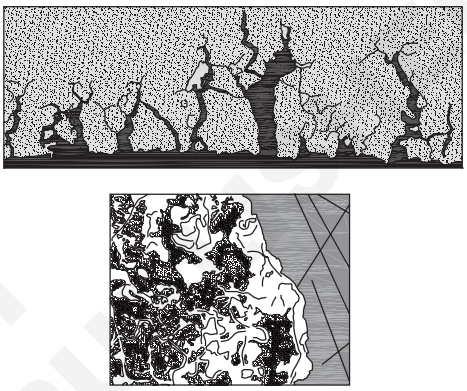
Galvanic corrosion: It is occurs when two different metals with physical or electrical contact are immersed in a common electrolyte or when a metal is exposed to different concentrations of electrolyte. Where two metals are immersed together, it is known as galvanic couple

Fig 5



INTER GRANULAR CORROSION

Fig 6

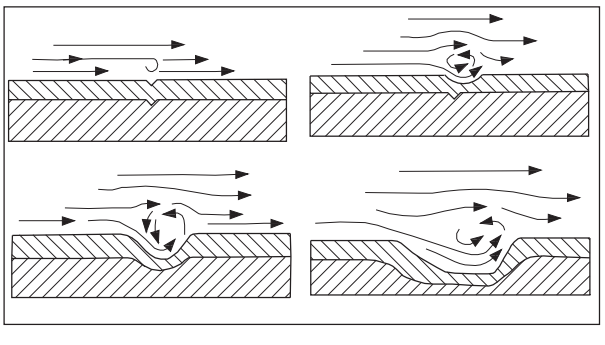


the more active metal corrodes fast than the more noble metal. Which is useful when using a sacrificial anode to protect a structure from corrosion

Effect of Corrosion: - It is occurred poorly planned construction projects can lead to a corroded structure needing to be replaced it can be prevented with proper application corrosion protection. Corrosion can lead to safety concerns loss of life additional indirect costs and damage to reputation.

Erosive Corrosion: - It is occurred by mechanical abrasive due to the relative movement between the metal surface and corrosive liquids. This type of corrosion is commonly seen in metals carrying moving fluids in them. (Fig 7)

Fig 7

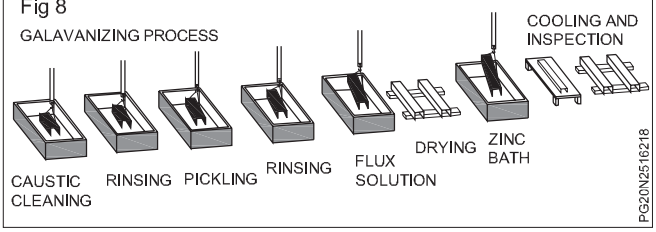


Corrosion Prevention of Rusting: Corrosion can be prevented by the following methods.

- By painting
- By applying grease or oil
- By galvanisation the process of depositing a thin layer of zinc metal on iron
- By the tin plating and chromium plating
- By alloying it
- By selection of optimum material
- By using corrosion inhibitors.

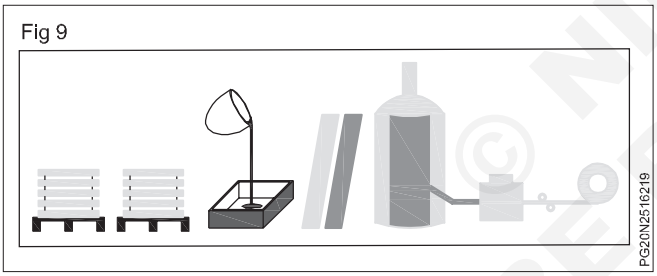
Galvanization: Galvanized metal is coated with a thin layer of zinc to protect it against corrosion. The zinc oxidizes when it is exposed to air creating a protective coating on the metal surface.(Fig 8)

Fig 8



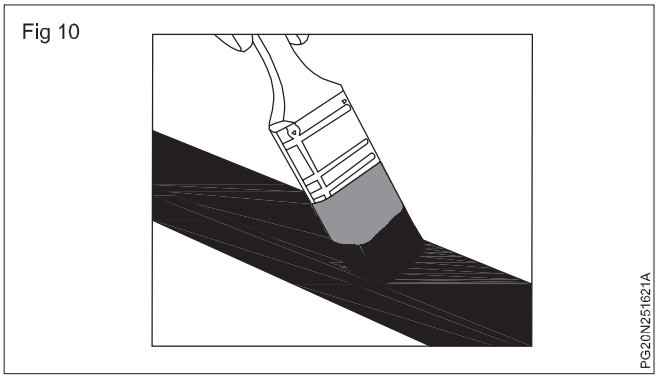
Alloying: It is the method for improving the properties of a metal by mixing the metal with another metal or non-metal for example stainless steel, it does not rust at all.(Fig 9)

Fig 9



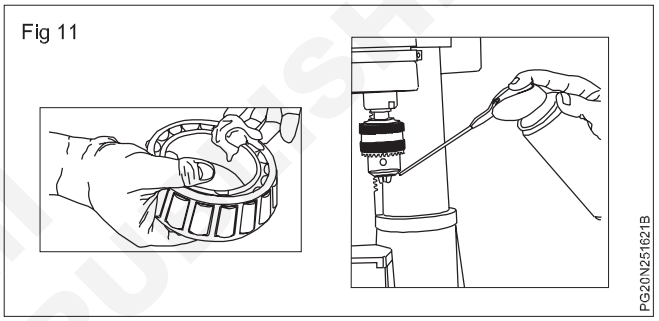
Painting: Rusting of any metal can be prevented by coating the surface with paint which protects iron from air and moisture.(Fig 10)

Fig 10



Greasing/Oiling: - When oil grease is applied on the surface of an iron object, then air and moisture can't come in contact with it and hence metal rusting is prevented. (Fig 11)

Fig 11



Metal Surface Preparation

Objectives: At the end of this lesson you shall be able to
- **state the types of sand papers**
- **state the types of sanding and cleaning method.**

Sand Paper: Sand paper is used for sanding a wood, metal, drywall surface preparation before painting the object. Sanding can be done by hand as well as in tandem with power tools. The electric sanders to create the best finishes on these materials, sand paper also used to prepare metals for a paint job

Sand paper for power sander is solid in the shape of sheets, belts and discs.

Sand paper grit grads is a key to completing a sanding application choose the sand paper grit accordingly with sand paper grit chart

The grit of sand papers is a rating of the size of abrasive materials on the sand paper. The grit numbers represent coarser abrasives that scrape off materials much quicker. The higher grit number is equivalent to a finer abrasive, which creates smoother surface finishes.

Sand Paper Types: Besides the grits and grades,from sand paper is made out of materials that vary from chemically it can be made from the grains of natural minerals like a garnet or from synthetic ones like aluminium oxide, alumina zirconia or silicon carbide. The sand paper grit and its backing material. Backing for sand paper includes paper, cotton, polyester, rayon PET film and rubber. Mylar is used to as backing for extremely fine grits. Grit size refers to the specific size of the abrasive grain 36, 60, 80, 120 etc, while grade is a broader term with each grade including a range of grit, rough, medium and fine grade.

Selection of Sand Paper: According to the metal type and their condition, select the sand paper grit size and grade of sand paper identify the type of sanding system required to prepare the metal surface (Dry sanding / Wet Sanding).

Using the Right Grit: For heavy sanding and stripping you need coarse sand paper measuring 40 to 60 grit, for smoothing surfaces and removing small imperfections, choose 80 to 120 grit sandpaper. For finishing surfaces smoothly, use a super fine sand paper with 360 to 600 girt.

Power Sanding: An electric power tool is used to prepare the job with smooth and finish surfaces and it is used to remove material from the surface. The sander moves a piece of sandpaper or another abrasive rapidly, often in a circular motion. You can use an electric sander for a variety of tasks in many industries including auto body repairand finishing works.(Fig 1)

Fig 1

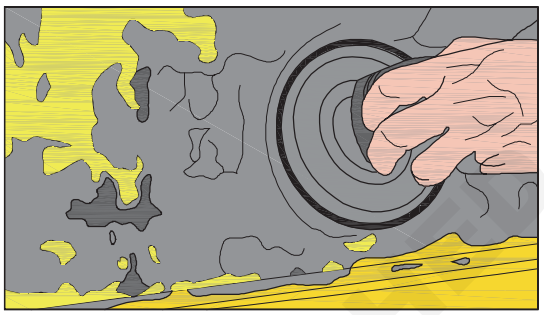


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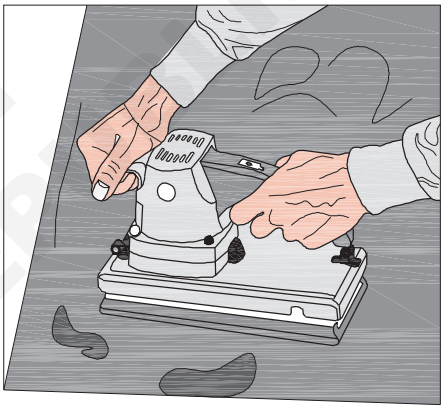
Fig 2



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Wet Sanding: The wet part of wet sanding refers to the use of water or some other liquid as lubrication to help carry away grit particles that are removed. Without the liquid, material can build up in the sand paper and leave behind scratches that are larger than the particle size running surface finish.(Figs 3A, 3B, 4)

1 Wet sanding does not generate dust and you can feel the smoothness of a body as you sand.

2 Use plenty of water when wet sanding. Water speeds the sanding action by washing away debris that can clog ultrafine grit.

3 When final wet sanding that or gently curved surfaces, use a sanding block will help plane down and level minor surface imperfections much better than just using your hand.

Fig 3

Fig A

Fig B

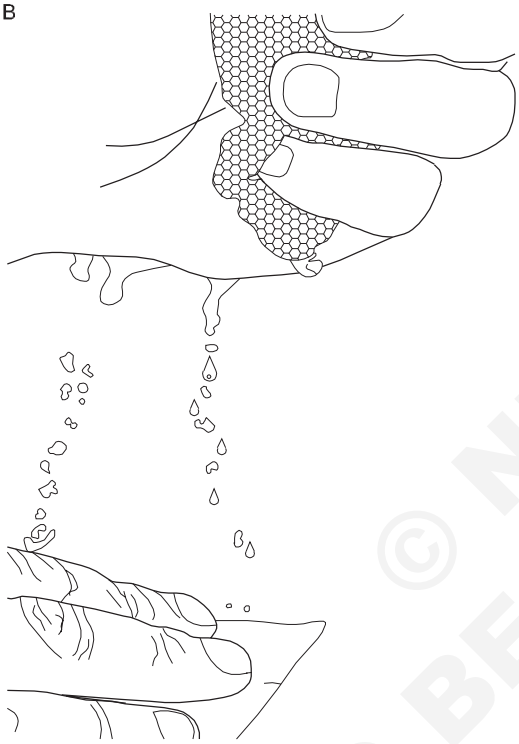

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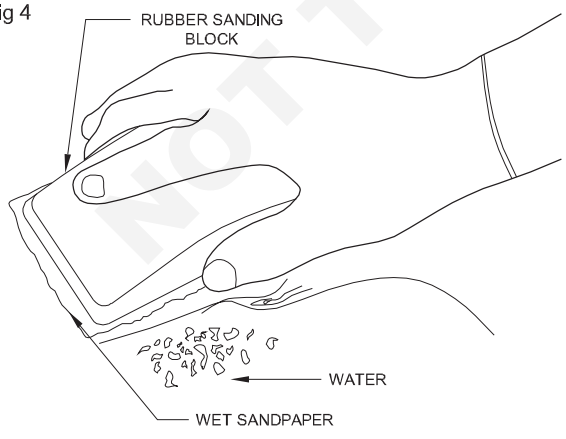
Fig 4



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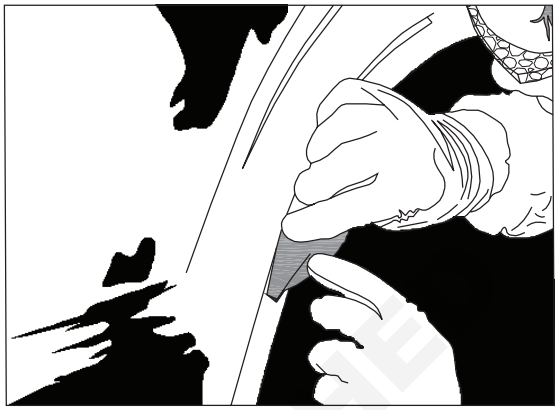
Hand Sanding: The purpose of flat surface hand sanding is to remove any marks or imperfections on the panel surface. Hand sanding blocks are increase the speed and efficiency of your work as well as providing a more even finish due to weight being distributed evenly across the block. (Fig 5)

Fig 5



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The flex pads shaped block will provide great comfort and comes in either a light weight soft foam version.

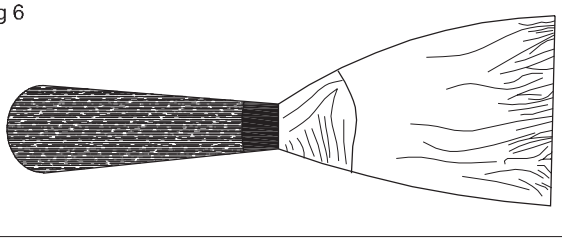
The (mica) (murlon) sanding blocks are not only ergonomic but coupled with an (abranet) abrasive and an extractor will provide with dust free sanding solution. when using a hand sanding block replace the abrasive as often as possible. Otherwise the finish will be poorer due to reduced efficiency of the paper.

Dry Sanding: - Dry sanding is required small circles to get an even finish no need any liquid lubricant during dry sanding process.

Comparison Between Wet and Dry Sanding: The difference between dry sanding and wet sanding is the movement use. Dry sanding requires small circles. Wet sanding uses straight lines, alternating direction between passes. This way each successive pass works to remove the scratches from the previous one. Dry sanding no need of lubricant but wet sanding used water as a lubricant between sand paper and metal surface

Scraper: Paint scrapers and sharp blades are used for remove the old paint, glue, putty or adhesives layered on the metal surface.(Fig 6)

Fig 6



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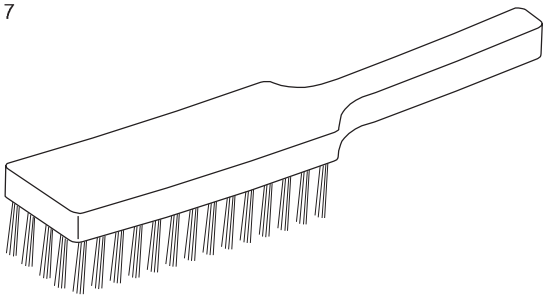
Wire Brush: Wire brush have different shape and sizes. But its purpose is same brush rubbing contacts helps to remove the organic materials such as soap, oil and inorganic material type rust inhibitors, scale or rust formed on the metal surface. Wire brush cleaning method is used to smooth as well as clean the rough metal and wood surface specially wire brush sanding system is used on metal surface to remove the deep rust layered on the surface and makes it smooth surface finishing. (Fig 7)

Fig 7



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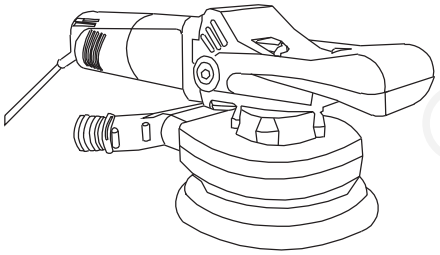
Orbital wire brushing: Orbital wire brushing (sanding) system is one of the mechanical power sanding system. It is used to remove the rust /dust, mil scale paint and foreign mattress layered or formed on the metal surface by rubbing the orbital wire brush on the metal surface. The degree of cleaning with the orbital wire brush operation depends on the quality requirements of the metal surface. (Fig 8)

Fig 8



ORBITAL SANDER

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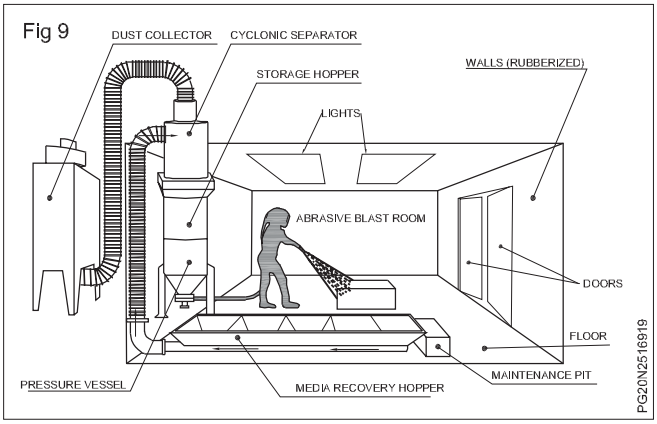
Paint Burning: There are various methods are used to prepare the old painted metal surface like mechanical sanding and chemical sanding system where the thick painted surface will take more time to remove from the surface, so that cases paint burning by applying heat on the painted metal surface is used. For this purpose blow lamp and gas hot flame is used. Apply heat on the surface to be removed the paint and wipe the burned paint by cleaning cloth. Ensure the old paint on the surface is removed by burning and cleaning method.

Sand and Shot Blasting: Different blast media can be used to vary the profile created on the metal surface Sand and shot blasting used most soils without cutting too apply into the metal and leaving a visible texture on the metal surface. The degree of cleaning with sand blast operation depends on the quality requirement of the metal surface sand blast is used to remove the visible dust, rust, mil scale, old paint and foreign matter. It is used for conditions where corrosion resistance is very important and the environment is high corrosive.(Fig 9)

Fig 9



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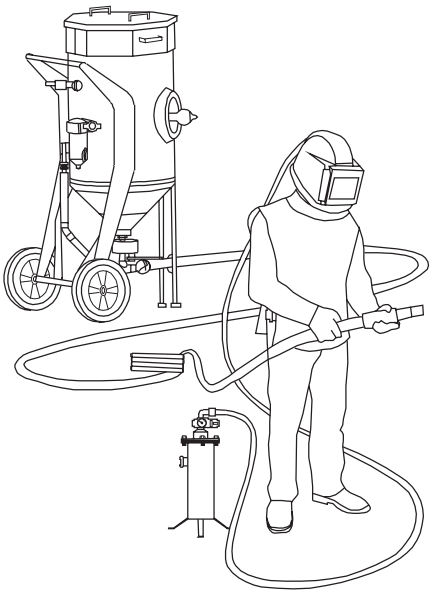
The blast media affects the depth of the blast profile and surface roughness after blasting. Blast media can be made of natural material such as silica, sand, mineral sand, flint, garnet, zircon, and other mineral products. Some other product such as walnut shell or corncob are also used in blast media. The sand blaster is removed rust from the deepest pits in the metal and with vacuum equipment the sand blasting can be performed while keeping the working area safe and clean without having to use special facilities. The sand blast abrasive hits the metal surface to be cleaned as high velocity and is shot in all directions which removes all surface impurities sand blast does not break down the base metal but just slightly peens it so as to increase the area for adhesion. The airflow will cool the surface being sand blasted some what eliminating thermal expansion of the metal. Follow the safety precautions while sand blasting method used to metal surface preparation.(Fig10)

Fig 10



SAND BLASTING

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Chemical Cleaning: The chemical pre-treatment process is the removal of dirt oils and other soils that could cause surface defects interfere with the development of a good quality conversion coating. Chemical cleaning methods include wiping the part with rag dipping the part into a solution or using a spray cleaning system. The cleaner may be alkaline, acidic, neutral solvent or an emulsion.

The particular chemical cleaner and process used will depend on the soils to be removed the size and abstract material of the part the type of coating to be applied and the quality for the product.

Phosphating Process: The phosphating is a chemical method of surface treatment in which metallic surface reacts with an aquads phosphate solution. For the phosphatig process, the metal surface is first cleaned with acid and then the phosphate layer is formed. The main benefits that phosphating provides is strong adhesion and corrosion protection. The phosphate coatings are applied to steel parts because iron in the steel is required for the coating to form.

Purpose of the phosphating is to enhance the anti corrosion and anti-rust properties of the surface of the material. Phosphating is improve the paint adhesion and prepare for the next process.

Pickling: The method of pickling rust scale is the most widely used in the industrial filed. Pickling is used hydrochloric acid, sulphuric acid, and phosphoric acid, nitric acid is seldom used because it produces toxic nitrogen dioxide gas during pickling hydrochloric acid pickling is suitable for use at low temperatures, should not exceed 45°·C. The pickling speed of sulphuric acid at low temperature is very slow, it is suitable to use of medium temperature 50° – 80°degree centigrade. It is will not produce corrosive residues but phosphoric acid cost is very high and slower pickling speed.

Pickling is used according to a certain concentration temperature and speed acids are used to remove iron oxide skin chemically. This process is called pickling :the pickling process includes dipping pickling, spray pickling and acid paste rust removal.

Types of Metal Primer Solvent and Automotive Paints

Objectives: At the end of this lesson you shall be able to
- **state the types of primer and solvent or reducer and its uses**
- **state the types of automotive paints.**

Primers: After the metal surface preperation, the primer is applied on the metal to achieve maximum adherence. Primer is a fairly thin material and this allows them to flow into grooves cut into the metal by the grinding disc.primer flows into these cavities, ,when applied wet and follows the contour of the sand scratches and irregularities of the metal surface. There are many types of primers are used depend on the type of metal surface.

Types of Primers: There are three basic types of primers, they are as follows.

- Oil based primer
- Latex primer
- Pigmented shellac primer

The above type of primers has its strength and weakness as and works base on certain surface and in particular circumstance these primers are used on the metal surface to cover up scratches , mild rust, remnants of old paint and other imperfections on the metal surface and it provide a homogenous background for paint job.

Water based acrylic and latex primers are not suitable for metallic surfaces if you try to apply on the metal surface, the finish may appear durable after initial application, heavy chipping or peeling will begin with in short period of paint application.

Metal etching primer is well suited for smooth metal surfaces, which are prone to finish failure, metal etching primer has an acid base, that allows it to etch stick metallic surfaces it is especially suited for galvanized metal, which is already highly resistant to rust.

Iron oxide primer is suited for metallic surfaces to resist form a rust on the metallic surfaces. IRO Oxide primer inhibits rust and is appropriate for any untreated metal surface subject to moisture

Zinc chromate primer is similar to iron oxide primer in that it bonds to metal surface and it inhibits rust. Zinc chromate is highly toxic and is typically not appropriate for use by inexperienced painters.

Galvanized metal etching primer is suitable for unwashed cast iiron surfaces.

Cleaning and Application of Primer:

- Scrub the metal surface with water based degreasing cleaner and apply fresh water spray on the metal surface
- Let allow to dry off
- Select the suitable metal primer
- Prepare the primer to apply
- Apply the primer by brush or sprayer depend on condition
- Follow the instructions of primer manufacturers
- Use the suitable primers on metal surface depend on type of metal
- Apply the primer on the metal surface evenly
- Wear a respirator while applying etching primer
- Wear safety gloves while prepare and apply the primers

Epoxy primers are two component material used for priming aluminium body, steel, zinc coated metals, plastic fillers and fibers glass. This type of primer gives on excellent corrosion film resistance and can be top coated with any top coat, it recommended for use under urethane and polyurethane top coats.

An alkyd enamel primer-sealer is an all purpose body primer for enamel top-coat. It is used as a sealer over old finish to minimize sand scratch swelling sink in or dulling of the enamel top coat. This primer sealer inhibits rust. It dries in 20 to 30 minutes and can applied over old lacquer or enamel surfaces.

Polypropylene primer is used as a base on rigid polypropylene and polypropylene plastics it can be top coated with acrylic lacquer or enamel.

Polyester primer surfacers are used on new work and repairs they fill surface flaws or heavy scratch marks in one operation. It has a fast dry time and high build up capabilities to fill imperfection and it can be used over properly cleaned and prepared steel, aluminium, fibre glass, wood and previously painted surfaces. This type of primer surfacer can be used under coat, base coat, clear coat system and it will not allow bleaching or staining problems from solvent penetration.

Sealers: Paint sealers are manufactured from different types of resins, such as a acrylic epoxy, acrylic lacquer and urethane resins sealers are used for provide adhesion between the new coat of paint and the old painted surface it is another purpose of using sealer is that they act like a barrier to prevent the solvents from penetrating or retard the penetration of the solvents. Through to the old finish. The sealers must be allowed to dry approximately 30 minutes before recoating. The acrylic lacquer sealer is used on cured painted surface.

Urethane scalars are two component sealer that have universal use. It seals porous substrates quickly. This type of sealer can also be used. When changing the type of top coat on metal body such as going from an enamel under coat or acrylic lacquer to acrylic enamel

Urethane Sealers: It is practically eliminates sand scratches swelling and also provide excellent colour hold out. It minimizes loss of gloss and featheredge lifting. It seals porous substrates quickly minimizes top coat buffing and gives improved toughness for chip and impact resistance

Solvent: Solvent is a substance that dissolve another substance to form a solution of solvent is a chemical substance or substances to form a solution of homogeneous mixture. A solvent is a pure or mixed liquid that is used to make the paint flow able prior to its application. Solvents make it possible to process apply clean or separate materials.

Solvents are volatile liquids added to paints, for dissolve the binder or to modify the paint viscosity. The particular solvents that may work in a given formula will depend on their solubility characteristics. There are three classes of solubility strongly hydrogen bonded. Alcohols fit into the first category, ketones, either and esters into the second and hydrocarbons in the third class. Resins used as paint binders have a range of parameter values that effect solvent selection. The solvent and binder must be compatible.

Thinners and Reducers: Thinners and reducers are developed thinning and reducing agents it is used with lacquer and enamel finishing materials generally thinners are used thin lacquer based products to spraying viscosity. Reducers are used to reduce enamel products to a spraying viscosity. These products should never be intermixed because they are formulated to do specific jobs. Enamel reducers and lacquer thinners are necessary for the application of lacquer and enamel auto motive finishes.

Types of Paint: There are many types of paints are available in the market. Paint is used to protect the material from weather effect and chemical effect. Paint is used to increase the life of the object. There are different type of paints are used to protect metals. Types of paint are as follows.

- Oil paint
- Vitreous enamel
- Acrylic paint
- Cement paint

Paints have the capability to enhance the look of metallic and wooden parts beautifully

Oil Paint: Oil paint is one of the most popular choice and it easy to apply and clean.

Enamel Paint: This type of paint is available in various colours with added pigmentations. This is a form of hard glossy coating and easy to clean. Enamel paints are very long lasting, water proof and chemically resistant to offer good coverage and colour rentention. Enamel paints are used for various applications interior and exterior of walls and concreate, plaster, glass materials etc. However these are slow drying paints and require a titanium coating before application.

Emulsion Paint: This type of paint used for binding materials such as polyvinyl acetate and polystyrene and it also contains driers like cobalt and their pigments are used to make different shades of emulsion paints. This type of paint dry fast an are hardened in nature and you can easily clean the surfaces with water. These paints are durable, offer good colour retention and alkali resistance.

Cement Paint: It is a kind of paint in powder form. It is easy to mix with water to achieve nice paint consistency. Cement paint has white or colour cement as the base and also contains pigments, accelerators and other additives. This is durable and water proof kind of paint type and commonly used in rough applications.

Bituminous Paint: It is made from dissolved asphalt or tar and a available in black colour. This water proof and alkali resistant. This paint is used in under water iron works, concrete foundations wooden surfaces and iron pipes to provide rust resistance.

Aluminium Paint: It is made of mixing aluminium particles with oil varnish. This paint is used on metals and wood, gas tanks oil tanks, water pipes and radiators.

Anti Corrosive Paint: This type of paint is used for visual appeal, surface durability chemical protection, and past protection.

Automotive Paint: Automotive paint is different from any other generic paint. It is categories that are pigment thinner and binder. Further it classified water borne paint or solvent paint. Solvent borne paint consists of the solvent such as lacquer urethane or enamel.

Rubber Base Sound Deadening Paint: Rubber based paint is formulated with rubber microspheres and sound absorbing fillers. This type of paint reduces sound transmission the soft pigment fillers absorb sound and prevent it from bouncing off the surface.

Stoving Enamel Paint: It is formulated system to give a non yellowing property high gloss, and hard and durable finish. It is very good protective and decorative stoving enamel for home appliances electrical fittings, toys, and automobile industries. It is resistance to oils, water, solvents, alcohols and limited Ioleranic to Ketzonic solvents gives this system wide range of application. This paint can apply by brush spray gun and conventional spray.Apply this paint before apply top coat.

Epoxy Enamel Paint: Epoxy enamel paint is ideal for protecting and decorating metal surface. It is used for paint industrial strength metal protection.

N.C Paint: - N.C Paint is based on nitrocellulose specially

modified short oil alkyd resin. This is suitably plasticized contains pigments to produce beige shade. It is designed to use as a top-coat and also can be used for refinishing purpose.

PU Paint: Polyurethane paint coatings help to protect substrates from various types of defects such as corrosion, weathering, abrasion and other deteriorating process it also thermosetting in nature. These coating can be formulated to be glossy muted, opaque or transparent polyurethane coatings may appear to be usually similar to other coatings.

Metallic Paint: Metallic colour has a great deal of acceptance and eye appeal with the buying public and as long as the demand for these shades exists, car manufacturers will continue to use them.

Acrylic Lacquer: It is provide a superior finish because they combine the advantages of lacquer and the qualities inherent in acrylic resins. Acrylic lacquer dries by evaporation and require compounding and buffing in order to being out of gloss. The main reason for used is because they can tolerate larger amount of aluminium in their formulation thus offering a wide colour selection.

Water Base Automotive Paints: This type of paint does not cause as much harm to the environment compared to solvent based automotive paints water borne automotive paints are composed about 10 percent solvent compare to around 74% for water borne automotive paints waterborne paints typically have higher coverage than solvent based paints, which lets them cover a car more efficiently and spend less time applying paint. Benefits of waterborne paints as follows.

- Waterborne paints are cleaner for environment.
- Waterborne paints are the healthier option for your employees.
- Waterborne paints may cost less than other paints.
- Get a high gloss finish without the extra coating.
- Waterborne paints are durable.

Pearl Paint: Pearl paint is a mid coat that is applied over a base coat. Pearl paint has ting flacks of incidenscents mica added to a clear coating that acts a binder for the pearl. Pearl car paint colour is pearl white. Car paint colours are created by combining pigments and dyes with pearlescent pigments to achieve a wide variety of colour.

Types of Painting Process

Objectives: At the end of this lesson you shall be able to
- **state the traditional painting process**
- **state the modern painting technology.**

Painting Process: - Painting process is the creative act itself without concern for talent, skill or accomplishment. The purpose painting is to protects the metal surfaces from the corrosion and increase the life of an object. The purpose of this lesson is to provide traditional and modern painting technology. This lesson can be given the information about the painting by the method of brushing, Deeping, barrelling, aerosol, roller coating, suction spray vertical spray, pressure vessel, spray airless, electrostatic and power coating.

Application - Brush

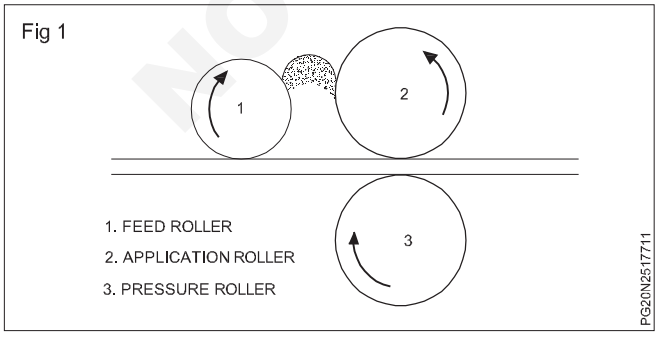
Brushing is the most common method for applying coatings. While brushing is a somewhat slow procedure many small jobs do not warrant the use of any other application method. Brushing is especially useful for touch up work, spot priming, work in confined areas or where spraying is impossible. less paint is wasted when applied by brush than by any other method.

Either natural or synthetic bristle brushes are suitable for use with “solvent based’’ coatings. Synthetic bristle brushes are preferred with “water based’’ coatings because natural bristles tend to swell in water.

Application - Roller

Rollers are efficient tools for applying industrial coatings and are suited for broad flat surfaces. The general rule for selecting a roller cover is ‘the smoother the surface the shorter the nap’. Solvent thinned coatings should be applied with either lamb’s wool or synthetic covers and water reduced coating should be applied with synthetic covers. When using rollers to apply coating systems such as epoxies and polyurethanes. Which contain strong solvents, be sure that the roller cover selected is constructed with glues which are resistance to these strong solvents.(Fig 1)

Fig 1



Air Spray

The air spray gun uses air at 30 to 85 pounds per square inch (psi) to atomize the paint into a fine spray. This produces a smoother finish, and can be used on many surfaces. Air spraying is versatile; the operator can vary the air pressure, air volume, paint pressure, and spray pattern. It is much faster than painting by hand unless a lot of masking is required for the job. But air spraying does produce a lot of overspray (the paint that misses the intended target), and preparation and clean-up take more time.

A high volume low pressure (HVLP) spray gun uses a higher volume of air at only 10 psi. This reduces the overspray and increases the transfer effciency. It is portable and easy to clean, and has a lower risk of blowback to the worker. However, the atomization may not be good enough for fine finishes, and production rates when using HVLP may not be as high as with conventional spraying.

Airless Spray

This method uses paint under high pressure, 500 to 6,500 psi. Airless spraying has several distinct advantages over air spray – it is twice as fast, produces a higher film build, is more portable, cuts overspray by more than half, and is thus cleaner and more economical. But airless spray is limited to painting large areas, requires a different nozzle to change spray patterns, the nozzle tends to clog, and the nozzle can be dangerous to use or to clean because of the high pressures involved.

Electrostatic Spraying

The differences between this and air spraying are that electrostatic gun has an electrode at the nozzle and the object to be painted is grounded. The electrode runs 60,000 volts through the paint at 225 microamperes. The charged paint is attracted to the grounded object. This required less pressure, produces little overspray, and uses relatively little paint..Electrostatic guns are good for painting oddly shaped objects. They also produce a uniform coat because the paint itself act as an insulator; once the object is covered, it can take no more paint.

The advantages are only one coat is possible only conductive materials can be painted, it’s more expensive, slower, has higher maintenance cost, and it is limited to chargeable paints, and the surface of the object must be extreamly clean,because the gum uses electricity, this method presents a possible shocks hazard.

Powder Coating

This is a variation of electrostatic spraying. The difference is that what is sprayed is a paint powder, The object is then bake, and the powder melts into a smooth, durable coat. Overspray can be reused, and no other

pollutants are created or released because the powder has no solvents in it. The equipment for powder coating is expensive, so it may be economical for only larger businesses. A variation of this plasma powder coating. The powder is fed into an extreamly hot gas stream and is sprayed at the object. Plasma powder coating is for large objects that can't fit into a conventional curing oven. Overspray cannot be reused because it hardens.

Another variation is flame sprayed powder coating, where the powder is melted with a high temperature flame. Again, it is for large objects and overspray cannot be reused.

Rotary Atomizing

Another variation of electrostatic painting, rotary atomizers use centrifugal force, not air or hydraulic pressure, to drive the paint out of the nozzle. The atomization of this method is excellent, as is the transfer efficiency. This method can also be used with paints of different viscosity. Cleanliness is especially important to this method. Rotary atomizers can present a fire and safety hazard.

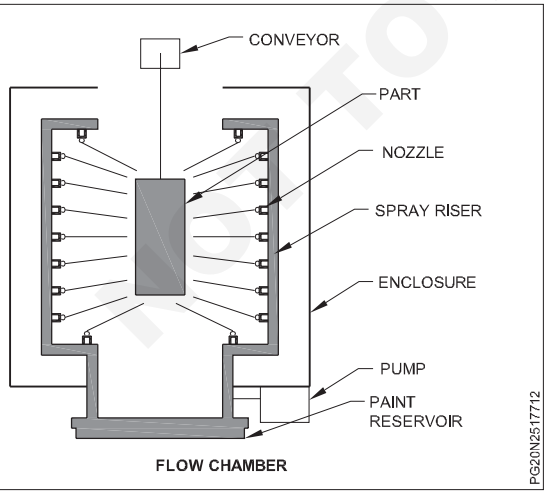
Dip Coating

With this process, parts are dipped into a vat of paint. This allows for a high production rate and transfer efficiency, and it requires relatively little labour. The effectiveness of dip coating depends greatly on the viscosity of the paint, which thickens with exposure to air unless carefully managed. Dip coating is not suitable for objects with hollows to cavities, and generally the finish is of lower quality.

Flow Coating

With this method, parts are carried on a conveyor. Anywhere from 10 to 80 streams of paint coat the parts. This system has the advantages of dip coating, along with low installation costs and low maintenance requirements. The quality of the finish is also about as good as with dip coatings. (Fig 2)

Fig 2



FLOW CHAMBER

Curtain Coating

Instead of many streams of paint, curtain coating uses a water fall flow of paint to coat parts on a conveyor belt. Curtain coating has a high transfer efficiency and covers parts uniformly, but is suitable only for flat work. The quality of the finish is highly dependent on the viscosity of the paint.

Roll Coating

Paint is applied to auxiliary rollers, which then transfer the paint to the application rollers, which run across the part. This method has a high transfer efficiency and high production rates, but is limited to flat work.

Electro Coating (or Electrode position)

Parts to be painted are dipped into the paint. Then a current is applied, which electrically deposits the paint on the object. Parts are made primarily of steel. The transfer efficiency of electro coating is over 90%. High production rates are possible, and production can be automated. However, this method is costly and requires a lot of energy. Also, employees need high level training to use this system.

Auto Deposition

This is a dip process where organic paints are precipitated onto iron, steel, zinc and zinc-alloy plated objects. It is effective for its anti-corrosion properties and coverage of objects. Auto deposition also uses water-borne paints and uses no electricity. But auto deposition produces a dull or low gloss finish and has few available colours.

Barrel Painting System: Barrel painting system is used for paint in multicolour for internal and external surfaces of barrel and drums. Barrel painting system is accurate lancing system. Painting is covered by 13 nozzle spray gun system in this painting system provides uniform coating on the metal - surface. This system is operate and controlled by PLC for accurate paint in different colours in internal and external surface of the drum or barrel.

Aerosol Painting: - Aerosol paint is paint that comes in a sealed, pressurized container and is released is an aerosol spray when a valve button is depressed. Aerosol painting is one form of spray painting, it leaves a smooth, even coat on the surface unlike many traditional roller and brushed paints.

Vertical Spray painting System: - Start painting by coating each vertical surface with vertical positioned the paint spray gun. Spray paint lightly coat on the surface to avoid paint runs. Then hit the horizontal areas before starting the second round.

Spray Painting Instruments

Objectives: At the end of this lesson you shall be able to
- **state the principles of spray painting**
- **state the spray gun accessories and their functions**
- **state the types of spray gun and their adjustment.**

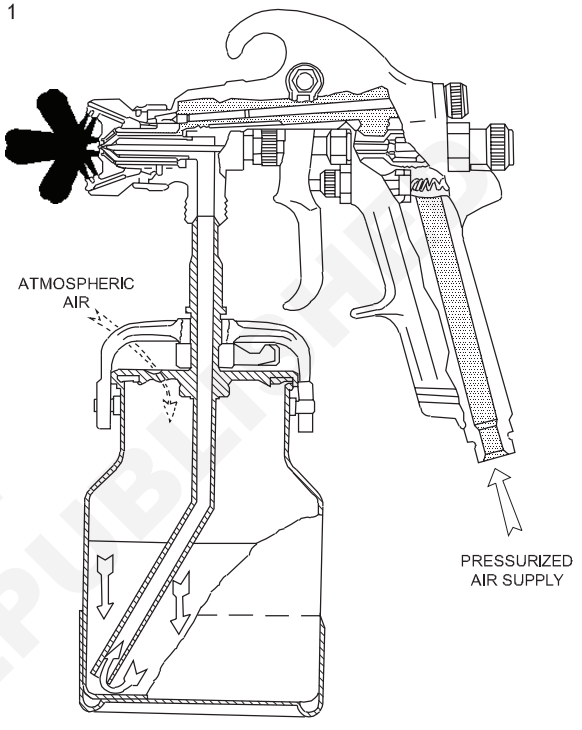
Principles of Spray Painting: - A spray gun breaks the liquid sealer, primer, paint and so on into a fine mist and forces it on to the surfaces of the metal or wood or any other surfaces it is the key component in refinishing system. There are many types of spray gun available in various sizes. Each spray gun specifically designed to perform certain task. Even though all spray guns have common parts and components. Each spray gun type and size is suited only for a defined range of work.

General Description of an Air Atomizing Spray Gun

The basic function of an air atomizing spray gun is to compressed air to break up material into small droplets and give these droplets direction. The spray gun itself provides two convenient valves to start and stop the flow of compressed air and fluid. The mixing of air and material can take place outside the spray gun between the “horns” of the air nozzle. This is described as “external mix atomization’’. If the mixing of air and material takes inside the air nozzle of the spray gun, we use the term, “internal mix nozzle’’.

Material can be brought to the spray gun by creating a vacuum at the face of a siphon type external mix nozzle. This vacuum draws the material through a tube coming from an open top material container to the air nozzle of the spray gun for atomization. This method of atomization and material delivery is called “siphon spraying’’. See Fig 1. When heavier fluids or higher production rates are required, the material can be pressurized and forced up to the air nozzle for atomization. This method is then called “pressure feed spraying.’’(Fig 1)

Fig 1



SIPHON CUP AND GUN

Parts of a Spray Gun

The basic parts of a modern production spray gun are outlined as follows:

Item Description

A The air nozzle of a spray gun is the most important part of the entire spray gun. The air nozzle directs air jets to atomize the fluid and to give the particles velocity to reach the product surface.

B The fluid nozzle is the second most important part of a spray gun, for this part provides a control for metering material delivery.

C Needle assembly acts as a stop-start valve for the material flow through the spray gun in conjunction with the fluid nozzle.

D Side port control or fan control regulates the spray pattern width by controlling the air supply to the “horns’’ of the air nozzle.

E Fluid control assembly provides mechanical pressure on the needle valve so that it will close when the trigger is released.

F The spray gun body handle is designed to hold all the parts and give the operator a balanced and comfortable handle for spraying.

G Air inlet to provide a connecting point for the air hose, normally ¼ in. N.P.S.

H Trigger activities and controls the air and material movement to the nozzles.

I The air valve controls the air movement through the spray gun.

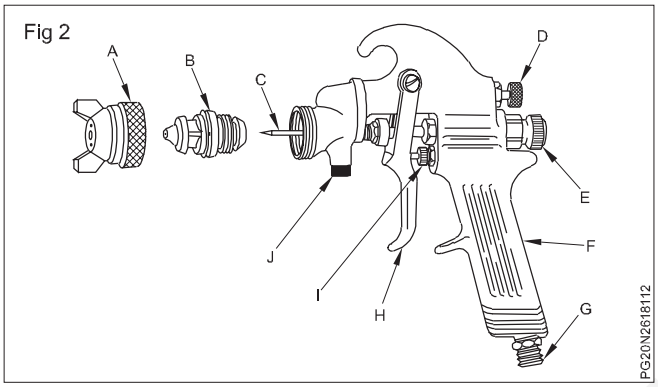
J Fluid inlet connecting point for siphon cup or material hose, normally 3/8 in. N.P.S.

The versatility of using compressed air to atomize material has made this type of spray gun the main means of applying a coating in the finishing industry today.

These spray guns can handle all types of spray able liquid materials and can be controlled to such a degree as to produce the finest possible finish on a product, with lowest possible equipment cost. This typeof spray gun is a precision tool. The spray operating efficiency is dependent upon a knowledge of proper spray gun selection, spraying techniques and maintenance.

Spray Gun Design

A Bleeder or non-bleeder type spray gun. Most production spray guns are non-bleeder type. Air flow through spray gun only by the action of the trigger. Bleeder type spray guns are normally used with small portable air compressor to maintain constant pressure, and prevent the possibility of starting up the compressor against load. Air discharges from the air nozzle continuously.



B Construction Features:

1 Removable head,

2 Cartridge type valve assemblies,

3 Adjustable needle assembly,

4 Trigger bearings and a wear plate.

C Material used in the construction of the spray gun:

1 Aluminium,

2 Brass,

3 Stainless steel.

D Method of construction:

1 Drop forging,

2 Die casting,

3 Rough casting.

E Spray Operation Features:

1 Weight,

2 Location of controls (Front or rear of spray gun),

3 Handling characteristics,

4 Balance.

F Design Features:

1 Number of parts,

2 Ease of air flow through spray gun (pressure drop),

3 Air nozzle and fluid nozzle design,

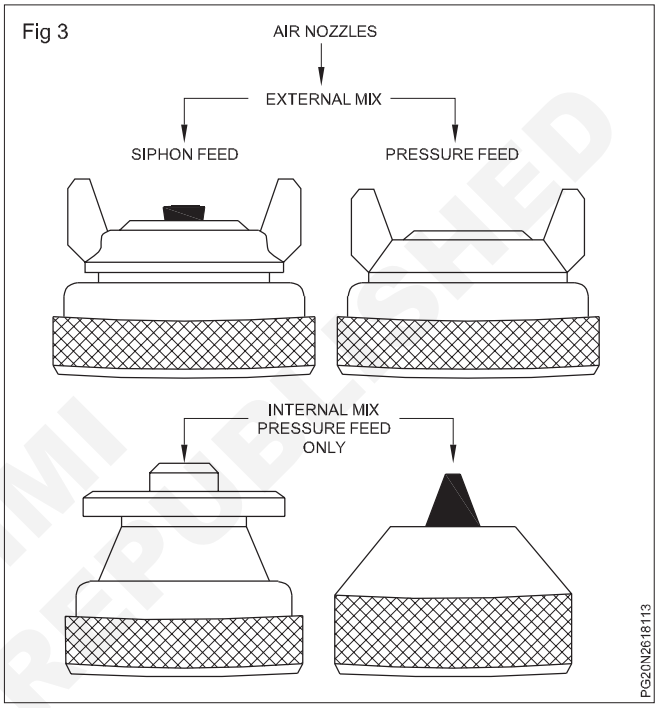
4 Protective finish,

5 Type of material used in construction of fluid passageway.

Compare these points to the expected service one may receive as compared to the initial cost of the spray gun selected.

Nozzles

A Air spray gun nozzles are as the following categories: (Fig 3)



B The control and operation of these air nozzles depend on many factors such as:

1 Proper type of air nozzle,

2 The size selected,

3 Spray gun used,

4 Method of feeding material to the nozzles,

5 Material to be sprayed,

6 Setting of pressures air and fluid,

7 Adjustment of spray gun controls.

C External Mix Air Nozzle.

The most common type of air nozzle used today is the external mix nozzle. The reason for its wide acceptance is that it will produce the finest atomization which, if controlled properly, will give you the best possible finish. These air nozzles are designed to put compressed air to work in the following manner:

1 The annular ring, the space between the fluid nozzle and the air nozzle, provides a column of air to surround the fluid stream. (See Fig 4. A-1).

2 The fluid stream expands and mixes with the air coming from the annular ring of the air nozzle. This is called first stage atomization.

3 The holes which are in a straight line with the “wings”, “ears” or “horns” of the air nozzle are containment holes. (See Fig 4. A-2)

A To keep the spray pattern from expanding too fast.

B To keep the “horns” clean.

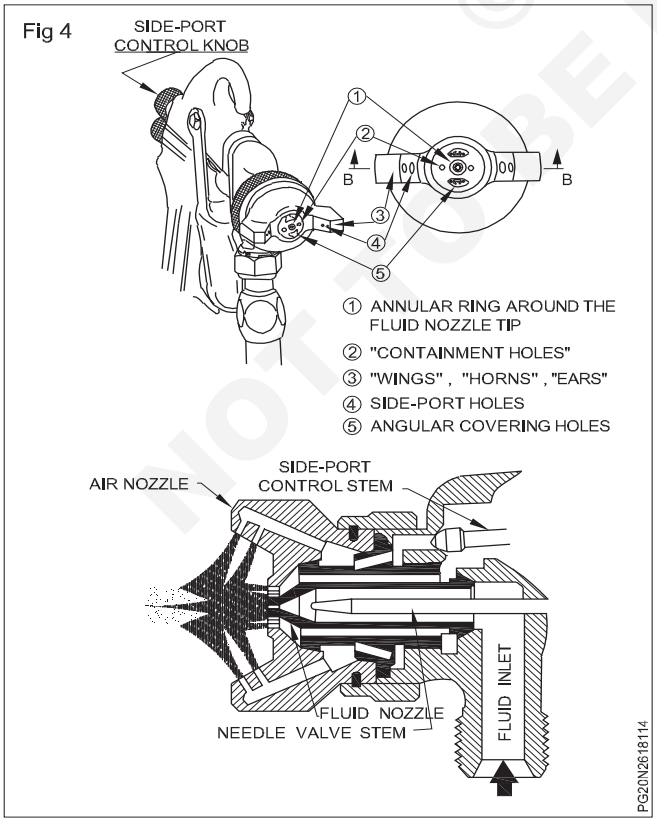
4 On pressure feed air nozzles, a second set of holes may be indexed 90° from the containment holes. These holes are called second stage atomization. (See Fig 4. A-5), these air passages add additional force to help atomize the fluid stream since in a pressure system, the fluid comes out of the nozzle at a higher velocity than a siphon system. The air movement at this point, creates an air cushion at the face of the nozzle: this helps to keep the face of the air nozzle clean.

5 The air passageways in the “horns” (sometime called “wings” or “ears”), are called side port jets. (See Fig. A-3).

6 The side port jets of air, strikes the fluid stream just ahead of the second stage atomization point. The primary purpose of these side port air jets is to form or shape the air and fluid stream into a “fan” shape. Some additional atomization may also result.

7 The size of the “fan” width can be controlled by regulating the amount of air diverted to the side-port jets (See Fig 4. B, Side Port Control Stem).

Fig 4

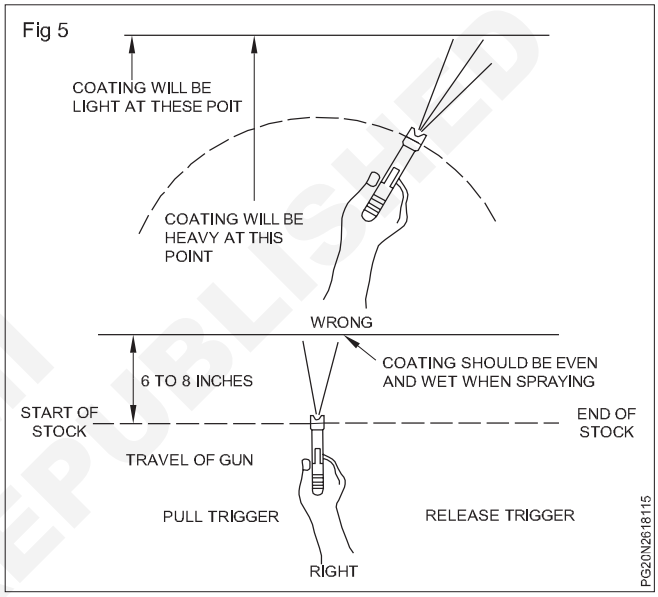


Spray Gun Controls

A Operator spraying techniques (Fig 5)

The first requirement is proper handling of the spray gun. The spray gun should be held perpendicular to the surface being covered and moved in even strokes parallel with the surface. The stroke should be started before the trigger is pulled and released before the stroke is finished. This is easy materials. The distance of spray gun is held from surface is detumined by the material and atomization pressure, it may be vary from 6 to 12 inches, but the material deposited should always be even and wet. Overlap each stroke by 50 percent over the preceding stroke to obtain a uniform finish.

Fig 5

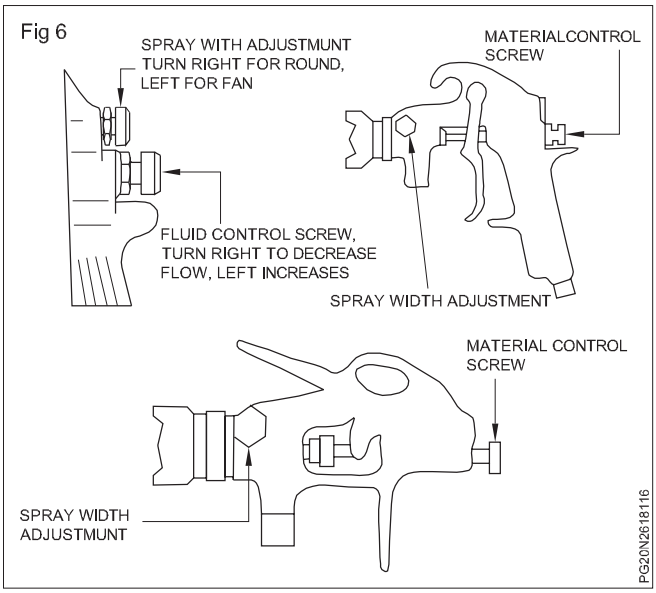


B Adjustment of Spray Gun Controls (Fig 6)

The proper adjustment of spray gun controls permits a spray operator to control the size of the spray pattern and the amount of material coming out of the spray gun.

The spray gun controls will be located on most spray guns in one of the three following positions:

Fig 6



C Silphon Spraying

Set atomization pressure at approximately 25P.S.I and test spray pattern with fluid control knob opened. If material atomization is too coarse, increase air pressure by 10 P.S.I and test spray pattern again. Continue this until you have 50 to 60 P.S.I at the spray gun. If material atomization is still too coarse close (turn clockwise) the fluid control knob on the spray gun slightly. Adjust the spray pattern width and repeat adjustment until a proper spray pattern is achieved using the lowest possible air pressure that will produce the desired finish. Additional thinning of material may also be required.

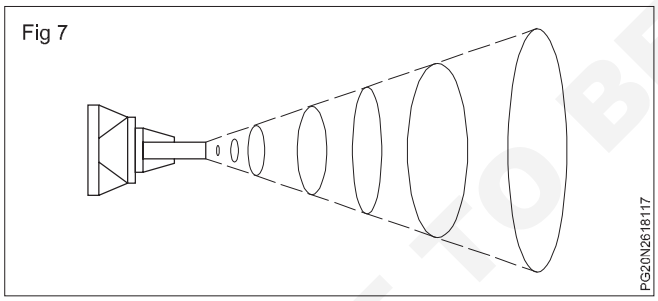
D Pressure Spraying

Select correct fluid nozzle orifice size using the previous fluid nozzle selection charts and set atomization air at about 25 P.S.I and test spray pattern. If spray pattern is too coarse, raise air pressure. Adjust desired spray pattern width, repeat spray gun adjustment and fluid pressure setting if necessary. In some instances, material may require additional thinning. Remember keep fluid control screw in “open” position. Use correct fluid nozzle size and proper fluid pressure setting to obtain proper fluid delivery. NOTE: To reduce “over-spray” with the lowest possible atomization air pressure and the lowest possible fluid pressure that will give you the required finish you are seeking.

E Spray Pattern

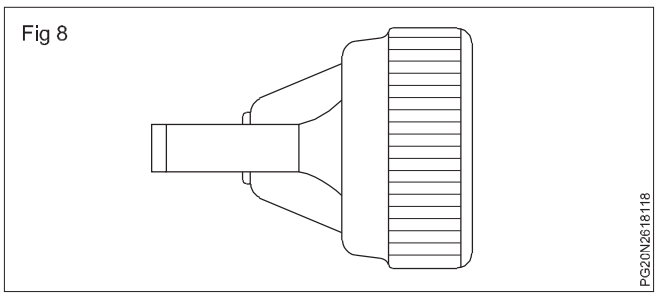
The spray pattern of an external mix nozzle on a spray gun equipped with a fan control is variable from round to fan with all spray patterns in between.(Fig 7)

Fig 7



In normal operation, the wings on the nozzle are positioned horizontally as illustrated here. This provides a vertical fan shape spray pattern which gives maximum coverage as the spray gun is moved back and forth parallel to the surface being sprayed. (Fig 8)

Fig 8



Types of Spray Gun: Spray gun feed refers to how the liquid material is feed into the gun body. There are four basic methods of feeding liquid refinishing material through the air spray gun

- Gravity feed type
- Suction feed type
- Pressure feed type
- Pressure assist feed type

Gravity Feed Type: In this type of spray gun, the refinishing material (Primer, sealer, or paint) is initially feed into the gun by gravity and then suction forced to the nozzle tip. Gravity feed spray gun can be used for base coat/clear coat work and to spray under coat refinishing materials such as primers, sealers as well as some lighter spray on fillers.

The operation and adjustment of this gun is about the same as a suction feed gun. But gravity – feed gun is easier to handle because of better balance. The cup is also up and out of the way when spraying and it is less likely to touch and damaged a painted surface. This gun also is less likely to leak and drip paint when spraying which can ruin the paint job. The main requirement of gravity feed is that container be vented so that atmospheric air can replace the material as it is being sprayed.

Viscosity and flow characteristics of the material directly affect rate of flow to the gun as do hose size hose length and nozzle size. When the spray gun trigger is partially depressed the air valve opens and air rushes through the gun. As the air passes through the openings in the air cap a partial vacuum is created at the fluid tip. Further squeezing of the trigger with draws the fluid needle from the fluid tip. The vacuum sucks paint from the cup, up the fluid inlet and out through the open fluid tip. Air enter through the air hole and replaces the siphoned paint. The inlet air vent holes in the cup lid must be open. (Figs 9,10)

Fig 9

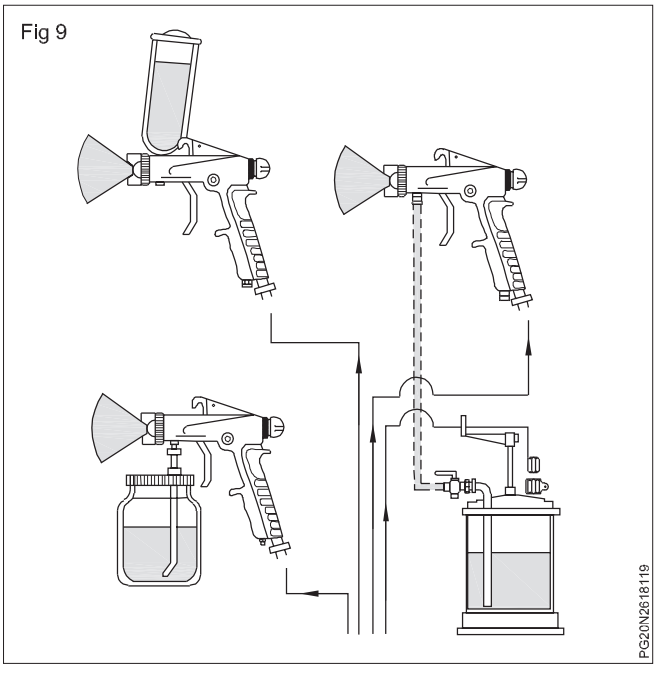
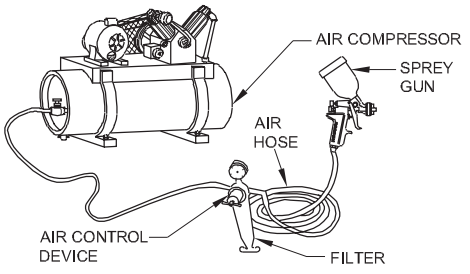


Fig 10



Suction-Feed Spray Guns

Suction spray guns Suction spray guns use airflow through the gun head to form a siphoning action (negative pressure) in the cup that pulls the refinish liquid through the gun body and into the airstream. When negative pressure or suction is formed at the bottom of the cup outlet, atmospheric pressure enters the vent hole to make the liquid flow out of the cup and through the spray gun. With a suction gun design, the paint material is often held in a 1-quart (0.94-liter) cup attached to the bottom of the gun.

Both low-efficiency and HVLP high-efficiency suction-fed spray guns are available. The body of an HVLP gun will be thicker for added airflow at lower line pressures.

The suction-fed spray gun was once the most common type of gun, but most paint technicians now prefer the gravity-fed type. It is easier to hit the vehicle with the suction feed gun's bottom-mounted cup when spraying.

An **air vent hole** and hose on the siphon spray gun allow atmospheric pressure to enter the cup. This vent can become clogged with dry primer or paint. If the vent is plugged, paint will not flow out of the gun.

When the spray gun trigger is partially depressed, the air valve opens and air rushes through the gun. As the air passes through the openings in the air cap, a partial vacuum is created at the fluid tip further squeezing of the trigger withdraws the fluid needle from the fluid tip. The vacuum sucks paint from the cup, up the fluid inlet, and out through the open fluid tip. Air enters through the air hole and replaces the siphoned paint. The inlet air vent holes in the cup lid must be open.(Fig 11)

Pressure Feed System: A Pressure feed system applies paint that has been forced to the gun by pressure, either from compressed air or a pump. Pressure feed systems are used in situations requiring more volume, delivered from a larger vessel, rather than the small cups used in gravity and siphon system. It is also suitable for paints with higher viscosity. (Fig 12)

Airless Spray Guns

Airless spray systems use hydraulic pressure to force the fluid through a spray tip or orifice at high pressure. The combination of pressure and orifice size created pattern orifice sizes are catalogued by flow capacity and degree of spray angle.

Fig 11

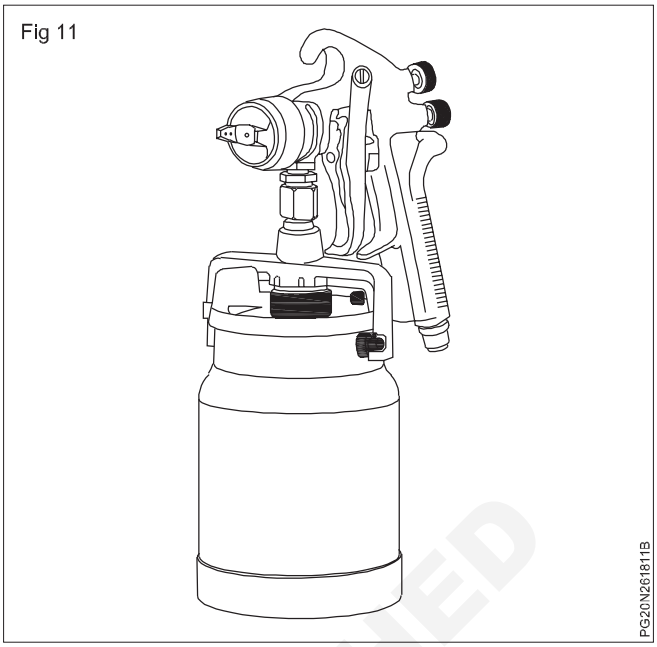
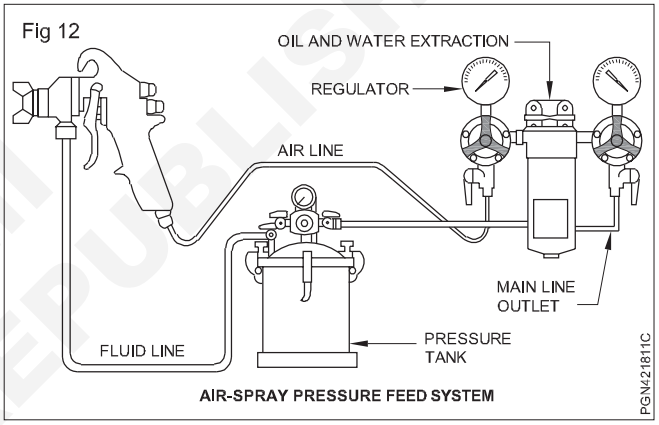


Fig 12



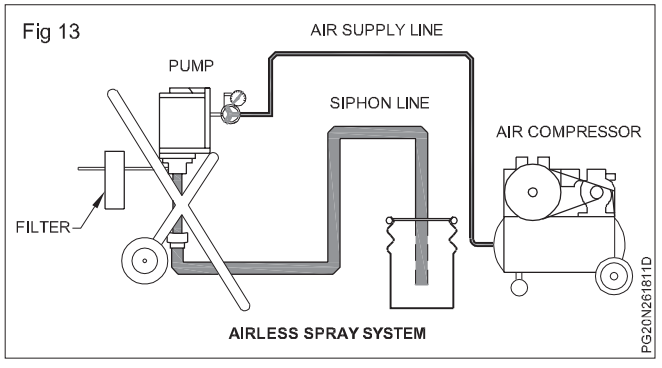
AIR-SPRAY PRESSURE FEED SYSTEM

An airless spray gun does not use compressed air for atomization, so there isa no air nozzle with atomizing ports like those found on an air-spray gun. There is only one trigger position, full open.

Airless spray system works with a high-pressure pump that delivers fluid to the gun tip at 500-6000 psi and forces the fluid through the orifice.

Airless spray systems can be used with heaters to reduce the spray viscosity and improve finish quality. The heater helps to control spray viscosity for consistency and may be particularly helpful with thicker material shows an airless spray system.(Fig 13)

Fig 13



AIRLESS SPRAY SYSTEM

Holding of Spray Gun: Before attempting to paint a vehicle it is critical that the spray gun and air supply be set up and adjusted properly clean dry air the correct pressure must be connected to the spray gun. The spray gun must be adjusted to produce correct spray pattern for uniform application of the new paint film.

Hold the spray gun in correct position and maintain the proper distance from the spray gun nozzle to the surface being painted. Most spray gun manufacturers recommended to keep the spray gun about 6 to 10 inches from the surface being paint sprayed.

HVLP guns should be kept 6 to 8 inches from the body surface. Older higher pressure spray gun should be kept a little farther from the body 8 to 10 inches if you hold the spray gun too close to the surface paint will pile up unevenly on the surface and the paint film can run or sag. If you hold the spray gun too far away the material will partially dry before hits the surface. The paint will look dull and will not flow smoothly.

Difficult areas such as corners and edges should be sprayed first. Aim directly at the area so that half of the spray covers each side the edge or corner. Hold the gun 1 to 2 inches closer than usual.

Spray gun stroke: The spray gun stroke refers to the hand motion used to move the gun while spraying. The proper stroke is important in obtaining a good pant job. Hold the spray gun at the proper distance from the surface if the humidity or temperature is high a slightly shorter distance may be necessary if the spray gun distance is too close the high velocity of the spraying air tends to ripple the wet paint film if the gun distances too great more reducer will evaporate resulting in orange peel dry film or poor colour match excessive spraying distance also causes a loss in materials due to overspray generally hold the spray gun perpendicular to the surface being sprayed.

Comparison of Different Spray Guns

	Air Atomized spray	**Airless Spray**	**Air Assisted Airless**
Finish appearance	Excellent	Coarse	Very good
Transfer efficiency	Low	Good	Good
Fluid flow rates	Very low medium, usually less than 30 fluid oz/min	High or very high flow rates, over 80 fluid oz/min	Wide range, 7 fluid oz/min to 78 fluid oz/min
Booth maintenance	Lot of rebound and overspray, booth maintenance is high	Less rebound and overspray, less maintenance	Least rebound and overspray, maintenance is low
Pattern adjustment	Yes	Tip selection	Yes (limited)
Tip plugging	Virtually none	Yes	Yes
Equipment life	Very long due to very low fluid pressure	Very high fluid pressure, high tip wear and shorter pump life	Less tip wear, lower fluid pressure
Noise	Noisy	Quiet	Quiet
Emission level	High	Lower	Low

If the pump is sized properly to reduce cycles, the wear is not different than the AAA.

Type of spray painting method: - There are different types of spray painting method is used in the field work. They are as follows.

- Air atomized spray
- Air assisted airless
- Air less spray
- Air electro static
- Electrostatic techniques
- Air electrostatic
- Airless electrostatic
- Air assisted airless electrostatic
- Rotating electrostatic discs and bells
- High volume high pressure (HVHP)
- Air assisted airless electrostatic
- High volume low pressure (HVLP)
- Booth spray

Non-spray method of painting

- Brushing
- Coating
- Powder coating
- Continuous coaters
- Centrifugal coating
- Curtain coating
- Roller coating
- Electro coating
- Auto deposition

The above types of spray painting and non spray painting method is used.The spray coating material (paint, varnish, primer, sealer, surfaces) etc. Spray through the air onto the surface. The most common types used compressed air to atomize and direct the paint particles

Three basic methods apply paint in production installations, spraying, dipping and flow coating spray or method is frequently used.

Air Compressor for Painting Process: Air Compressor is a basic equipment needed to operate the spray gun. Using an air compressor and a paint sprayer will help to cover more space at one time and it helps to get even coat of paint on the metal/wood wall surfaces.

Required instruments for spray painting: There are various types of instrument are used in spray painting system to achieve the quality of painting. They are as follows.

- Air compressor, air filter, air control device, air hose
- Paint sprayer (gravity feed gun, suction feed gun, pressure feed gun, HVLP gun, airless pressure gun, air assisted airless spray gun).
- Rotary atomizer
- Automatic spray supporting equipment (Robotic painting)
- Dip coating immersed tank
- Flow coating - Paint tank, Pump encloser, Spray riser, nozzle conveyor.
- Roller coating - Feed roller, application roller, pressure roller
- Curtain coating – Pouring head, conveyor, slot adjuster.

Paint spray booth

Objectives: At the end of this lesson you shall be able to
- **state the paint spray booth**
- **state the different types of spray booth**
- **state the spray booth maintenance**
- **state the drying equipment**
- **state the air supplied respirators.**

Paint spray booth: Paint spray booth is an enclosed or semi-closed area used for the spray painting of fabricated items it may be equipped with a source of filtered air to keep the atmosphere dust-free, a water fall back drop to trap overspray and an exhaust system to vent the fumes of evaporating solvents. (Figs1 and 2)

A liquid spray booth is an enclosure around the spray operation that provides contaminants of the oversprayed paint and controls the spray environment. The spray booth includes an exhaust fan to create negative air pressure inside the booth. The exhaust air contains the overspray, directs paint solids to the filters, and directs the solvent vapors to atmosphere or an abtement ststem. The booth provides a clean and safe environment for the operator and smooth airflow to enhance paint transfer efficiency.

The liquid spray systems, the airflow can be either vertical in a down draft design or horizontal in a cross draft design. Airflow is necessary to contain the paint overspray by creating a slight negative pressure inside the spray booth.

Fig 1

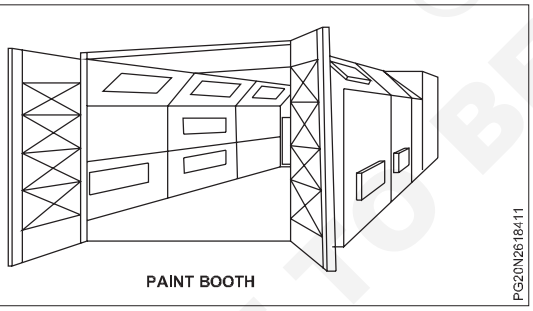


Fig 2

One and two room spray booth: Basically, the spray booths are used for water-wash and the paint arrestor type (Figs1 and 2). Water-wash booths are used for air washing action to trap the paint particles. A water-wash booth delivers clean air to the atmosphere, and thus less pollution, as well as a constant air velocity that results in a better ventilation system.

A booth that uses disposable paint-arrestor filters is usually suited for limited or interrupted spray operations, such as a refinish shop where paint use is moderate. Moderate consumption would include minimal overspray, and the amount of paint being sprayed would not exceed 2 gallons per hour. These booths work best when the coating used does not dry too rapidly. If the materials sprayed can react chemically with each other, a water-wash system must be used.

The paint-arrestor type of booth removes airborne paint particles from the spray booth exhaust air by using a disposable paint-arrestor filter. These filters must be of a good quality and must be changed as required; other-wise they choke off the air to the exhaust fan, In a booth with inter-locks, a pressure differential switch shuts of the compressed air when insufficient air is going up the stack. The OSHA code requires that filters be examined after each period of use, and if any clogged filters are present, they must be discarded and replaced immediately.

Down draft spray booth: The OSHA code also requires that the clogged filters must be removed and placed in a water-filled container or a safe detached location and disposed of at the end of the day's work. In some areas a draft gauge must be installed to meet code requirements (Fig 3). This draft gauge or manometer should be installed on the side of the booth; the pilot tube is placed on the intake side and the other tube on the exhaust side of the filter stack to indicate there is a pressure differential or drop across the filter bank. After new filters are installed, a reading should be taken on the manometer (Fig 3) and noted. The filter media will need replacement when a ½ in. or 0.635 mm increase is indicated on the manometer. This is caused by the air movement through the filters diminishing due to restricted passages in the filter media.

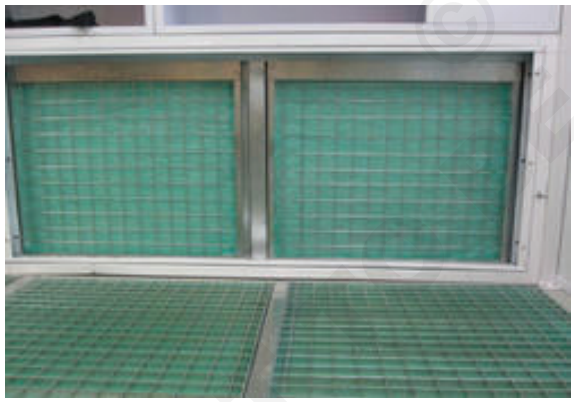
The paint-arrestor filters are made from a fire retardant treated paper, and the holes are formed into a diamond-shaped configuration. Several thickness of paper are sewed together; therefore, as air flows through the filter

Fig 3

media it is forced to move back and forth and sheds the paint particles on the filter media through centrifugal force. The size of the holes in the first sheet of paper on the filter are the largest, and they get progressively smaller toward the back of the filter.

Usually two filters are used in each frame present in the filter bank exhaust; they are usually placed one against the other with the small holes toward the inside of the exhaust filter bank (Fig 4). A grid is used on the inside to help hold and prevent the filter from collapsing, and one grid is on the outside to hold the filters in place. The two most common sizes are 1 x 20 x 25 in. (2.5 x 51 x 63 cm) or 1 x 20 x 20 in (2.5 x 51 x 51 cm).

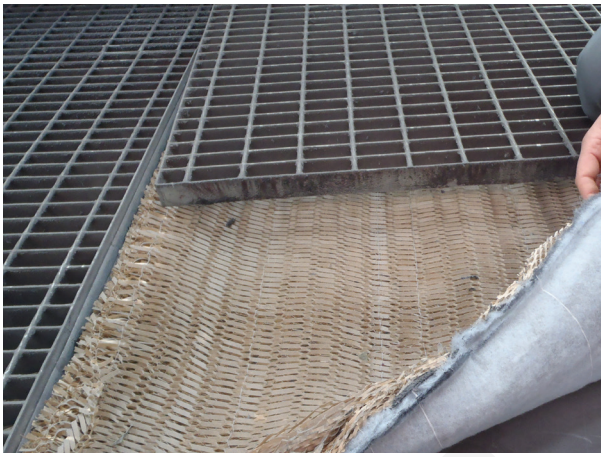
Fig 4



When the filters need to be changed (Fig 5), the grid is removed, the filters are removed, a new filter is inserted at the back, the filter that was on the back is installed on the front, and the grid is replaced. The reason that they are changed in this fashion is that the greater portion of the paint is on the side facing the inside of the booth.

This method of changing the filters cuts the cost in half and is still very effective in cleaning the air. The filter bank area must be cleaned of all residue dried paint before completing the filter change. An accumulation of dried paint inside the filter bank could cause spontaneous combustion if the right conditions were present. The old filters must be disposed of according to code in a safe and appropriate manner.

Fig 5



The paint-arrestor-type spray booth is less expensive to buy, is lighter, and is easier to install. In many states, provinces, and cities, it is required by code that the booths be equipped with a sprinkler system of sufficient capacity and with proper location of sprinkler heads. The electric and building codes must also be followed, and consulting the local authorities can save a purchaser or contractor many headaches as well as money. These authorities can help advise as to what equipment is necessary, what electrical and fire prevention codes to follow, and the location of the spray booth in the paint shop. These regulations are usually in line with the National Fire Protection Association (NEPA).

Dual draft gauge used in down-draft spray booths.

Filter media shown with opposite sides, showing the different size holes in the material.

Cross draft paint spray booth: The cross-draft booths (Fig 6) are lately have changes been made to this design. One change is the semi-down draft (Fig 7) in which the air is drawn from the upper levels of the shop. This air is usually cleaner and is pulled through filters located in a plenum is equipped with a baffle so that the air is distributed evenly and smoothly over the vehicle.

Fig 6

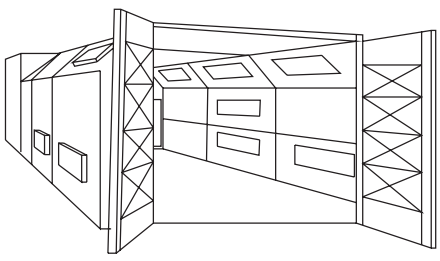
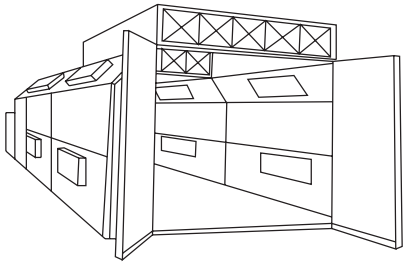


Fig 7



In the cross-draft spray booth the air is drawn through filters installed in the doors. The air travels horizontally along the vehicle and is exhausted by an exhaust fan.

These booths leave a lot to be desired, especially since the air velocity must be adequate to remove paint fumes and provide a safe working environment, but yet low enough to allow for a good paint job. OSHA and NFPA require a design velocity of 100 feet per minute (FPM) or 30.48 meters per minute (MPM).

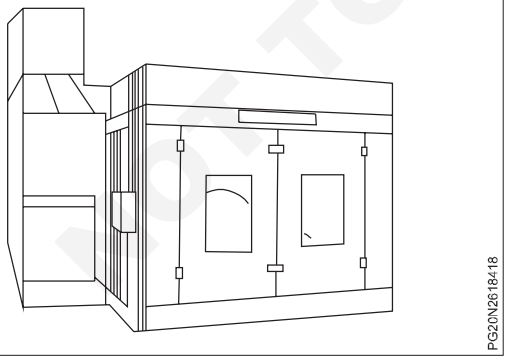
The speed at which this air moves makes it difficult for the intake air filters to remove all the dust that is pulled into the booth by the exhaust fan in a negative pressure booth. The intake air filters are a self-sealing type and are designed to be efficient at an air velocity of 125 FPM (38 MPM) at 75°F or 21.1°C. They are made from a soft, pliable polyester fabric coated with a special adhesive material to provide superior dust-trapping capabilities. They are held in a built-in reinforcing frame without a perforated metal facing, which would reduce air flow.

The life expectancy of the intake filters varies according to the amount of air going through them and the temperature of the air. The higher the velocity and temperature, the quicker the filter material will break down and start shedding fibers. Therefore, a program suited to the particular shop conditions must be followed as to when these filters have to be replaced.

The filters are provided to give a smooth, even flow of clean air, which in turn envelopes the vehicle being painted and carries away spray fumes and evaporating solvents. These filters are available in different sizes, but the most popular sizes are 2 x 20 x 20 in. (5 x 51 x 51 cm) or 2 x 20 x 48 in. (5 x 51 x 122 cm)

Air filtration system in paint booth: Down-draft spray booth (Fig 8) and was developed in Europe. The down-draft spray booth is designed on the same principle as automotive production line down-draft booths. The replacement air passes through filters in the ceiling and flows around the vehicle and through gratings in the floor.

Fig 8



This varies from conventional spray booths where the air flow is from one end to the other across the vehicle. The air flow pulls the overspray down and away from the painter into the pit instead of along the length of the vehicle being sprayed.This minimizes the chance of overspray and contaminants collecting on a freshly painted vehicle and spoiling the finish. This type of spray booth gives superior quality to the painted vehicle and draws the overspray away from the painter; it gives a finish comparable to an original factory finish. Due to the better filtration system and different air flow, it helps to eliminate the two major causes of unsatisfactory refinish jobs: airborne dirt and a bad painting environment.

A variation of the down-draft booth is the cure spray booth. This booth operates the same as a down-draft spray booth in the paint application phase. But after the spraying operation is completed, the painter does not have to move the vehicle for the curing stage. The curing stage is initiated by the painter by flipping a lever and then selecting the temperature and time.

The purging of the solvents from the booth atmosphere and changing the cycle to a high temperature air flow is automatically carried out by pre-programmed controls. The curing time varies from 20 to 30 minutes, which depends on the type of paint used and the size of the vehicle. The booth controls are preset for each temperature and curing time to ensure consistent results.

The fresh air used is about 10% and is heated and mixed with recirculated air, maintaining a steady temperature without using an excessive amount of fuel. The air is filtered at all times; therefore, the car is not exposed to any dust-laden air. Air flows through the spray booth in the same direction except that much less air flows when the booth is in the curing phase.

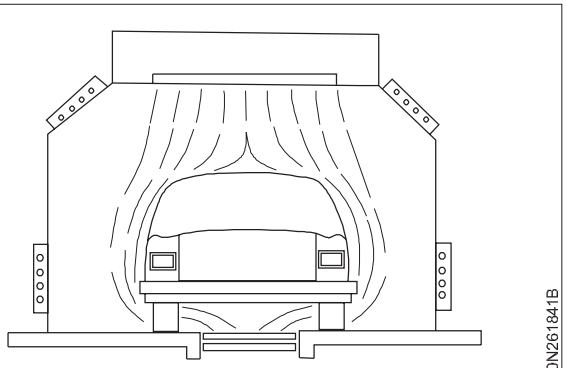
A spray booth should have walls that are smooth; this will eliminate dust clinging to them. The booth should be fireproof and should have an unobstructed working area as well as an access door so that the painter can go to and from the spray booth without opening large doors. The spray booth must have a lighting system that provides enough intensity and uniformity to produce good working conditions. Fluorescent light fixtures are usually used as they provide more uniform illumination.

Booths installed in the United States are equipped with vaportight fluorescent lights. Explosion-proof lighting, switches, and inter-lock must also be provided to meet electrical codes as required. (Figs 9, 10 & 11)

Fig 9

Fig 10

Fig 11



AIR FLOW IN A DOWN-DRAFT BOOTH.

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Maintenance of paint spray booth

- Keep the spray booth is good operating shape
- After painting swept and wash the paint booth floor
- Floor can be dampened to help keep dust problems to a minimum
- The booth should be kept free of un required materials such as parts, water bucket, brooms, squeegees, dust pans, and trash cans.
- Air hoses should be hung on hose hangers and not laid on the spray booth floor.
- All filters should be changed as required.
- All door seals should be kept in good repair, so that dust will not come through open gaps.
- The glass lenses, fluorescent fixtures, and spray booth walls should be kept in a clean condition.

Reverse flow paint booth: The exhaust is located in the front near the drive in doors to be pulled directly into the exhaust. The paint booth provides great air filtration at the entrance of the booth limiting shop dust from entering the booth.

Regular flow paint booth: During spray jobs in paint booth the exhaust system must draw substantial of air out of the shop in order to operate. These volumes must be replaced with equal volumes of air coming into the booth.

The air being pushed in and pulled out are alone with two types of fans. The exhaust fan that pulls the air out of the standard tools paint booths is a tubeaxial exhaust fan. It is a propeller blade type fan. Tuberaxial is the best fan to be used on the exhaust of the booth because they are designed to pull the air. Aluminium blades are used because they will not spark, causing a fire, which is important when working with flammable paint coating.

The fan that pushes the air into the booth through the sure-cure is a blower fan, designed to force the air into the booth. Controlling the air flow and pressure is a delicate balance between input air and exhausted air.

Wet filteration System: Water wash booths trap paint overspray with curtains of water and deposit then into a collection tank. Which must be cleaned of sludge periodically.

Water wash systems are ideal for operations with very high production rates while dry filteration systems are better fit for most other operations. Wet filteration require a high initial investment, but are ideal for operations using very high paint volumes that need a uniform and constant air flow.

Dry filter system: Dry filter booths use layered filters to separate the paint particulate from constant air stream passing through the exhaust filter. There are many types of materials and designs available for dry filter media. Dry exhaust filters and even reclaim systems available. The dry filteration system require dry filter replacement and the periodic maintenance needed.

Types of infrared drying equipments: Infrared dryers belong to family of generate heat at targeted material type of due this utilization of infrared dryers for heating help the dryer to provide various advantages. Variable speed AC motor with imported variable.

A diverse range of equipment is used industrially for drying operations including tray, screen conveyor, screw conveyor rotary drum, tunnel, bin, tower, spray, flourished bed, and flash driers. Some driers have a direct mode of heating. Where by air entering the drier is brought into contact with the wet solid.

Near infrared drying equipment: Near infrared drying technology is that it is designed to minimize maintenance equipment. The radiation emitter which generates high filament temperature and heat intensities from 1000 to 1500 kw/m2. The emitters are designed for an average operational life of 5000 to 6000 hrs. The emitters performance could be extended to as much as 8000 hours.

The Infrared panel heaters are used to ensure a properly cured and blaster free surface. Normally it involves a 10-20 minute curring process. This method interrupts the continuous car production process, as the damaged vehicles must be removed from the line and placed into special spot repair booths.

Far infrared drying equipments: Adopted the technology of far-infrared radiation heating, heating speed of this infrared lamp cure time is 60% to 80% faster, and it only heats objects within its infrared range efficiently utilizes the energy its aluminium alloy frame and 304 bright stainless reflector are sturdy and durable.

The large drying area, the electric paint dryer lamp is used. This lamp working temperature is adjustable and this lamp is fitted with the powerful 2000W short wave infrared lamps to let heat pass back through the coating via conduction.

Description of air supplied respirators: The different materials present in the workplace and the many airborne chemicals, dust and elements that are inhaled can damage the lungs severely. Some chemicals also irritate the skin and eyes and some absorbed by the skin into the body.

Some possibly harmful elements found in paint are, antimony, barium, cadmium, nickel and selenium, when paint hardeners and gloss improvers are used, isocyanates are introduced into the air that a painter breathes. Therefore, it is of great importance that breathing protection be wear as required.

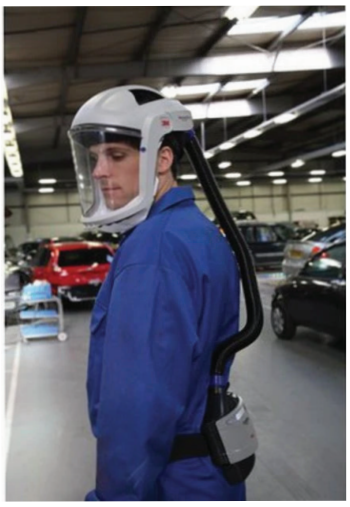
When working is dusty conditions or when power/dry sanding is done, a dust mask, such as this mechanical type respirator that removes dust and solid particles from the air a person breathes. This respirator covers the nose and mouth and when covered with dust is thrown away with vacuuming or light brushing, masks can be cleaned so that they last longer. When the respirator is clogged with dust from filing plastic or fiber glass, it should be discarded. Masks should be stored in a clean box or cupboard for proper hygiene. (Fig 12)

Fig 12

The respirators most generally used for painting are made to protect against the general types of paints such as lacquerer, and enamel mists and organic vapors. A poor-fitting respirator must never be used as it endangers the painters health.

Types of respirators: Respirator is are used at all times when spraying paints that have polyurethane additives in them. This respirator can be used when spraying in areas that are closed as they are supplied with clean, pure air at all times. All the components must meat the code such as the regulator, waist belt assembly, air supply hoses (25 foot or 7.6 meter) and air regulator. The air line used by the hood or respirator cannot use the same source as the spray gun. The air used for the respirator must meet the standards set by OSHA or CSA as per table given below these guide line set rigid purity standards for compressed air. (Fig 13)

Fig 13



Breathing Air Standards

(Maximum allowable contaminant level)

Contaminant	OSHA	CSA
Carbon monoxide (ppm)	20	5
Carbon dioxide (ppm)	1000	500 ± 25
Oil (Condensed)		
Hydrocarbons (mg/m3)	5	1
Odors and tastes	Slight	Slight

Half-face piece pressure respirator: The half mask respirator is used where eye protection is not required. This respirator protects the lower part of the face and the lungs from hazardous vapors, dust and chemicals. The same air system must be used for hood air respirator and full face shield type air respirator and half face shield respirator. The half mask is held securely enough to prevent leakage. (Fig 14)

Fig 14

Full face respirator: The full face respirator air hose is attached to the regulator on the wrist belt and the regulator is plugged into the hose line. The respirator is ready to use, when the regulator pressure is adjusted as required. The air supplied respirator must be inspected for defects after each use. If defective, it must be repaired immediately. The regulator should be connected to the breathing air source at 30 to 125 PSI. (Fig 15)

Fig 15

Fig 16

Air supply unit:

Air supply unit for hood and half, full face mask: Many paint shops are used a small oil-less compressor that is vary from a diaphragm type oil-less piston to an oilless turbine type driven by an electric motor. (Fig 16)

The compressor air intake must be located so that only clean fresh air is drawn into the compressor. Great care must be taken to place the intake away from engine exhaust. Chemical processes and dust sources. The air should be checked often to assure its purity.

Paint shop equipments and tools

Objectives: At the end of this lesson you shall be able to
- **state the wet sanding stand and paint hangers**
- **state the sanding and masking method.**

Wet sanding standard: The wet part of wet sanding refers to use of water or some other liquid as lubrication to help carry away grit particles that are removed without the liquid, material can build up in the sand paper and leave behind scratches that are larger than the particle size running finish.

Paint hangers: 36 mm is a perfect storage solution for those who do not have any room to spare on their work benches it can be mounted on a wall and it can be combined vertically and horizontally with other paint hangers. Painting stand that is quick, easy and convenient to use. Adjustable frame that extends from 50-70 inches in height is 70 inch long and six hooks to hold parts for painting or drying it is great for hoods, doors, fenders and tail gates.

Panel Drying Ovens: The function of panel drying oven is to remove moisture from a product, depending upon the process and production requirement, a batch or conveyor configuration is available.To meet both process and safety requirements, the exhaust system is engineered to accommodate specific moisture release rates.

A drying oven is designed to remove moisture from the oven chamber so to dry the samples as quickly as possible. The drying oven process introduces fresh dry air to the chamber and expels the warm moist air simultaneously allowing to rapidly dry the samples. A drying oven provides high performance drying and heating.

Paint shakers: The paint shaker is formed by a housing mounting a vertical mainshaft, which supports a container clamp assembly at one end is engaged through a simple crank arm at its other end to a double acting air cylinder motor.

Paint blade agitator: Strong and economical paint mixing agitator blades that are shaft mounted. Thoroughly mix paint at 200 - 900 rpm. Stirrer blade easily mixes high viscosity materials.

Churning Knives: Product churning is similar to the razor and blades business model. This involves selling a basic product at a loss, but receiving very high profit margins on associated products that are necessary for the basic products continued usage.

Knife is cutting instrument consisting of a sharp blade fastened to a handle or knife is a sharp cutting blade or tool in a paint mixing machine.

Paint scale: Paint mixing scales bring a new level of comfort and functionality into the automotive body shop, and for this reason the scales are often referred to as an automotive scale or automotive paint scale. Even though they can cover a larger range of applications including being used as an ink mixing scale.

Paint cabinet: Semi gloss, gloss, the harder the finish the better matte paint on kitchen cabinet is impractical. Would not even use eggshell finish.

Painting costs a lot less than buying new cabinets and having them installed. If you need to make an economical choice. Painting is the way to go even if you are not forced into making the most economical decision, painting is still an attractive option.

Tack Cloth: Tack cloth is a specified specialized type of wiping cloth that is treated with a tacky material. It is designed to remove loose particles of dust, dirt and link that would contaminate a surface that is to be coated, laminated, photo-etched or otherwise finished.

Purpose of the strainer: Strainers are important components of piping systems to protect equipment from potential damage due to dirt and other particles that may be carried by the process fluid.

A line strainer is a device to filter out grit and debris from a water line to protect appliances from being damaged by contamination. Sometimes line strainers are integrated into other fittings to provide a combined function such as safety systems fitted to unevented hot water cylinders.

Masking tape: Masking tape also known as painters tape, it is a type of pressure-sensitive tape made of a thin and easy-to-tear paper, and an easily released pressure-sensitive adhesive. It is available in a variety of widths. It is used mainly in painting to mask off areas that should not be painted.

Types of oven for painting

Objectives: At the end of this lesson you shall be able to
- **state the types of oven**
- **state the function of oven and its care.**

Curing: Curing is the process of converting the applied wet paint to dry film. The paint may cure by solvent loss (Lacquers and emulsion) chemical reaction(enamels) Oxidation (oil base house Paints), melting and re-solidifying or melting and cross-linking (powder coatings). Energy is usually required for dependable and consistent drying of industrial coatings

Air dry paints relay on solvent evaporation into the atmosphere. The temperature and humidity will have a profound inspect on the drying time. Low temperature or high humidity will not provide sufficient atmospheric heat to rapidly dry the paint ovens can be used to speed up the drying time and make it more predictable.

Ovens: Paint cure ovens are encloses in which the coating on the painted parts is forced to cure

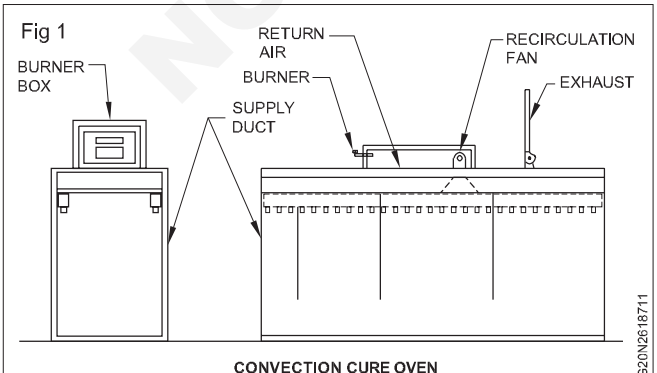
More rapidly than by air-drying alone usually they are insulated and provided with a means of exchanging solvent rich air for fresh air. They range from small batch type boxes to large conveyor equipped structures.

Finishing systems often use convection ovens, infra (IR) ovens, and ovens that combine convection and IR equipment for drying and curing. Various oven suppliers have their own design methods that can be effective. However, a few standard concepts should always be considered, regardless of the manufacturer.

Convection Curing

A convection oven cures by circulating heated air around the part to heat the substrate. The part conducts heat into the paint dries from to heat. The convection oven uses a heating system that re-circulates hot air through supply duct and distributes it throughout the oven. The basic components include the insulated walls and roof, the supply duct, and the burner box, which houses the fan(s) and heat source. (Fig 1).

Fig 1



CONVECTION CURE OVEN

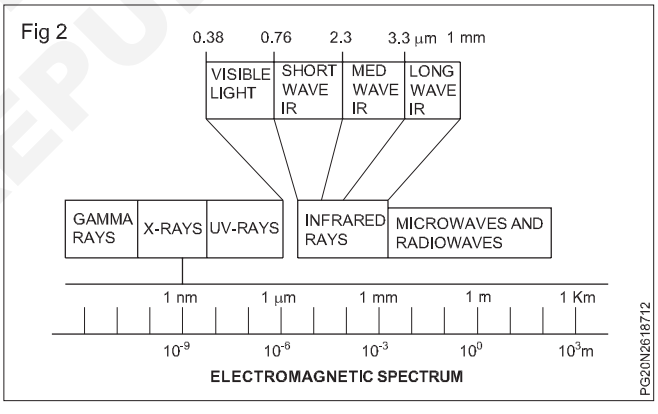
The curing of organic coatings is a function of time and temperature as defined by the paint supplier. Typical oven cure cycles range from 10 to 30 min. The time and temperature required depend on the type of coating and the substrate. The cycle must be long enough to bring the substrate to the desired temperature, and maintain it for the prescribed time.

Infra Red Curing

IR curing can be a great asset for faster oven process times, and it can also contribute to the quality of the finish.

IR energy is a form of electromagnetic radiation. There are three wavelengths of IR energy, measured on the electromagnetic spectrum in microns, between visible light and microwaves. These wavelength bands are shortwave (0.76-2.3 μm), medium wave (2.3-3.3 μm), and long wave (3.3-1,000 μm) (Fig 2).

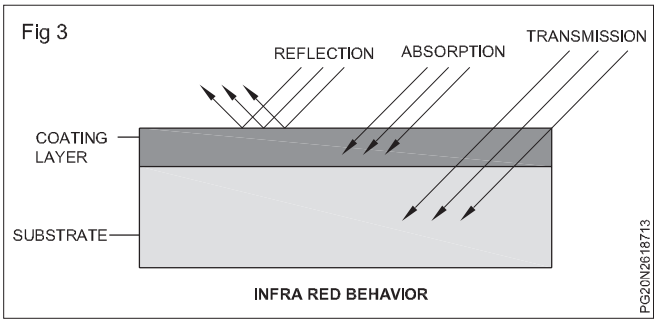
Fig 2



ELECTROMAGNETIC SPECTRUM

IR energy is transmitted from an emitter and directed at a target. Depending on the wavelength of IR and the nature of the nature of the coating, the energy can behave in one of three ways: reflection from the surface, absorption into the coating, or transmission into the substrate (Fig 3).

Fig 3



INFRA RED BEHAVIOR

Energy reflected from the surface has little or no benefit, although it is possible that it will be reflected back to the part surface by the reflectors located around the emitters. Transmission into the substrate will contribute to the cure

of the coating, but it may not be a very efficient use of the **IR** energy with substrate that have relatively fast thermal conductivity. The advantage of **IR** is fully realized when the energy is absorbed by the coating, creating molecular oscillation, and generating heat.

Most organic coatings will absorb the highest percentage of energy in the medium wavelength. Short-wavelength absorption characteristics are quite low; most of the energy is transmitted into the substrate, leading to a smaller processing window and more colour sensitivity. Long-wavelength IR provides less surface heating because of low electromagnetic energy levels. It is best suited for wood drying or similar low-temperature applications.

In order to fine-tune the appropriate IR system for a specific coating, testing is required. Shortwave IR may be suitable for some preheat situations, but care must be taken to avoid overexposure. Shortwave systems are very useful for products that have relatively simple geometry where the surface can be uniformly exposed to the emitters.

Medium-wave IR provides good absorption characteristics with less intensity than shortwave, and it is more flexible for a variety of coatings and different parts. Long-wave IR is useful where low wattage per square inch is required.

The nature of energy transfer by light makes it difficult to maintain uniformly over irregular surface. In order to react to various parts of different mass and shape, the intensity or position of the emitters must be adjusted by the operator or a programmable logic controller (PLC). This lack of flexibility limits the number of applications where it is practical to use IR alone for curing, particularly if the throughput will vary in size, shape, and mass. In situations where the mass-to-surface ratio and the part geometry are changing rapidly, it may be difficult to control the amount of energy and avoid excess or insufficient cure.

A combination of IR and convection can make excellent oven, providing flexibility, saving space, and offering dependability and reasonable energy efficiency. For example, an oven may be equipped with an IR section at the entrance to begin the cure process prior to entry into a larger convection zone. It can shorten the overall cure cycle and reduce the risk of contamination that may occur in the convection zone.

It also can be zoned to effectively react to different masses on the part and accelerate cure on heavy substrates.

In some cases, IR can be the best, if not the only, way to cure a coating. Very massive parts that would require impractical cure times with convection heating can be cured fairly quickly in an IR oven that is properly designed. Testing is required to determine the precise intensity of the emitters and he optimum arrangement.

Oven Maintenance and Cleaning

Oven maintenance is a critical issue in the design. It will be necessary to clean the inside of the oven, so the duct interior and exterior must be accessible, and the surfaces should be smooth so that they can be washed or vacuumed. Main doors and swing-in dock lights should be included be where possible. For high-quality finishing systems, such as clear-coat or plastic lines, interior lighting may be used to facilitate cleaning the oven.

Oven Exhaust

Cure ovens must be exhausted to remove solvents, gases, and the by-products of the combustion. Oven exhaust also creates a negative environment in the oven enclosure, which helps to contain the oven atmosphere at the product openings.

The amount of air exhausted from the oven is based on the amount of solvent that is carried into the oven and the by-products of combustion. The exhaust volume must be high enough to prevent a loss of gases from the openings. Excess exhaust will unnecessarily increase the cost of oven operation.

Exhaust is required to prevent the build up of solvent vapors to explosive levels. Safety codes require that solvent vapour levels should not exceed 25% of the lower explosive limit (LEL). 10,000 ft^3 (280 m^3) of fresh air must be supplied for each gallon (3.79L) of solvent evaporated.

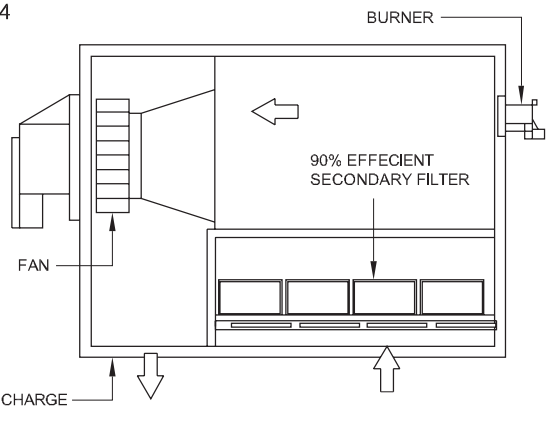
Oven Filtration

The negative air pressure in the oven may attract particulate from the facility that can cause dirt defects on parts. Vacuuming the oven interior regularly will help to prevent contamination from building up in the oven and becoming a problem.

Another way to help avoid an oven dirt problem is by providing return air filtration. A filter framework is built into the return air opening of the burner box and high-temperature filters are installed in the frames. While the efficiency of the filters varies for each application, a typical combination would feature a row of 30%-efficient filters serving as the pre-filter layer for a secondary layer of 90%-efficient filters. This prevents the blower from circulating dirt onto the parts and constantly sweeps the oven (Fig 4). High-efficiency filters may not require a pre-filtered air stream.

If return air duct is used, the filtration should not be located in duct that is in close proximity to the parts. Return air filtration should only be located in the return opening.

Fig 4



Oven Location

Ovens can be located directly on the floor, elevated on support steel, or located on the building roof. A floor-mounted oven with product openings in the sidewall should feature some method of heat containment as described previously, and the floor should be insulated to reduce heat loss. Elevated ovens remove process heat from the floor and save floor space. An elevated oven can cost considerably more than a floor-mounted oven because of increased installation costs and additional materials. Bottom entry and exit openings in an elevated oven will provide the best possible the best possible heat containment.

The Impact of Catalysts on Curing

Catalysts are chemicals that are added to the paint to accelerate cure by chemical reaction. Strictly speaking, they are not energy sources. Catalysts are effective, because they permit the paint chemicals to react more rapidly at any given temperature than they normally would. Thus, curing can be achieved more quickly at the same temperature or in the same time at a lower temperature. This can be important when coating heat sensitive materials such as thermoplastics or when fuel conservation is important.

Heat Recovery

A well-designed cure oven will not exhaust enough Btu's to make it cost effective to install a heat exchanger for heat recovery. The volume of exhaust is based on the amount of gases that must be removed from the oven interior to maintain a safe environment. Since the exhaust is gas laden, it is not possible to use the heated air without a heat exchanger. A good heat exchanger is expensive and the efficiency will be around 75%.

The stack gas temperature must be maintained above the dew point to avoid condensation in the stack. This limits the amount of energy that can be recovered from the stack gas. With the cost of the heat exchanger, duct and fan for recover, sense to recover heat from an oven.

If volatile organic compound (VOC) abatement equipment is necessary, heat recovery through the use of a secondary heat exchanger may be worthwhile because of the high temperature used in a thermal oxidizer. The recovered heat can be used for a boiler, hot oil heater stages of a pre-treatment washer.

Sealant and its application

Objectives: At the end of this lesson you shall be able to
- **state the purpose of sealant**
- **state the application of seal**

Sealant: - Sealants are commonly used for seal the gap between metal joints, welding joints and it provide a water resistant seal that maintains a strong hold a against harsh weather conditions. The modern sealants are composed of an elastomeric compound for flexibility together with a filler product sealants are usually polymers these pliable compounds allow gaps to be bridges and the sealant to resist a degree of movement. There are many different sealant products available, each designed for a different application including structural applications.

Types of Sealant: In construction used the seven most common types sealants are as follows.

- **Water based latex** – used situations where gaps/ voids are very small and moment is minimal it can pull away from the substrate creating gaps allowing water to penetrate.
- **Butyl** – it is hard to apply due to their stringer consistency butyl is not suitable for building works.
- **Polysulfide** – it is a excellent flexibility even at low temperatures water little shrinkage and it can be used for under water applications. It is very costly them other sealant but its life also very high.
- **Silicone** – it has excellent thermal resistance good dynamic movement capability and good adhesion. silicones can be used structurally for bonding glass or metal to frames it is have very good durability performance.

Polyisobutylenes: It is very good resistance to chemical attack and have very low permeability. It is resisting the transmission of vapour gases. It has mostly used for factory applied rather than site applied.

Polyurethane: - it has excellent resilience to abrasion and shear forces as well as having strong adhesion and movement capability.

Sealant Properties: - The following are key properties of sealant

- Consistency
- Durability
- Hardness
- Exposure resistance
- Movement capability
- Modulus
- Adhesion
- Staining
- VOC content (Volatile Organic Compound)
- Ease of application
- Cost

Application of Sealant: - Select the suitable sealant depend upon the nature of work (wood, building, metal, PVC) usually sealants are used for fill the gaps between welded joints and metal joints, wall joints, wood work joints to protect from water leakage through the joints. Seam sealer is needed any where water leakage might be a problem between panel joints often on welded joints of two metal sheets.

After application and drying of self itch primer before use the sealant . Read instructions of sealant manufacturers and follow the procedure step by step as per instructions printed on the sealant packing. Open the seal of sealant and fill it in caulk gun and then apply sealant by using the caulk gun to the panel joints. Modern sealers are two part materials. A caulk gun with an intermix up tip is used to mix and apply the seam sealer ingredients. (if sealant packing label instructions is not clear) Refer computer based data to find out where and how sealant should be applied. (Fig 1 & 2)

Fig 1

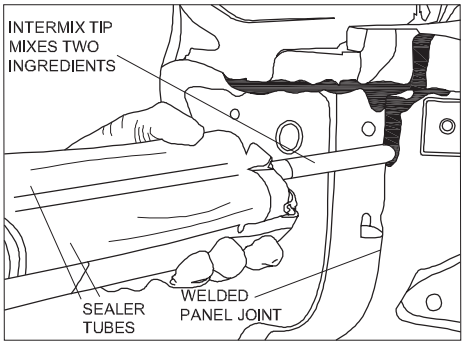
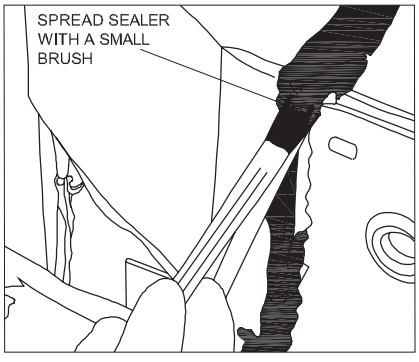


Fig 2



Paint viscosity

Objectives: At the end of this lesson you shall be able to
- **state the importance of paint viscosity**
- **state the method of paint preparation and mixing for different application**

Paint: Paint can be defined as a fluid material, it is spread over surface in the form of thin layer, will form solid, different and cohesive opaque film. Some paints are also available in powder form. The painter and artist use the paint for the art or processes of applying paints to a surface such as canvas to make a picture or other artistic composition

Paint coatings consist of resins, pigments, solvents and additives. Particular types of coating applying will have varying amount of each of these constituents. Resin or binder hold all paint constituents together and enable them to cure into a thin plastic film. The end use of a painted product should determine viscosity ready to use or sometimes we need to prepare and mix the solvent to bring suitable viscosity of paint. Viscosity is a measurement of the flow characteristics of the paint. The paint should always be tested before using a fresh batch of coating on any surface. The paint viscosity varies considerably from job to job and is sometimes reflected in poor gloss, poor hiding, excessive fade and poor metallic colour.

Paint viscosity:

Viscosity is a very important paint property, usually determined by measuring the time required for paint to flow through a hole in the bottom of a metal cup. A number of cup sizes and drain hole diameters are available for use with different viscosity paints. Three widely used viscosity cups are the Fisher, Ford, and Zahn viscometer. Table 1 gives conversion values for use with these cups.

Table 1

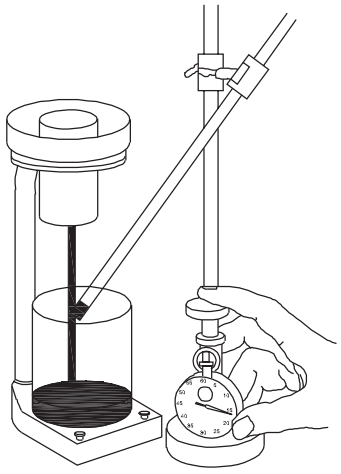
Reduction /Thinning Percentage	Reduction/Thinning Proportions	Paint (Color)	Solvent
20%	= 5 parts paint/1 part solvent		10%
25%	= 4 parts paint/1 part solvent		25%
33%	= 3 parts paint/1 part solvent		33%
50%	= 2 parts paint/1 part solvent		50%
75%	= 4 part paint/3 part solvent		75%
100%	= 1 part paint/1 part solvent		100%
125%	= 4 parts paint/5 part solvent		125%
150%	= 2 part paint/3 part solvent		150%
200%	= 1 part paint/2 part solvent		200%
250%	= 2 parts paint/5 part solvent		250%

It is important to correct the viscosity cup flow-out times for the temperature of the paint. The recommended spray viscosity is typically based on a temperature of 70 F. if the viscosity is measured at a colder or warmer temperature, the actual viscosity could be too low or too high. A paint supplier can provide the appropriate corrections for their product. Be sure that the type of zahn cup or other viscosity cup used is consistent. In addition, be sure that the method of measurement is consistent. Some operators consider the first break in the paint to be the stop point, while others may wait until the cup is virtually empty.

Several easy to use viscometers are manufactured and one of them should be part of the refinishers equipment perhaps one of the most popular is the no-4 ford cup. This cup holds 100cc and has a cone shaped bottom with 4mm orifice bowl

Method of using viscosity cup (Fig 1)

Fig 1



USING THE VISCOSITY CUP

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1 Check the temperature of the material; it should be approximately 70° F (21.1C).

2 Read the paint manufacturer's directions for proper reduction. Add the reducer, stirring until the thinner and material are well mixed.

3 Place a finger over the orifice in the bottom of the cup and fill with material at hand. A stop watch is used to time the number of seconds it takes the cup to empty or the flow of material to break.

Different materials have different spraying viscosities. For example, acrylic lacquer will spray best and give good hiding and flow-out at 18 to 22 seconds. Alkyd enamel will show its best qualities at 20 to 23 seconds, acrylic enamel at 18 to 21 seconds, and polyurethane enamel at 18 to 22 seconds.

Unfortunately, a number of paint shops never use a viscosity cup, but the importance of measuring the amount of thinners according to the paint manufacturer's directions cannot be stressed too strongly. Consistent control will give each job uniform hiding, gloss, better flow out, and good gloss retention. It is interesting to know that car manufacturers and paint companies control viscosity to within a variation of 1 second from the desired viscosity.

Over reduction and under reduction of paint result in a good many cases of excessive orange peel, sags or runs, mismatches with metallic shades, and poor hiding.

When mixing colours to match, add only a small amount of colour at a time. This is very important when mixing metallic colours. Sometimes, when adding extra colour to metallic's, it is necessary to add some extra-clear vehicle to the paint in order to keep the high gloss.

Paint preparation and mixing for different application:

Select the any paint product, carefully read the manufacturers directions on the paint container label. While different type of paints might have the same general characteristics, each manufacturer has specific formulations for their products.

When reducing paint refer to the product builletin for the proper procedure. Always read and follow the manufacturers directions. Keep in mind the following points, while prepare the paint for particular application

- Proper reduction viscosity of paint material
- Use of paint additives (hardeners, catalyst, flex agents) when necessary
- Spray application techniques and typical flash time
- Number of paint coats required for different painting work
- Type of coating procedures
- Clean up and disposal procedures
- Safety wearing while paint preparation and mixing with solvent and ingredient
- Select the proper paint solvents (Reducer or thinner)

Note: Some paint products are ready to spray. They do not require reduction and it can be sprayed right out of the can.

The blending solvent will help dissolve the original paint film. So it matches the new clear coat more closely. The blending solvent will help the two finishes flow together more smoothly.

Paint mixing instructions:

Solvent mixing instructions printed on the container label that state how much of each ingredient must be added to the paint product. A percentage reduction means that each ingredient must be added in certain proportions. For instance if paint requires a 50 percent reduction, this means that one part reducer must be mixed with two part of paint.

Proportional mixing numbers compare how much of each ingredient must be mixed regardless of quantity. The first number is the part of paint needed. The second number is usually the hardener. A third number might be used to denote the amount of reducer required. The sequence of ingredients can be vary some instructions list for ingredients to mix so read the paint manufacturers instructions carefully study the percentages and parts

of each material that must mixed. Use the diachronic or computerized scale when mixing and also show how much of each ingredient to add.

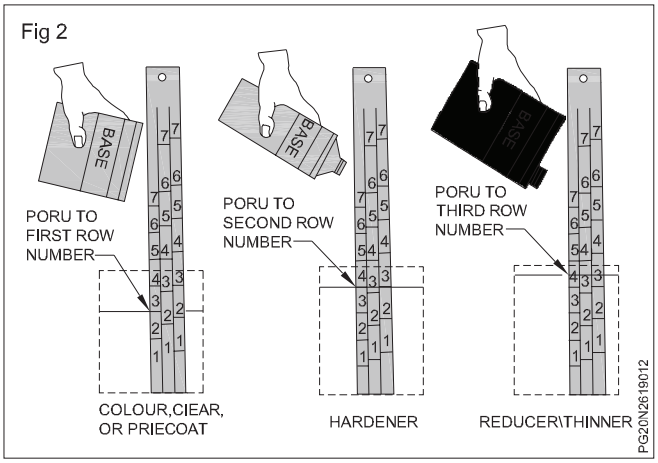
Paint mixing stick can be used to add repair material ingredients in the correct amounts. Choose the correct stick for the paint material using to mix. Only use the perfectly clean containers with horizontal sides when mixing paint products.

The mixing container should be big enough to hold all paint, hardener and solvent needed for the job. The several liter container saves mixing time for an overall paint job.

Use the graduated seals paint mixing stick, that allow to easily convert ingredient percentages into part proportions. Place the correct paint mixing stick for the type of paint into the straight sided container. Pour paint into the bucket stop pouring, when the material is even with the number corresponding to the type of product. The material must be usually be even with a number on the left column, which might be depending on the quantity of paint needed.

Basic steps for using a mixing stick. Fig 2A show the information on the top of the mixing stick you must usually pour in paint or primer first up to arrow mark indicated in the Fig 2A. Pour the amount of material into the bowel.

Fig 2



Stop when you reach any of the numbers on the mixing stick, next used material hardener, pour the hardener into the can unit it is even with the same number on the mixing stick Fig 2B. But in the next column. If the paint was even the number 5, pour in hardener to number 5 on the next or center column on the stick. Next Fig 2C pour in solvent until the liquid is even with 5 on the stick in the right column. Pour all materials slowly so you do not add too much, stir materials with a metal stick

Pressure feed paint spray system

Objective: At the end of this lesson you shall be able to
- **state the uses of pressure feed system.**

Introduction:

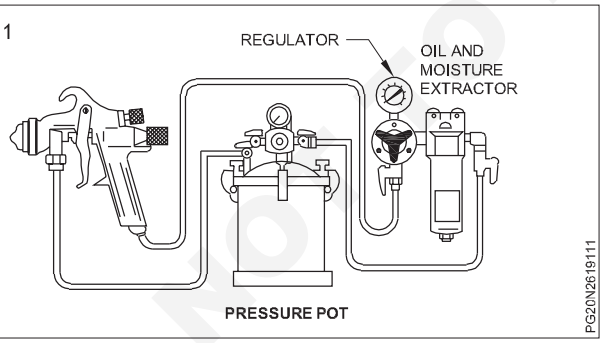
Liquid paint can be applied in many different ways mainly three major components of a paint line are pretreatment application and cure. Paint can be applied by spray using pressure feed guns, automatic guns, automatic rotary rollers. Most of the different type of industrial painting system apply liquid coatings with spray guns. The liquid coating is delivered from the paint container to spray gun that uses pressure to break the liquid paint into a finely divided misk spray on the metal surface. The pressure feed system is used in situations requiring more volume delivered from a larger vessel.

Pressure feed system:

High volume low pressure (HVLP) gun technology is a form of air spray that uses a restrictor to reduce the velocity of the coating material for increased transfer efficiency. HVLP paint spray gun can provide higher transfer efficiency compared to other conventional spray guns. Without electrostatic charging. It is useful for nonconductive surfaces such as plastic and wood. HVLP gun uses a high volume of air delivered at low nozzle pressure in atomize paint into a pattern of low speed particles.

The high pressure of conventional spray guns tends to blast the paint into small particles in the process, it creates a fair amount of over spray. The transfer efficiency of high pressure system suffers as a result of overspray particle bounce and blow back. (Fig 1)

Fig 1



Uses of HVLP pressure spray system:

- HVLP spray gun relies on air delivered to the tip at pops or less to break the paint into small particles
- Paint material flows into the air stream far less amount of paint is lost in overspray, bounce and blow back. Hence the dramatic improvement in transfer efficiency
- It can work with any material that can be atomized by a spray gun.
- HVLP spray gun can be used for two components paints, urethanes, acrylics, epoxies, enamels, lacquers, stains, primers and so on.
- It has larger internal air passages and it is designed to operate on lower line or hose pressures.
- Most redesign HVLP guns use conventional inlet pressure to help atomization
- This gun allowing a high volume of air and paint to pass through the gun. This increases gun efficiency so that more paint is applied to the body surface and very less paint is wasted as over spray.
- Modern HVLP gun is easy to handle and it produce an excellent paint finish.
- HVLP gun reduces air pollution and paint west in many weather conditions.
- Its high transfer efficiency improves the quality of finished product
- HVLP pressure feed gun are used side by side to paint identical surface areas and this gun have enough paint to finish the job
- HVLP gun useage is helps to saves on the cost of paint and the time needed refill the gun.
- HVLP gun designs place the air valve in the handle to control the air pressure.
- A rule of thumb would be to hold the gun 6 to 8 inches away from the painted surface when spraying with HVLP, compared to 8 to 10 inches for a conventional gun.
- HVLP gun greater distances result in excessive dry spray and back of film build up
- Use the high airflow through air hose inside diameter to produce ideal atomization, spray fan, and material deposit on the surface.

Note: Always use the manufacturer recommended size air hose, air nipples and air couplers with HVLP spray gun. Use the recommended hose size for HVLP spray guns to allow for sufficient airflow.

Airless and Electrostatic spray painting

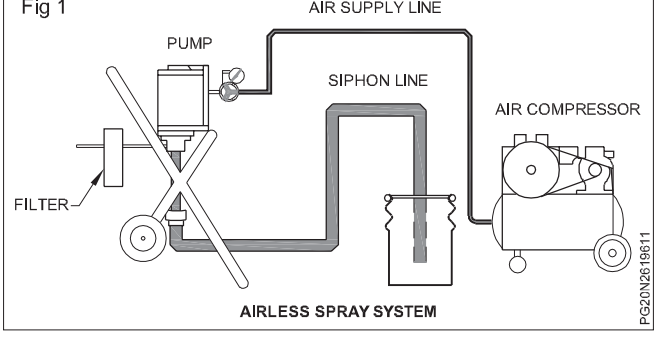
Objectives: At the end of this lesson you shall be able to
- **State the airless painting system**
- **State the electrostatic spray painting system**
- **State the electrostatic airless spray system.**

Airless painting system:

Spray painting is a painting technique in which a device sprays coating material through the some source of pressure onto a surface. The most common types employ compressed gas- usually air to atomize and direct the paint particles. The spray system is usually distinguished by their size and the size of the spray pattern they produce. Some special case used the airless spray systems by using a high pressure pump connected with to build up high pressure 300 to 7500 pounds per square inch pressure to atomize the paint coating by using different size nozzle tip to atomize and spray pattern size. Airless painting system is used to paint heavy duty industrial, clerical and marine coating. Airless spray system have some advantages as follows

- Paint coating penetrates better into pits and crevices
- Paint coating makes a uniform thick coating is produced
- This system reducing the number of coats required
- In this system very wet coating is applied to ensuring good adhesion and flow out
- Most coatings can be sprayed with very little thinner added
- Reducing the drying time and decreasing the release of solvent into the environment
- Airless pump is used to produce high pressure
- Airless spray gun does not use compressed air for paint atomization, so there is no air nozzle with atomizing port like those found on air spray gun
- Airless spray system works with a high pressure pump, that delivers fluid to the gun tip at 500-6000 PSI and this pressure forces the fluid the nozzle tip orifice
- Airless system can be used with heater to reduce the spray viscosity and improve finish quality as shown Fig 1.

Fig 1



AIRLESS SPRAY SYSTEM

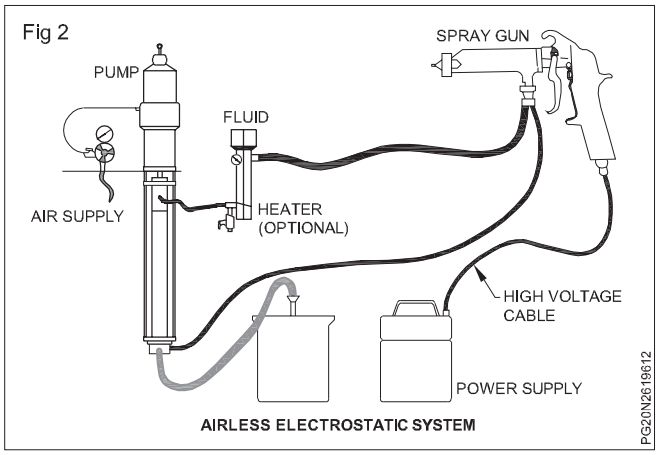
Note: Airless units and all connected components must be grounded to prevent static discharge. Electric units have three wire grounded plugs, air driven pumps have ground straps, and a proper airless hose has a ground wire built into the jacket of the hose. Never attempt to remove a hose, gun or any piece of the system without first releasing the pressure and disabling the pump

- Airless paint spray system need to be careful not to trigger the gun toward any part of their body.
- Air spray system's transfer efficiency can be very good and a lot of fluid can be delivered per minute making the airless system a good device for field application
- Airless spray gun delivers more fluid with less fog than a conventional air spray gun.

Electrostatic spray painting system:

Electrostatic paint spray application is designed to enhance the attraction of the paint material to an earth grounded surface. The basic features of the spray gun are same, but a power supply is used to provide voltage and charge the sprayed coating material. Electrostatic attraction uses the chemistry science where two surface that have the same charge will repel each other and unlike charge attract. Fig 2 shows the system with an airless gun.

Fig 2

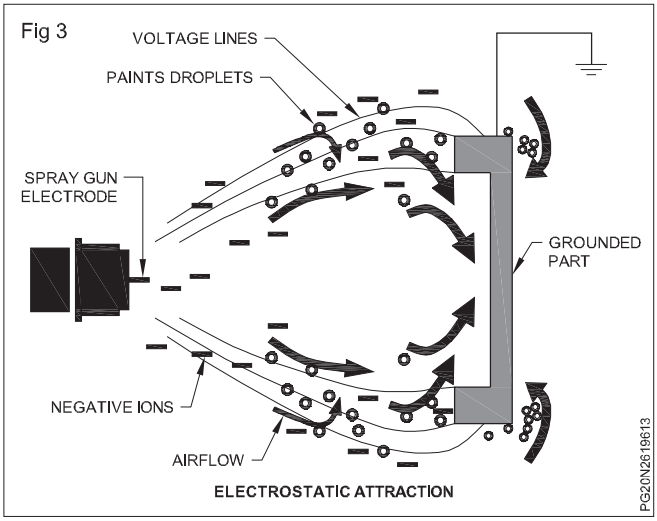


AIRLESS ELECTROSTATIC SYSTEM

High-voltage electric charge is added to the atomized paint particles as they leave the gun. A voltage generator is connected to an electrode at the gun tip. The voltage source can be external or internal. When the gun is triggered, the electrode discharges a concentrated field

of negative ions. Paint particles travel through this ionized area and become charged with negative ions.

The charged particles of atomized paint are directed toward the earth grounded part from the spray gun. As they approach the target surface, the electrostatic charge creates a strong attraction to the part surface. The charged particles are strongly attracted to all bare surfaces of the grounded part as shown in Figure 3.



The atomized paint droplets will be attracted to the best available ground. It is important to maintain a clean conveyor and clean hooks, and the ground should be checked regularly.

Effective use of electrostatic systems requires certain conditions to be met.

1 The coating must be in the proper conductivity range. The majority of solvent-borne coatings will work with electrostatic systems.

2 The atomized droplets should be round and remain as wet as possible. Sometimes a slow evaporating solvent is added to maintain this wetness.

3 An electrical field must be established and maintained in the proper position to direct the charged particles toward the part.

4 Forces such as excessive spray booth velocity and abnormally dry air will interfere with the electrostatic attraction process.

5 The parts to be coated must be electrically conductive to earth ground.

Earth grounding of the part is very important to provide the maximum benefit from the electrostatic spray applicator. The national fire protection association (NFPA) states that all conductive objects in an electrostatic coating area must be grounded and have a resistance of no more than 1 meg-ohm.

In a well-grounded application, the charge of the paint at the surface induces an opposite charge in the part that is equal to the field strength of the arriving ions and paint droplets. When a good connection is made, the circuit is complete and the charge is lowered from cloud to ground. The return stroke is a flow of charge (current) back to the cloud.

It is essential to have a good path to ground and maintain it religiously to avoid a discharge. Earth – ground is measured with an electrical megohm meter. A good ground has a resistance of less than 1.0 meg-ohm as recommended by NFPA. The meter uses two probes to measure resistance between the conveyor and the parts hanger and between the hanger and the part. All paint systems must have good ground to avoid static electric discharge. It is particularly important in electrostatic systems due to the high voltage of the system. The use of a megohm meter that can generate 500 – 1000 VDC is essential. Devices powered by small batteries are not an acceptable way of determining earth ground.

If parts are sprayed on a cart or a support other than a conveyor, they should have a cable attached to provide a path to ground. Lack of ground reduces transfer efficiently and creates an unsafe environment. All electrostatic operations should work efficiently to be sure that the parts are grounded.

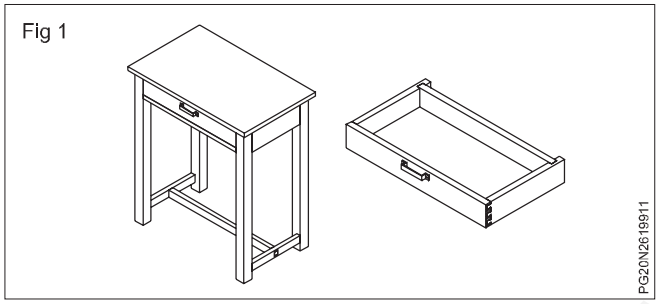
Article and machine painting process

Objectives: At the end of this lesson you shall be able to
- **state the process of article and machine surface preparation for painting**
- **state the method of painting a article and machine surface.**

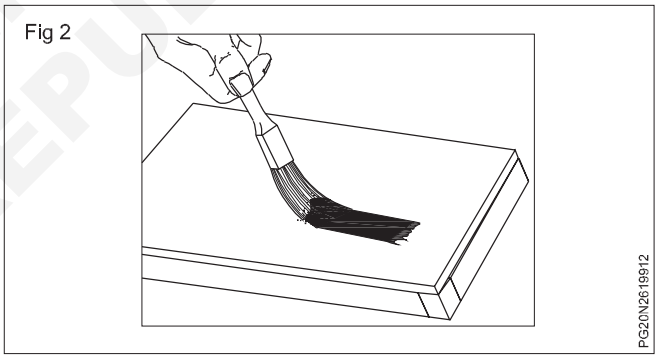
Wooden article painting:

The quality painting of wooden article surface is not very difficult, but it does take some practice. Always use a dust mask when sanding the wooden surface. Follow the following steps to prepare for painting the wooden article.

- Select the wooden article for painting work (Fig 1)



- Clean the article with clean sugar soap solution. It is important to get rid of all residue and dirt before you start painting like as any grease or dirt will stop paint from adhering
- When it is dry check for any repair you may have to make and fill any holes or dents if need use the wood filler to cover the holes, cracks and dent on the wooden surface
- Sanding the surface by using 120 grit sand paper by hand or power sander as on situation required
- Essentially making thousands of scratches in the wood by sanding which are invisible to the eye.
- Clean away the dust before moving on to the next step and mask off areas not to be painted
- Priming is essential for making sure that the overall finish is more durable and it should also ensure that no stains will come through your finished paint
- Use a paint brush or paint roller, apply an even coat of wood primer all over the piece of furniture and let it dry completely
- When the primer has completely dried very light sand with some fine sandpaper by using 240 grit by doing this can be removed any little bumps or air bubbles that will inevitably have developed on the surface
- When everything is completely smooth, wipe the wooden surface with clean soft cloth
- Select the wooden paint and prepare it for apply
- Read the instructions printed on the paint packing tin label and follow the steps for painting process
- Apply an even coat of paint all over your furniture by using paint brush, roller or paint spray gun
- It is best to apply a lot of thin coats of paint
- Once again be making scratches for the next layer of paint to stick to, but as before you will also be removing any lumps and bumps
- Remove any dirt and dust the sanding has created
- After sanding clean the surface before apply next coat of paint. Don't try to apply a thicker coat of paint
- When painting, always apply lots of thin coats instead of trying to cover in one thick coat it will give you a more even finish and avoid drips.(Fig 2)



- Ensure the wooden article is properly painted and it is good shining. If need do one more coat of paint for more gloss.

Machine painting:

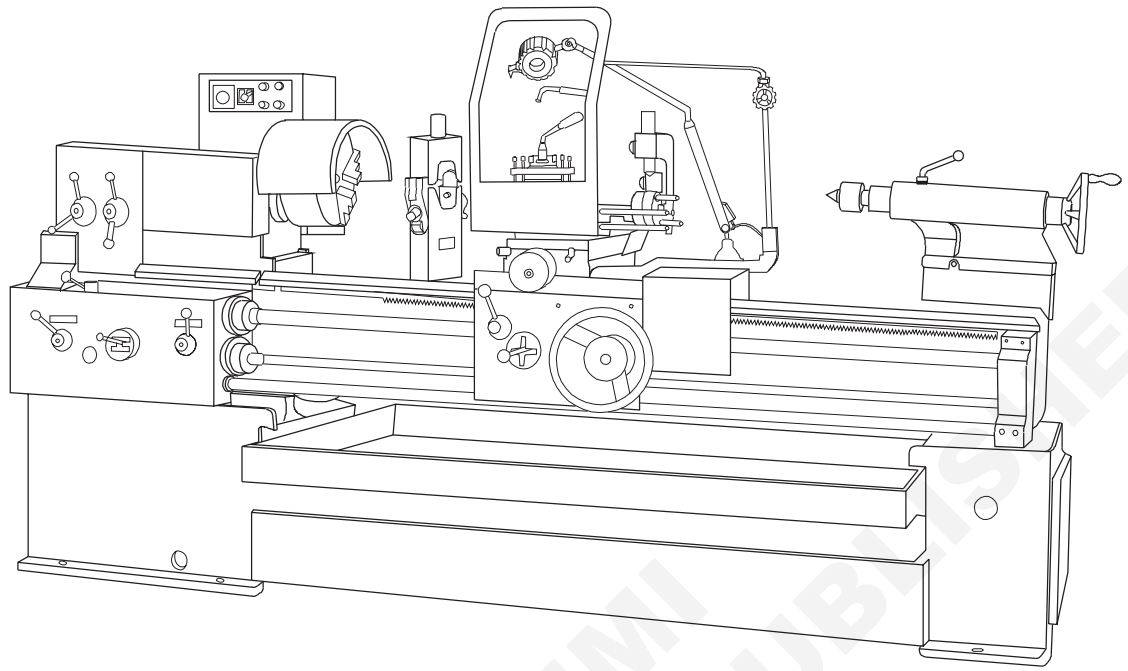
A coat of paint can make an old machine look new again some shops prepare machines with a two part primer and then apply a two part ure thane paint. Specially the following paints are used for paint the industrial machinery

- Metal paint enamel
- Zinc phosphate metal primer
- Black bitumen paint
- Polyurethane enamel gloss paint
- Two pack epoxy primers and top coats

Normally paints are used for right paint for the right purpose. Gloss or semigloss, acrylic, water reducible, corrosion resistant coating for industrial work. The DTM B66 paint can tinted to provide any colour you desire and use for repainting a lathe machine.

Machines are usually painted olive green or battle gray and their surface thus have a low reflex ion factor. There is often too little brightness of colour contrast between the work and parts of machines forming its background. If these parts are finished light coloured paint, contrast is improved and the work made easier to see. The whole machine may be painted a uniform colour or a different, but also pale colour can be used for parts not in close proximity to the work. Most of the lathe are painted in green colour. Today lathes are available in many colours. (Fig 3)

Fig 3



Surface preparation of lathe machine:

- Clean the lathe machine with clean cloth
- Disconnect the electrical power connection of lathe machine
- Remove oil, grease and other contamination with a suitable detergent followed by pressure water washing. Aromatic solvents can also be used to remove the contaminants
- Inspect the lathe machine parts and lathe machine surface for any damage or cracks
- Before sanding the machine repair the damaged parts by replacing or welding method.
- Ensure that all welds/ weld seam are complete and continuous without any cracks and pinholes. Remove all weld spatters and round off all the sharp edges prior to further surface preparation
- Sanding the machine by hand or abrasive blast to remove the old paint deposited on the lathe machine surface (use any one of cleaning method like hand tool, wire brushing, chipping, power tool, flame cleaning or water jet cleaning)
- After sanding the surface clean with pressure air spray on the sanded area.
- Clean the surface with soft cloth and then inspect the machine surface for minor damages.
- Select and prepare the metal conditioner for apply on the machine surface.
- Apply metal conditioner on the machine surface by brush evenly
- Let it allow to dry off time.

Primer application:

- Select the metal colour primer and mix the solvent to bring proper viscosity to apply
- Select the primer application method by brush or spray gun
- Filter the primer before use to apply on the machine surface
- The machine parts not to be painted should be covered by masking material.
- Apply primer by brush or spray gun on the machine surface. Ensure the primer is applied evenly
- Let it allow to dry off time as per primer manufacturers instruction given on the label.
- After dry the primer inspect lathe surface for imperfection
- If need select the putty and prepare it for apply
- Apply putty on the lathe surface where it is needed.
- Let it allow to dry for 4 to 6 hours

- Sanding the putty applied area for make a level on the machine surface
- Clean the sanded surface with clean cloth, after cleaning don't make a finger print on the surface
- Ensure the Lathe machine is ready for painting
- Select the sealer or surfacer and prepare it for apply
- Apply the sealer or surfacer on the lathe surface smoothly
- Let it allow to dry for specified time limit and than clean the lath with soft cloth.

Painting the lathe machine:

- Select the paint colours for matching the lathe machine old paints
- Mix the paint with reducer or thinner to bring specified paint viscosity
- Filter the paint before the application of paint
- Select the painting tool (brush or spray gun)
- Carefully read the paint container packing label instructions before start to apply paint.
- Clean the lathe machine before start painting to remove dust deposited on the machine surface and ensure the mask is properly covered on unwanted painting spots
- Apply paint on the lathe surface evenly
- Allow the recommended dry off time between paint coatings
- You can use different colours on the lath parts for identification of parts easily
- Clean the lath machine painted surface and remove the mask materials
- Inspect the lathe machine painted surface and touch up the paint by brush if needed.
- Ensure the lathe machine surface is properly painted
- Connect electrical connections of lathe machine and assemble the dismantled machine parts.
- Ensure the complete lathe machine and its accessory's are properly painted and it is ready for machining function.

Car repainting process

Objectives: At the end of this lesson you shall be able to
- **state the car patch, dent removal process**
- **state the surface preparation and putty, metal primer application**
- **state the method of spray painting.**

Car repainting process:

Car painting is a process of next operations by paint restoration of car body including the operation of car body cleaning, priming, putty application, sanding painting and polishing of car body. The quality of auto paint depends on preperation and right actions of a car paniter. Painting a car is not a stressful job, it is quite fun, if you do it without any pressure. You need to have a clean dust free workplace and all the tools necessary for painting a car body.

Car body dent removal process:

Inspect the car body and identify the dented area on the car body. Select the dent puller or dent repair kit clean the dented surface and fix the dent puller on the dent marked area. Pull out the dent puller to remove the dent. Remove the dent by puller or light hammering by wooden mallet or by using dent repair kit. (use the tools depending on condition of dent occupied on the car body surface)

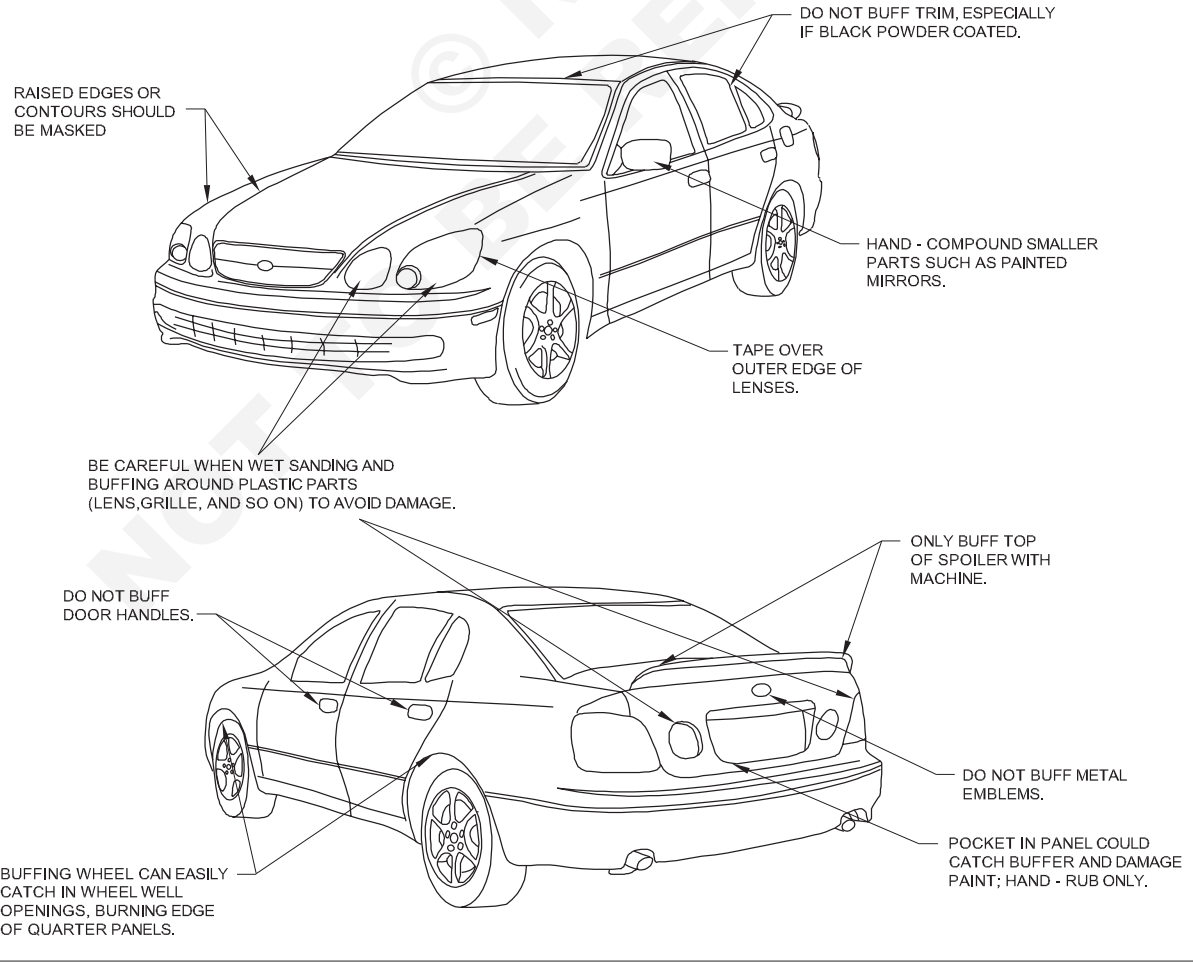
Surface preparation:

Thoroughly clean the surface of the car body from dirt dust and rust. Preparing the surface of the car body is a very important step. If improperly prepared repair area can lead to undesirable consequences such as chips, drips of paint and visible paint transitions improperly prepared repair area can lead to sub sequent flaking of the putty.

Metal conditioner application:

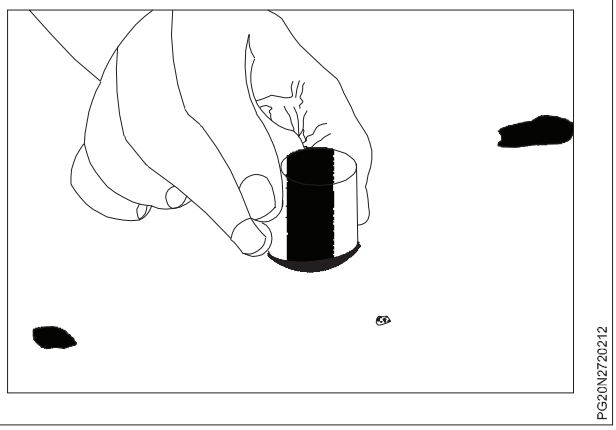
Clean the metal surface by using the abrasive materials by mechanical or chemical cleaning methods. Remove the old paint, rust and dust by sanding process. After sanding the surface clean it with soft cloth. Inspect the sanded area if need resand it for clean the car body surface. Ensure complete vehicle body is cleaned. (Fig 1)

Fig 1



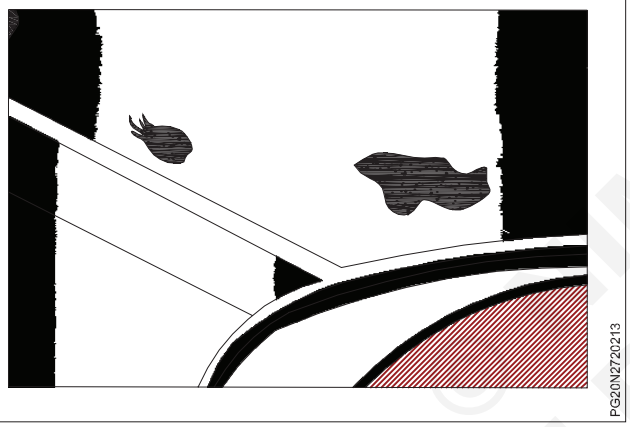
Dry sanding dirt in the paint finish with a detail sanding block and ultrafine sandpaper. Dry sanding will more easily let you see how much you have sanded off. (Fig 2)

Fig 2



Only sand enough to knock off the dirt-nib. This will dull the finish (Fig 3)

Fig 3



Select the metal conditioner and mix it with solvent to achieve the proper viscosity. Clean the car body surface with tack cloth and apply metal conditioner on the surface evenly by bristle brush. Let it allow to dry recommend time by the paint manufacturer's instructions.

Putty application:

Putty is used to cover the dent, gouges, dings, depressions on car body surface. Follow the following steps to apply putty

- Clean the car body surface
- Inspect the car body metal surface for damages.
- Mark the area to be applied putty on the car body
- Select the putty and mix the solvent with putty to bring as a flexible paste to apply
- Use the putty knife to apply paste on the metal surface where it needed
- Apply putty on the marked area and let it allow to dry off time as recommended by putty manufacturers directions
- Sand the edges around the hardened filler to smooth it out
- Strip the existing finish
- Always run your sander over the desired area in circles before painting
- Continue to sand until no gloss is left on the vehicle
- Wipe the painting area with a clean wet rag to wipe off any debris stay on the car body surface

Primer application:

- Clean the sanded surface of car body.
- Prepare the primer with solvent to achieve specified viscosity
- Filter the primer before application and mask the area which is not to be painted.
- Apply primer on the car body surface by spray gun at even thickness and allow it to dry as specified dry off time limited by primer manufacturers
- Inspect the primer applied area after trying 1st coat primer (Fig 4)
- If found any cracks, dent, gouges and depressions apply putty on it by using putty knife
- After dry off time again sand it with correct grade grit sand paper (120/ 240 grit)
- Clean the sanded surface with wet rag. Ensure there is no debris on the car body surface to be painted.
- Apply base coat of automotive primer using a sprayer and wait for coat of primer to dry
- Primer applied area should be sanded for two or more times to ensure a quality finish of metal surface.
- Apply surface sealer on the car body surface and let it allow to dry at least 4-6 hours gap between coats

Paint mixing:

Paint colour and viscosity is most important to spray mist and deposition of paint thickness on the metal surface. Select the paint and solvent. Read the instructions printed on the print container packing label. Follow the instructions step by step to mixing the spray paint.

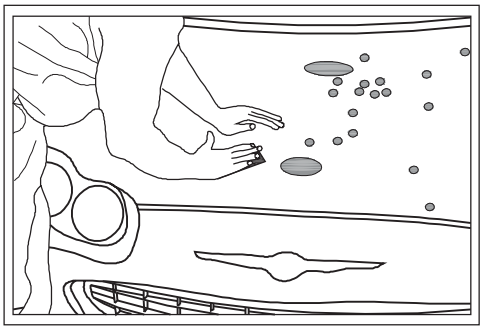
Shake the paint container before opening. Open the paint tin and mix the solvent as recommended ratio. Use the paint mixing stick to rotate and mixing it properly. Ensure the paint is as proper viscosity. Filter the paint before pour the paint in spray gun cup. Incase ready mix Shake the paint container before opening ready mix paint should be stir/ shake thoroughly before use. Continue stirring the mixed paint is free from lumps.

Paint application:

After dry sanding dirt-nibs, wet sand them 1500 grit sandpaper and water. Wet sand the scratches left from sanding.(Fig 4)

Paint is applied on the car body to shining and protect from the corrosion and weather condition. Painted vesicle body increase the life of the vehicle. Clean the metal surface with tack cloth. Apply base coat paint at even thickness on the car body surface. Let it allow to dry off time.

Fig 4



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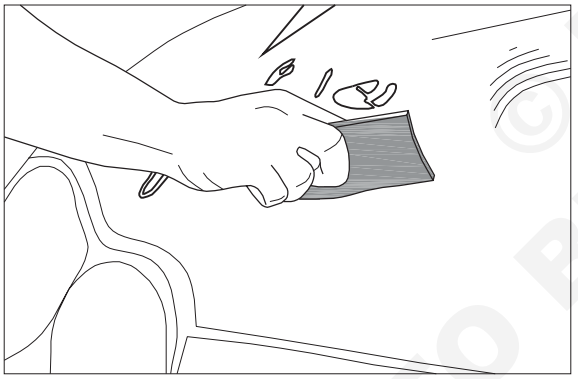
Wet sanding the base coat painted surface and rinse it with soft sponge with water. Water is work as lubricator between metal surface and sanding material. Clean the sanded surface and apply top coat/ clear coat paint and let it allow to dry for overnight. Remove the masking material and clean the painted surface and inspect for paint defects if found any mirror defects, apply enough rubbing compound and polish it with buffing pad for bright gloss. Ensure vehicle body painting is smooth finish.

Note: When wet sanding, squeegee off the water you can see whether the flaw has leveled. (Fig 5)

Only apply enough compound to buff a small area at a time.(Fig 6)

Fig 5



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Note: Buff a panel in passes, just as you would paint it. Move the buffer and forth in long passes so you can keep track of the amount of paint thickness removal.(Fig 7)

Before hitting the trigger, spread compound over the area with a pad. This will keep the compound from spraying off the pad.(Fig 8)

Fig 6

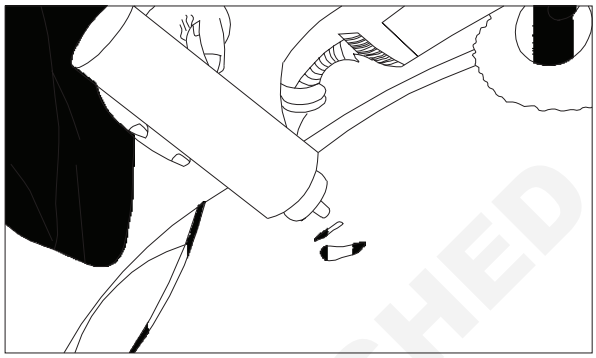

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Fig 7

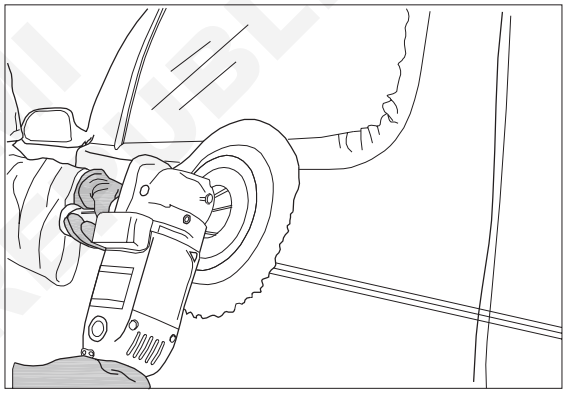

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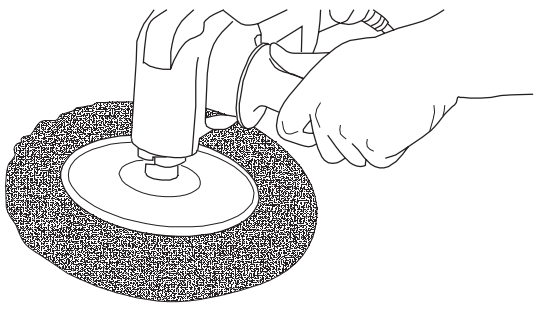
Fig 8



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Paint defects and its remedies

Objectives: At the end of this lesson you shall be able to

- **state the types of paint coating defects and its remedies**
- **state the importance of polishing**
- **state the removal method of defects by polishing.**

Paint defects: Paint can become brittle over time and susceptible to cracks and tears severe damage can be made invisible and brought back to original condition. It is need to do is repair, retouch and restore the paint

Causes for defects:

- Uneven flow of the applied coating
- Applying paint at high viscosity

- Continued application over a longer period of time.

Prevention:

- Apply paint under the recommended viscosity using correct reducer
- Apply paint quickly and evenly
- Use clean high quality brushes

Cure:

- After the coat gets dried, run down the surface to smooth and uniform level.

Brush marks:

While paint by brush get smooth finish and appear the brush marks.

The paint problems include a wide range of defects that can be found before or after painting. this lesson will help you. Avoid mistakes that result in paint problems and repainting. This lesson teaching you about paint problem, conditions,causes for defects, prevention and corrections.

Problems in wet paint:

Paint foreign matter in the paint that will adversely affect the finish (dust, lint, hair etc) if you notice something in the wet paint try to remove it right away the sooner the better, because catalyzed paint flash dry so quickly. A ting piece of lint or dust can often be lifted out of the wet paint.

Paint work can defective, it application defects or blemishes such as paint runs, paint sags, wrinkling, dust, bare or starved painted areas, colour variations, surface cracks, irregular and coarse brush marks, sanding marks, blistering, uniformity of gloss level and other irregularities in the surface that are visible. Always keep in mind the following points to avoid paint defects

- Identify each problem
- Under stand why it happens
- Learn how to avoid it
- Learn how to fix it

Causes for paint problems:

Painter mistakes that contribute to a poor finish

- Not reading the paint manufactures technical data sheet
- Misjudging paint drying times
- Incorrect gun set up
- Air pressure too low
- Air pressure too high
- Dirty equipment/ blocked filter
- Poor surface preparation
- Film thickness too thick
- Incorrect solvent/ too much solvent
- Impatience
- incorrect gun setup and spray distance

Types of paint defects:

There are different types of paint defects are occurred after refinishing the vehicle. They are as follows.

Haloes: The suface should shows different color shadows. (Fig 1)

Causes:

1 Poor hiding power, depending on insufficient film thickness due to:
   - Unsuitable application techniques, in the least accessible zones.
   - Insufficient or non – uniform coat application
   - Low covering colour requiring a specific coloured undercoat
   - Incorrect mixing ratio and low viscosity.
2 Too short flash – off time between coats or before clear coat application
3 thick or thin basecoat application

Remedy:

- Slightly sand and recoat
- If haloes appear when spraying – spray in a uniform method

Prevention:

- Use appropriate application techniques to reach a complete film thickness on the whole surface.
- Apply recommended number of coats as indicated on the technical data sheet
- Always check if the finishing coat needs a coloured undercoat: if this is the case always apply the specific coloured undercoat.
- Always stir paint thoroughly and filter it before application.

Fig 1

Bubbles: Bubble shaped irregular blemishes (Fig 2)

- Due to corrosion
- Due to drying
- Due to air trapping

Causes:

Due to corrosion:

1 Mechanical damage on the painted surface with subsequent humidity infiltration

2 Insufficient preliminary substrate pre-treatment or incomplete anti-rust treatment

3 Rust formation on sanded or damaged surfaces

4 Insufficient panel sealing

Due to drying:

1 High film thickness

2 Too fast hardeners and/ or thinners

3 Too short flash-off

4 Too high IR temperature

5 Too short flash-off in wet-on-wet process.

Due to trapping:

1 Insufficient putty or priming coat application

2 Insufficient flash-off time between primer and topcoat

3 Air pockets in the priming coat due to unsuitable thinner

4 Too high drying temperature

Remedy:

- Sand until bubbles and/or rust are removed
- If necessary, apply an anticorrosive primer in order to avoid further corrosion problems.

Prevention:

- Repair the damaged parts immediately and apply an anti-corrosive primer to avoid corrosion.
- Apply recommended paint layers, use hardener and thinners as specified on the technical data sheet – follow drying times in order to drying bubbles.

Fig 2

Blistering: The painted surface displays pimples/blisters of different sizes. (Fig 3)

Causes:

Blistering is caused by moisture or contamination under the paint due to:

- Moisture absorption forms the substrate (especially from putties and fillers) before painting.
- Moisture condensation on the substrate created by a sudden change in temperature (e.g. the hot car straight out of the oven into a cooler room).
- Contamination of the substrate by water, grease, oils, etc.
- Use of incompatible products or unsuitable thinners
- The painted surface, was exposed to a high level of moisture or rain, before proper drying time was allowed.
- Thinning of water-borne product with tap water (contains mineral salts).
- Presence of water in the compressed-air line.

Remedy:

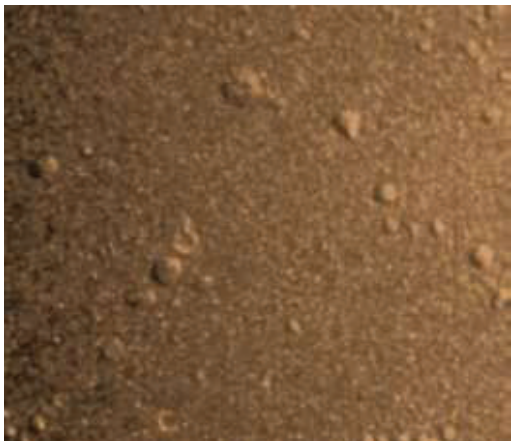
After through drying:

- It blistering have formed between the final and undercoat, sand until you reach a completely smooth surface, then re-coat
- If pimples have formed between the substrate and undercoat, sand thoroughly, clean accurately and repeat the complete paint system.

Prevention:

- Ensure the surface is thoroughly cleaned before any operation (use compressed air and silicone remover/ degreaser).
- Protect the surface before the paint application and immediately after, to avoid moisture condensation.
- Use documented paint processes to avoid any incompatibility.
- Check the compressed air supply periodically
- After wet sanding allow water to evaporate
- Only dry sand polyester putties.

Fig 3



Water Bubbles: Evaporated water marks/droplets can be seen on the painted surface. (Fig 4)

Causes:

Traces of water under the surface, due to:

- Residual water in case of wet sanding
- Water in the compressed air line
- Contact of the paint surface with rain or with sprinklings of water
- Water not evaporated from the water-borne basecoat and/or filler.

Remedy:

After through drying:

- Sand and polish the surface
- In case of deep defects – sand thoroughly and repaint.

Prevention:

- Always clean the surface thoroughly (by compressed air and with silicone remover/degreaser).
- Check the compressed air supply periodically
- Follow correct drying times recommended to temperature and relative humidity.

Fig 4

Popping:

Bubbles which are trapped during paint application,caused by overcoating, before previous application has dried. (Fig 5)

Causes:

Air of solvent vapours trapped in the film, due to:

- Too high viscosity – use of cheap thinners
- Too fast thinner (especially in summer)
- Inappropriate use of fast hardener
- Too high film thickness or too short flash-off time between coats.
- Too high ambient temperature, too near a heating source, too short flash-off time
- The painted car was exposed directly out in the sun immediately after the application of the final coat.
- Incorrect drying time before baking (for water borne clear coats)

Remedy:

After through drying:

- Sand to obtain a smooth surface and re-spray

Prevention:

- Always follow the technical data sheet before applying undercoats or finishing coats.
- Use the suggested thinners and hardener dependent on room temperature.
- Ensure spray viscosity is correct
- Respect the flash-off times between the coats and the dry time after the final coat
- Control the oven temperature and/or the distance of the IR lamps
- Check at regular intervals the oven temperature control gear.
- For water-borne products follow flash-off times before baking.

Fig 5

Gloss Difference: Some zones of the painted surface show insufficient gloss. (Fig 6)

Causes:

- Insufficient drying time of the undercoats
- Use of too aggressive thinners
- Use of inappropriate hardeners
- Too slow drying with excessive humidity
- Low baking with insufficient air recirculation
- Exposure of the painted substrate not yet through dried, to weathering and/or aggressive chemical agents.

Remedy:

After through drying:

- Polish using an abrasive compound according to the degree of gloss.
- If polishing does not restore the gloss, flat with abrasive paper, then re-spray.

Prevention:

- Always follow the technical data sheet instructions, apply the undercoats according to the suggested film thickness, allowing adequate drying time between all coats
- Follow the baking temperatures for undercoats and finishing coats in well aerated spray booths, especially in case of low room temperature and high humidity
- Avoid exposure of the painted surface to any aggressive conditions in the first days after painting.

Fig 6

Orange Peel: The painted surface shows poor flow and resembles orange peel. (Fig 7)

Causes:

Poor flow due to:

- Poor spray gun technique (gun held too far from the surface, causing the paint to dry).
- Unsuitable spray gun adjustment (air cap, air pressure, etc).
- Too high spray viscosity
- Use of too fast or unsuitable thinners
- Too short flash off between coats.
- Too high surface temperature and/or spray booth temperature.
- Application of too thick or too thin coats

Remedy:

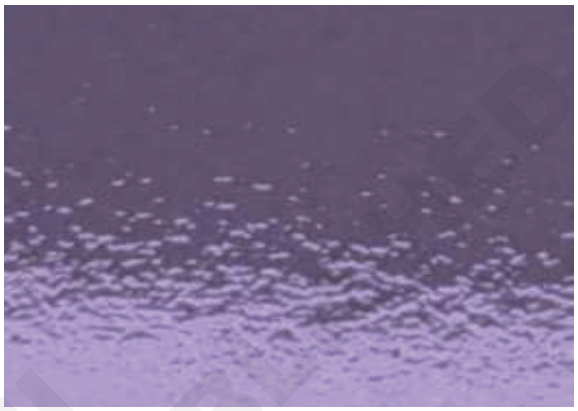
After the paint has dried thoroughly:

- Rub out orange peel with very fine abrasive paper and polish
- In severe case flat thoroughly and re-spray

Prevention:

- Always follow the technical data sheet instructions and use the sugggested techniques.
- Use the suggested thinners depending on the room conditions; check the spray viscosity and the air pressure.
- Apply uniform coats and follow the flash off time between the coats.
- Check the room conditions: temperature and ventilation.

Fig 7



Creaters in the Undercoat: Small holes showing on the surface of the undercoat (Fig 8)

Causes:

- Incorrect use of antistatic cleaning cloths that can contaminate the undercoat surface.
- The spray booth and/or the surface to paint are contaminated with silicone
- Contaminated compressed air supply (presence of water, oil, wax).
- Solvent contaminated spray gun when using water-borne products
- Air absorption
- Use of unsuitable thinners and/or hardeners
- Wrong drying times (without following the indicated times).

Remedy:

After through drying:

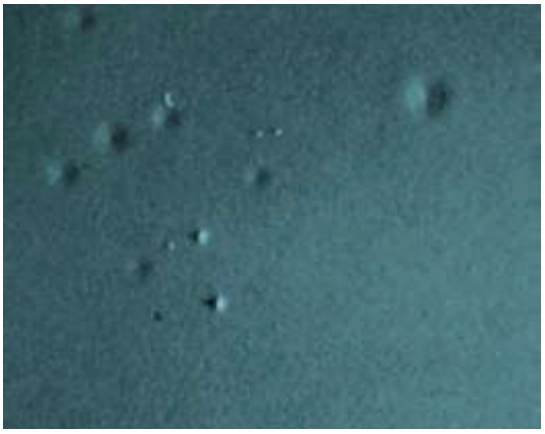
- Sand the cratered coat to eliminate any defect. Clean and degrease thoroughly with silicone remover, then apply a new coat.

Prevention:

- Degrease the substrate thoroughly before spraying, using the specific silicone removers. Remove the solvent with a clean cloth before it can dry.
- Check the spray booth filters and the oil/water separator and drain if necessary.
- Always check the surface before spraying the next coats; if necessary repeat as indicated above.

- Clean with suitable solvents and allow spray guns to dry when using water-borne products.
- Follow carefully the instructions of the technical data sheet

Fig 8



Cratering/ Fish eyes: Paint repelled by polluting agents, forms crater like depressions with relief edges inspection with a lens may reval a small impurity at the base. (Fig 9)

Causes:

- Incorrect use of antistatic cleaning cloth that can contaminate the substrate
- The spray booth and/or the substrate are contaminated with silicone
- Contaminated compressed air (presence of water, oil, grease, wax).
- Solvent contaminated spray gun when using water-borne products

Remedy:

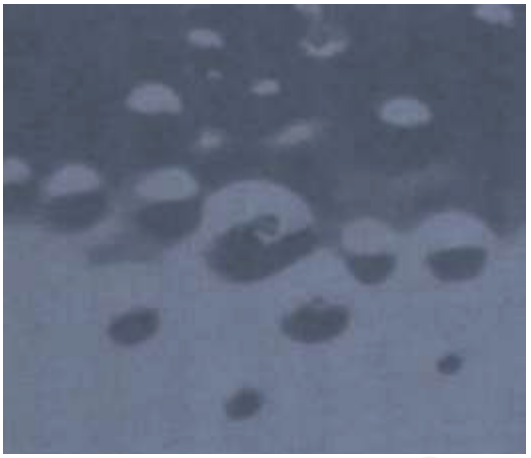
Allow through drying:

- Remove by sanding the affected paint, clean thoroughly and re-spray.
- If the paint still forms craters, add a specific anti-silicone to it.

Prevention:

- Clean and degrease the substrate thoroughly before spraying the next coat, using specific silicone removers. Remove the solvent with clean cloths before it can dry.
- Check the spray booth filters and the oil/water separator and drain if necessary.
- Always check the surface before spraying the next coats; if necessary repeat as indicated above.
- Use only perfectly clean spray equipment
- Don't use products containing silicone in the spray booth
- Clean with suitable solvents and allow spray guns to dry when using water/borne products.

Fig 9



Chipping - Poor Putty (Stopper Adhesion): Loss of putty adhesion from the substrate. (Fig 10)

Causes:

- Incorrect substrate pre-treatment
- Use of a wrong type of putty/stopper (e.g. normal putty on zinc coated iron).
- Wrong mixing ration with the hardener
- Incorrect IR drying (too near lamps, too long a drying time).
- Too high lamp temperature.

Remedy:

Strip to bare metal and repeat the cycle

Prevention:

- Use universal putties that can offer a good adhesion to all substrates.
- Read the technical data sheet and follow the mixing ratio (depending on the room temperature), drying time, use of IR lamps
- Sand and clean the substrate as following the instructions of the data sheet.

Fig 10

Spray dust: Paint particles settled on the car parts not to be painted. (Fig 11)

Causes:

The small paint particles settle on the wet film due to:

- Inadequate masking of the substrate
- Insufficient ventilation in the spray booth
- Poor spray gun techniques (e.g. spray pressure too high).

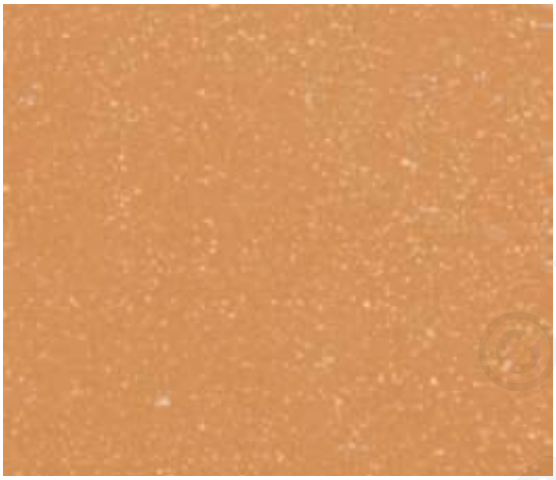
Remedy:

In most cases polishing is sufficient

Prevention:

- Mask accurately the surface to be protected, especially on the edges.
- Follow the application techniques as indicated in the data sheet (instruction label)
- Check the airflow in the spray booth

Fig 11



Metallic Impurities: Some aluminium particles appear in a vertical orientation in the finishing coat. (Fig 12)

Causes:

Inappropriate application of the metallic matt base coat i.e.:

- Poor spray gun technique (e.g. dry spray).
- Use of inappropriate spray gun (air cap, air pressure) and/or spray gun too far from surface
- Insufficient clear coat film thickness to cover the aluminium flakes (especially with ‘‘magnum size’’ coarse particles).

Remedy:

After clear coat through drying:

- Sand with P800 grit and apply a new coat of clear coat

Prevention:

- Always follow the instructions of the technical data sheet and use the indicated spray techniques
- Check the adjustment of the spray gun (air cap, coverage, air pressure).
- In touch-ups or for larger coverage, use specific ‘‘blenders’’.

Fig 12

Metallic Paint Clouding: The fresh paint shows local colder diffrences , after spraying the metallic coat light and darker spots appear. (Fig 13)

Causes:

Improper application technique, i.e.:

- First coat is too wet with a dry grip coat on the top
- Incorrect adjustment of the spray gun (air cap, air pressure)
- Incorrect spray viscosity
- Insufficient stirring of the paint.

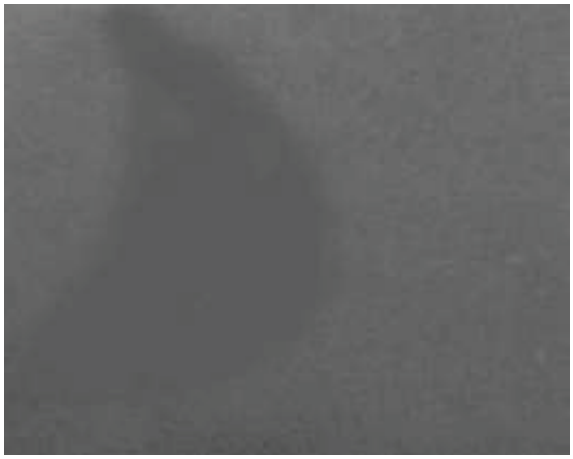
Remedy:

- Before applying the clear coat, apply a new uniform light/grip coat of the matt base, reduced with the specific ‘‘FADE-OUT THINNER’’ as indicated on the relevant technical data sheet.
- If the clouds appear after the clear coat application, sand the surface and re-spray (base coat + clear coat).

Prevention:

- Follow accurately the instruction on the technical data sheet.
- Check the adjustment of the spray gun
- Accurately stir the thinned base colour and filter it before spraying
- Use only the thinners indicated on the data sheet.

Fig 13



Water marking and spotting: The edge of evaporated water droplets can be seen on the paint surface. (Fig 14)

Causes:

When water drops on the paint surface and evaporates the outline of the drops may still be seen. This happens when the painted surface has been exposed to rain or water drops just after painting.

Remedy:

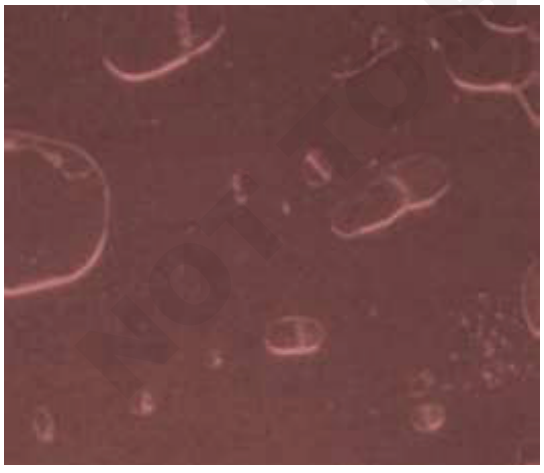
Allow the finish to dry through, then:

- Sand and polish
- If repeated polishing is not effective, sand the affected area and re-spray.

Prevention:

- Protect the car immediately after the painting and avoid contact with water before it has dried through.

Fig 14



Bleeding - Yellowish Stains: The freshly applied fipcoat shows load discoloration and yellowing in the areas previously treated with poluster pulty. (Fig 15)

Causes:

Too much hardener (peroxide) added to the polyester putty.

Remedy:

After the application has dried through:

- Sand thoroughly to the putty surface. Apply a sealer and re-spray the final coat.

Prevention:

- Use the correct mixing ratios (indicated on the data sheet).
- Use cartridge putties with dispensers that correctly measure the mixing ratios, or mix by weight with scales.

Fig 15

Pores in the filter: The surface shows some small holes. (Fig 16)

Causes:

Incorrect application of the filler-sealer due to:

- Filler application at too high viscosity or use of inappropriate thinner
- Application in layers, which are too thick
- Use of too fast hardeners especially in summer
- Filler drying in the direct sunlight

Remedy:

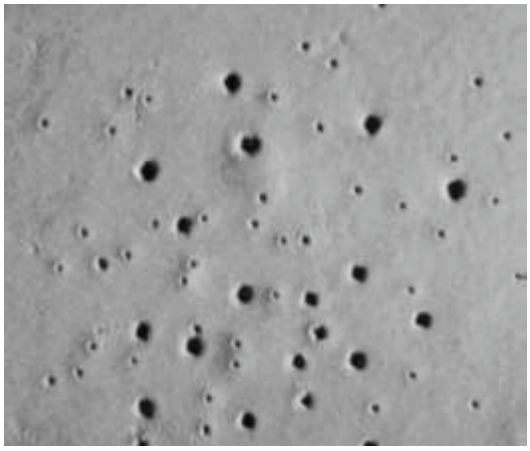
After application through drying:

- Sand thoroughly and re-spray the filler sealer

Prevention:

- Always consult the instructions of the technical data sheet: apply the filler/sealer in the suggested film thickness, follow the flash-off time between coats and allow to dry correctly
- Check the spray viscosity before the application
- Use the suggested hardeners and thinners, depending on the ambient temperature.
- Allow to dry inside the body shop, or in areas that do not allow exposure to direct sunlight.

Fig 16



Pin holding: The presence of deep holes in the paint surface, showing through to the sealer filler or to the putty. (Fig 17)

Causes:

Penetration of the final coat from holes due to air trapped in the application:

- Incorrect application of the filler (sanding, sealing, etc.)
- Too fast drying (over or IR lamps) of the filler applied in too thick layers.
- Inefficient filling technique and putty sanding (leaving hollows).

Remedy:

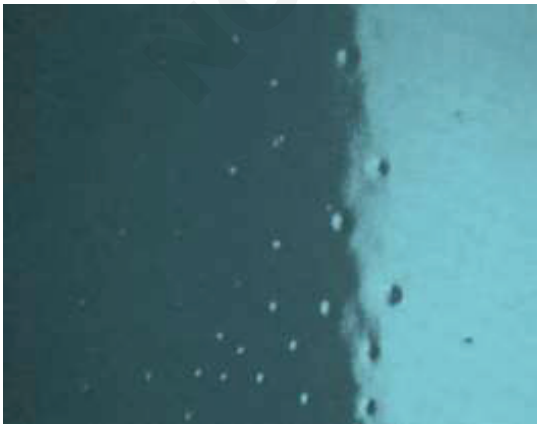
After through drying:

- Sand the paint or filler to completely remove the pinholes, apply suitable sealer filler, sand accurately and re-apply the final coat.

Prevention:

- Follow the instructions of the data sheet, and follow the correct application, flash-off and drying times.
- Build up the putty in thin layers in order to avoid trapping air in the mass.
- Always check the substrate before applying the topcoat and if necessary, operate as indicated above

Fig 17



Paint Colour Difference: The colour shade of the required area does not match the car original colour. (Fig 18)

Causes:

- Original car finish does not correspond with the mixed colour.
- The mixed colour was obtained using pigments different from the original ones: metamerism.
- Mixing colours have not been stirred enough
- Irregular spraying technique (number of coats, gun adjustment).
- The spray check was carried out in incorrect light
- The test panel was sprayed incorrectly

Remedy:

After through drying:

- Sand the repaired section, mix the colour again, compare a test panel and re-apply the colour
- Use coloured fillers when indicated

Prevention:

- Use colour chips and the other colour tools offered by the color-system correctly
- In any case, before painting the substrate, always use spray out cards, applying the correctly catalysed and thinned product with the same spray gun used in the final application. Check the colour under different visual angles and under different light sources.
- Use the recommended instruction outline on the technical data sheet.
- Mix the paint carefully and always filter before applying it (in the spray gun too).

Fig 18

Wrinkling: By using compatible filters. The paint sur face aquires a finely wrinkled appearance. (Fig 19)

Causes:

- Paint applied to a solvent sensitive and/or only partially dry substrate, without previous application of a suitable sealer
- Use of too aggressive or inappropriate thinner
- Use of unsuitable sealers for the substrate
- In case of two-coat finishes, partial removal of the clear coat by sanding, without correct sealing
- Too high film thickness

Remedy:

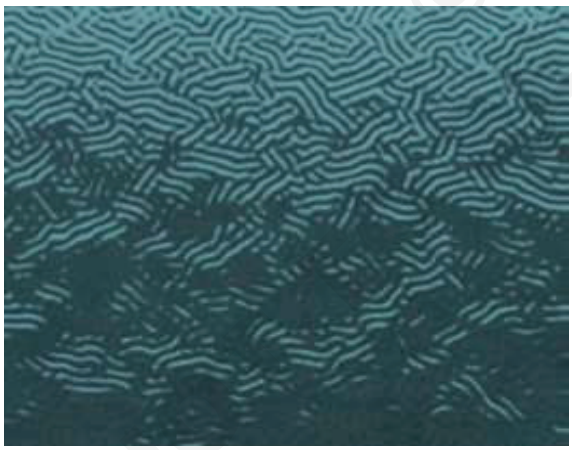
After through drying:

- In case of a slightly wrinkled surface sand with fine sand paper and wrinkling, thoroughly remove paint and reapply. Are spray if the surface shows serious signs of wrinkling, thoroughly remove the paint and reapply.

Prevention:

- Ensure that the substrate is not solvent-sensitive and has dried through. If it is the case, seal completely with a suitable sealer (e.g. a water thinnable sealer).
- If possible – apply a two-pack sealer in very thin coats to sensitive substrates, allowing long flash-off times between coats.
- Use only the recommended hardeners and thinners

Fig 19



Sanding marks: Fine scratches can be seen in the top coat. (Fig 20)

Causes:

- The sanding/grit paper was too coarse for the product subsequently applied
- Final sanding with too fine grit paper after previously sanding with coarse grit paper (e.g. P180 then P360).
- The primer or filler was not sufficiently through hardened for sanding
- Insufficient film thickness

Remedy:

- After it has dried through, sand the topcoat smooth with fine grit pater and polish
- If the surface shows serious marks, sand thoroughly and re-apply the topcoat and the sealer if necessary.

Prevention:

- Consult the data sheet for the substrates (putty and filler) and choose the correct sand/grit paper
- Using different sand/grit paper, follow the instructions from the data sheet in reference to the use of abrasive paper
- Always allow the substrate to dry through before sanding (see data sheet).
- Apply the topcoat in the correct film thickness

Fig 20

Contour Mapping: The edge of an underlying coat can be seen through to the peak showing different gloss zones. (Fig 21)

Causes:

The body filler has been applied incorrectly due to:

- Unsuitable/ too fast hardener or wrong mixing ratio
- Too thick film thickness and too short drying times.
- Air drying in high humidity
- The undercoat was applied on old paint etc. without correct sealing

Remedy:

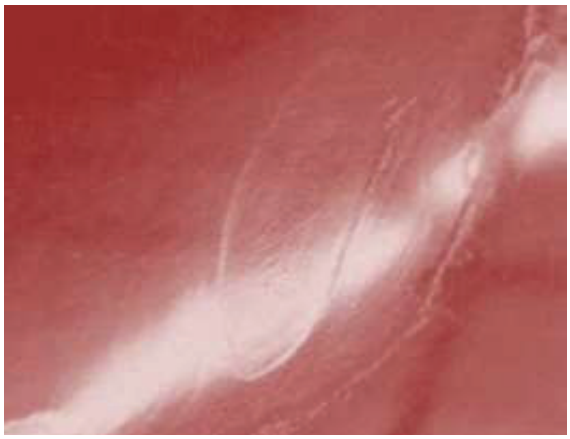
After through drying:

- Sand with fine paper and polish
- If the defect is more serious the surface must be sanded and re-sprayed

Prevention:

- Consult the technical data sheet, apply the filler in the suggested film thickness and follow the drying time.
- At low temperature and high humidity allow the film to low bake
- Always check old paint etc. and, if necessary, apply a suitable undercoat.

Fig 21



Removal of original coatings: Wrinkling is present in the finishing coat. (Fig 22)

Causes:

The original film was attacked by solvents:

- The original coatings were thermoplastic or powder-coats (normally used by car manufacturers).
- The original coating (solvent or water-based) had not dried enough.

Remedy:

Sand thoroughly, apply a suitable primer (water or epoxy) and re-paint.

Prevention:

Always check original coatings and choose the suitable paint system.

Fig 22

Rusting: Corrosion evident in the finished surface. (Fig 23)

Causes:

- Attack of the metal surface due to contact with weathering and chemical agents.
- Presence of humidity on the metallic surface before applying the anti-corrosive primer.

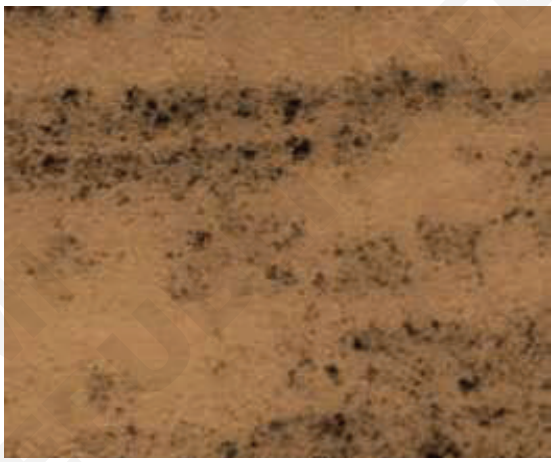
Remedy:

Sand the rusted part carefully down to bare metal, sand the steel sheet by removing all rust, clean the metal substrate by means of suitable detergents and then repeat the process starting from the anticorrosive primer.

Prevention:

- Repair the damaged area of the paint as soon as possible
- Thoroughly clean the metallic surface, dry it with clean cloths, and apply a suitable anti-corrosive primer on later than 30 min

Fig 23



Polishing marks: Patchy finish to the gloss, showing round spots on the finishing coat. (Fig 24)

Causes:

The film surface has been abraded because of:

- Unsuitable polishing techniques (speed, pressure) or unsuitable materials (rubbing compound, etc.).
- The film has not dried through yet.

Remedy:

After through drying:

- Repeat the polishing operation
- If necessary, sand slightly and re-paint

Prevention:

- Use specific polishing techniques and materials dependent on the finishing coat
- Allow the film to through dry before polishing it.

Fig 24

Peeling-Flaking: A paint layer detaches itself from the substarte or fron underlying layers. (Fig 25)

Causes:

The paint is affected by forces that prevent adhesion, loss of adhesion due to:

- Presence of wax, fat, silicone, oil, or other releasing agents.
- Inadequate surface adhesion
- Unsuitable temperature during application
- Incorrect film thickness

Remedy:

Remove loose paint layers and re-apply the system.

Prevention:

- Check accurately the substrate and choose a suitable paint system.
- Pre-treat the substrate correctly. Remember that sanding and sand blasting will improve the adhesion by increasing the contact surface
- Degrease accurately to remove any contamination that can reduce the substrate wetting by the new coat
- Check the spray viscosity: lower viscosity increases the substrate wetting and improves the adhesion
- Observe the flash-off time between coats indicated on the data sheet of the paint system
- In tow-coat system (basecoat + clear) low baking improves a better adhesion between coats.
- Avoid ‘‘mixed’’ cycles by using products of different paint manufacturers.

Fig 25

Dirty dust: Dust or dirk particles trapped in the dried paint. (Fig 26)

Causes:

- The surface was not clean enough
- The spray booth is not dust free (clothing creates dust)
- Filters are dirty or clogged. The airline is dirty
- The paint is contaminated
- Ineffective paint filtering

Remedy:

After through drying:

- Remove dirt by fine sanding (P1200), then polish
- If the dirt has been trapped deep into the paint, sand the surface and re-spray

Prevention:

- Thoroughly clean the surface (by air and antistatic degreasing agents).
- Keep the spray booth clean and wear fibre-free, antistatic overalls
- Replace the filters regularly
- Store the paint in tins that are clean and well-sealed. Filter the paint every time before pouring it into the spry gun pot.
- After use, thoroughly clean used equipment, especially the gun, and dry it with clean cloths.

Fig 26

Streaks: The final colour displays slightly different coloured streaks. (Fig 27)

Causes:

Unsuitable application technique due to:

- Incorrect adjustment of the spray gun: unsuitable or unclean air cap
- Irregular and/or not constant air pressure
- Too low spray visco,./ sity
- Too wet spraying

Remedy:

After through drying:

- Sand and re-coat

Prevention:

- Choose the spray gun and the relevant air cap in the relation to the data sheet and gun manufacturer settings
- Check the regular coverage of the compressed air.
- Always check the paint spray viscosity
- Apply correct product quantity as well as correct film thickness
- Follow the technical data sheet

Fig 27

Chalking: Deterioration of the paint film due to the decomposition of the blinders / payments within the painted surface. (Fig 28)

Causes:

- Incorrect hardener and/or mixing ratio
- Incorrect film thickness
- Deterioration due to weathering
- Incorrect technique applied

Remedy:

If the damage is very small, try to restore by polishing with abrasive paste, otherwise it will be necessary to repaint

Prevention:

- Use hardeners and ratios indicated on the technical data sheet
- Pay attention to each of the applied layers
- Work methodically, following the prescribed technique

Fig 28

Bleeding: Staining due to soluble dyestuff. (Fig 29)

Causes:

- Use of soluble pigments
- Reaction of the putty's peroxides with dyestuffs or pigments present in the paint film
- Bitumen or tar residues

Remedy:

- Insulate the damaged parts. In particularly serious cases, sand until bare metal and restart the correct paint process.
- Undercoat with BLACK fillers or paints (the best filler being black).

Prevention:

- Do a solvent test to verify the possible presence of soluble dyestuffs
- Check the putty's correct hardener and peroxide dosage
- Ensure that all possible tar or bitumen residues have been removed.

Fig 29

Stone Impacts: Deep paint damage due to external agents. (Fig 30)

Causes:

Impacting of the body work by stones, pebbles, etc.

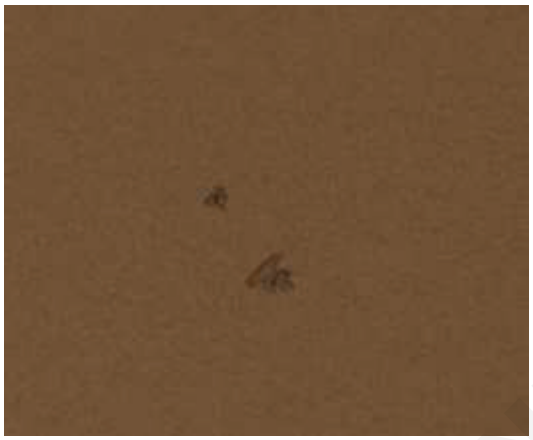
Remedy:

Sand the damaged zone, apply putty if necessary and then repaint

Prevention:

Because this is a situation removed from the painting process little can be done apart from being vigilant with regards to road surfaces e.g. freshly laid road chippings, unmade roads, road litter.

Fig 30



Overspray: Automized and dried paint particles that have settled on the surface during painting and not completely absorbed into the surface. (Fig 31)

Fig 31

Causes:

Insufficient overspray absorption due to wrong hardener and/or thinner as regards environmental conditions

Remedy:

Sanding and re-application in respect to correct conditions.

Prevention:

- Mask carefully the panels that are not to be painted
- Consult the technical data sheet for suitable thinners or hardeners

Sagging: Paint drops on vertical surfaces. (Fig 32)

Causes:

- Use of unsuitable hardeners/ thinners
- Incorrect viscosity
- Heavy application of product
- Incorrect flash-off between coats
- Incorrect air gap
- Incorrect spray fan

Remedy:

Allow to through dry, then remove the sagging. Polishing will sometimes be sufficient but in some cases it may be necessary to sand and repaint

Prevention:

- Consult the technical data sheet carefully and above all choose the right hardeners/ thinners in relation to the temperature and the relative humidity
- Ensure that spray equipment is perfectly clean and in good working order.

Fig 32

Haze: Opalescent haze formed on the paint surface. (Fig 33)

Causes:

Humidity/ condensation trapped in the paint:

This may be caused by the following:

- Less favourable climate conditions
- Unsuitable thinners
- Incorrect air pressure
- Using more forced drying than recommended

Fig 33

Remedy:

Polishing may remove the defect. If this is insufficient, sanding and repainting will be needed. If after repainting this phenomenon reappears, check the application method and conditions (spray gun adjustment, ventilation, drying temperatures).

Prevention:

- Avoid application in extreme climatically conditions (strong humidity, too low temperatures).
- Use thinners recommended on the foreseen on the technical data sheet
- Ensure the environment is suitably air-conditioned (suitable temperatures and relative humidity).

Importance of polishing:

Paint compounding involves different abrasive paste and liquids to hand and machine polish surface to high gloss or shine. The rubbing compound is used to abrade and smooth a surface film by hand to level minor surface imperfection. Rubbing compounds remove the surface gloss and must be followed up with a hand – glazing compound to restore paint shine. Rubbing compounds are used for the following reasons

- Eliminate the sand scratches around a repair area
- Correct a gritty surface
- Smooth and bring out some of the gloss of lacquer top coats
- Repair paint on areas that cannot be buffed with a machine.

Machine compounds are water based to disperse the abrasive while using a power buffer machine compounding is just like sanding. You would start out with a coraser rated compound and follow up with finer compounds to bring the paint to a high gloss and shine.

A buffing pad is rotated by an electric or air buffer to force the compound over the paint surface. If buffing done properly this will remove small scratches and it will bring quickly glossy shine on the surface

A polishing machine uses an orbital action to bring out the full paint gloss or shine. The orbital action polishing machine is needed to bring out a show type finish in paint. It will remove swirl marks and the finish will look like it has been hand polished. Use the wool pad buffs for fine finish.

The faster the buffer is moved across the surface, the slower cutting rate. The slower buffer is moved the higher the cutting rate. The buffer speed and pressure have an effect on the paint cutting and polishing action. The excessive buffing heat can cause swirl marks, warping discoloring and hazing and make the material dry out too quickly. If the area is hot to the touch, there is a too much heat, cool it with water.

Hand and machine glazing and polishing:

Glazing or polishing involves using very fine grit compound to bring the paint surface up to full gloss. It is usually done after compounding. You can hand – polish small or hard to reach areas. Machine polish larger areas to save time.

Slight defects in the topcoat can be repaired by polishing. The choice of compounds depends on the extent of the damage. Final polishing should always be done with an ultrafine polishing compound.

When using rubbing compounds and machine glazes be sure to follow these procedures:

1 Use a single manufacturer's product line.

2 Follow the manufacturer's recommendations for use.

3 Use the materials sparingly.

4 Use the buffing wheel to evenly distribute the material over the area that is being repaired .

5 Keep the pad flat and directly over the surface being repaired.

6 Use a slow, methodical motion so you can keep track of how much area has been buffed.

7 Use the finest grit product possible last. Using a finer grit product may take a little longer initially but will generally require less time to complete the repair.

8 Reduce swirl marks by avoiding coarse products and worn buffing pads.

Instead of a circular action buffer, you should use an orbital action machine for final polishing. An orbital action polisher will move the polishing compound in a random manner to remove swirl marks from buffing.

Car body dent removal process

Objectives: At the end of this lesson you shall be able to
- **state the car body dent**
- **state the process of dent removal**
- **state the different types of denting process**
- **state the removal process of defects by polishing.**

Car body surface dent:

Car body dents are happen due to hitting a external force on the car body surface. The hitting external force make a dent or damage on the car body surface dent can be occurred due to an accident and many other reasons. Car body have a metal and plastic parts, both can be dented or denaged by accident or hitting any heavy pressure on the car body surface.

There are four types of dents, including small and large dents in plastic and small and large dents in metals before start trying to fix them, determine what the dent is in and then proceed.

Small dents in plastic:

- using the heat gun/ blow dryer, heat up the dent
- after this warm to the touch shake the compressed air, flip upside down and spray the area with the ultra- cool air
- The dent should pop out by itself, though a suction dent puller may be needed.

Large dents in plastic

- Using the heat gum/blow dryer, heat up the dent after its warm to the touch attach the suction dent puller and then pull the dent out with puller's handle
- You may need to heat the area up again to completely pull out the dents
- You also might need to push out any smaller dents that appear during this process with hands

Small dents in metal

1 Wipe the area down with a microfiber towel ensure there are no particulates that will cause a bad seal or damage your paint

2 With the provided glue from the dent repair kit, up the glue and apply about a tablespoon of glue to the deepest points of the dent.

3 Attach the provided bridge puller head to the glue and allow it to dry completely, about 4-8 minutes.

4 Once dry, attach the bridge puller and slowly begin turning the dial to pull out the dent.

5 After the dent has been removed, detach the bridge puller, and, using heat gun, remove the leftover glue.

Large Dents in metal

1 Using the heat gun/ blow dryer, heat up the dent.

2 After it warm to the touch, attach the suction dent puller.

3 Pull the dent out with the puller s handle.

4 Once you've reduced the dent s overall size, switch to the bridge puller.

5 Wipe the area down with a microfiber towel to ensure there ensure there are no particulates to cause a bad seal or damage your paint.

6 With the provided glue gun from the dent repair kit, heat up the glue and apply about a tablespoon to two tablespoon of glue to the deepest point of the dent.

7 Attach the provided bridge puller head to the glue and allow it to dry completely, about 4-8 minutes.

8 Once dry, attach the bridge puller and slowly begin turning the dial to pull out the dent.

9 After the dent has been removed, detach the bridge puller, and, using the heat gun, remove the leftover glue.

Using the right dent removal tools and methods.

a For panels that can be easily accessed, the process requires one to take the panel out, and then fix the dent using the hammer off and hammer on technique

This ensures that absolutely the minimum amount of body filler is needed.

What FNG mechanics usually do is to fix the dent in-situation. They don't bother to take the panel out and fix it using above technique

They also don't have a variety of hammers, dollies and spoons at their disposal. They do with the generic peen hammers, a regular file (which they use as a shrinking dolly) and a screwdriver.

Invariably this leaves behind ripples, dings, small creases in the job. To be filled up with body filler of course less than ideal.

b For panels that cannot be easily accessed, e.g.runnung boards.

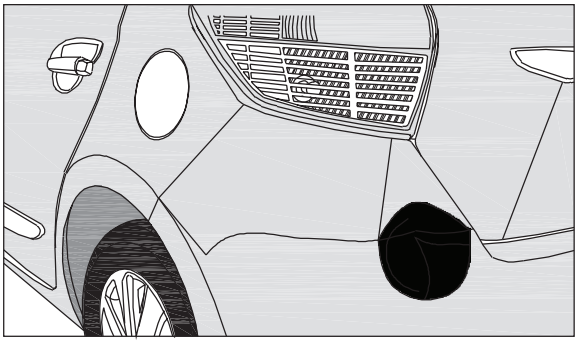
The proper method requires either using a spot weld/ slide-hammers (for easy to remove dent) or cutting out the running board using an ox-acetylene torch, fixing the dent, and plug welding it back. (for dents where the creases are just too much)

If ingenuity is striking follow the method to remove it

I Option1: Often use a chisel and hammer to open the seam weld, and then use a screwdriver + file to push out the dented area.

II Option 2: In other cases, especially when the crease is too much to handle using this method, they will punch holes into the running board – a bit like swiss cheese, and then use a screwdriver or a pick like tool to pry out the dent.Something like this Fig 1.

Fig 1



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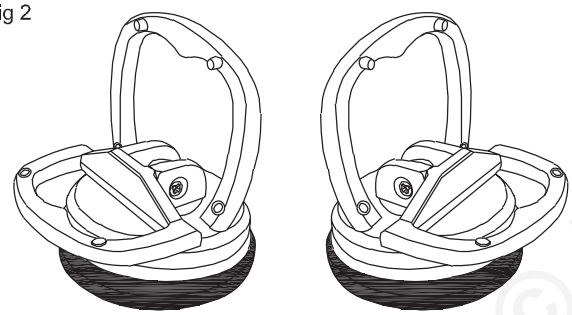
Dent repair tools:

There are many types dent puling and repair tools used to repair the dent damaged car body surface. The following tools are used for repair the small and large dents. (Fig 2)

Fig 2



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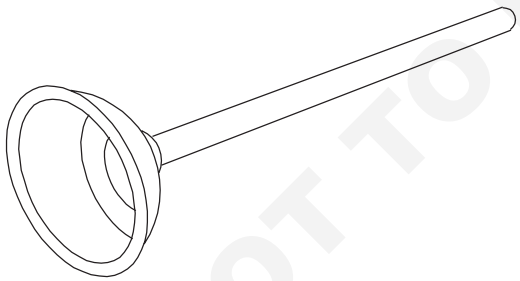
Suction cup:- (Fig 3)

It is used to remove the small dents

Fig 3



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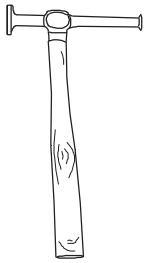
Hammers

General purpose pick hammer:

General purpose hammer for body jobs (Fig 4)

Fig 4



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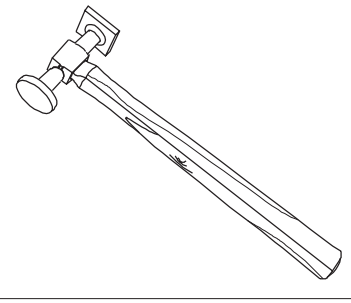
Bumping hammer: (Fig 5)

Heavier head with round and square faces for thicker metal:

Fig 5



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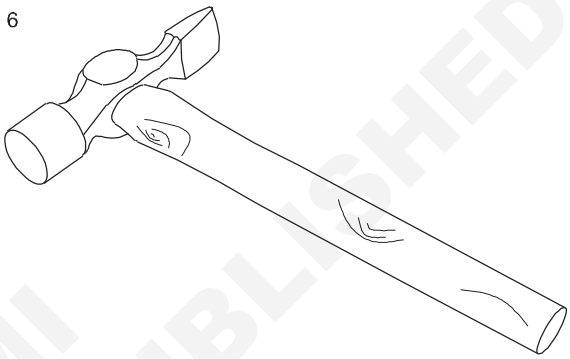
Cross peen hammers (Fig 6)

Fig 6



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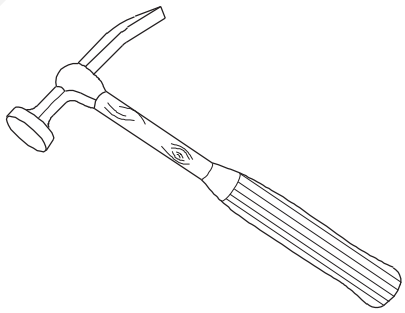
Cross-chisel hammers: (Fig 7)

Smooth or straighten detail creases and inside corners.

Fig 7



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Pick fin hammer:

Pick fin hammer works on restoring contours of dented fines e.g.50's cars with nice tall fins (Fig 8)

Fig 8

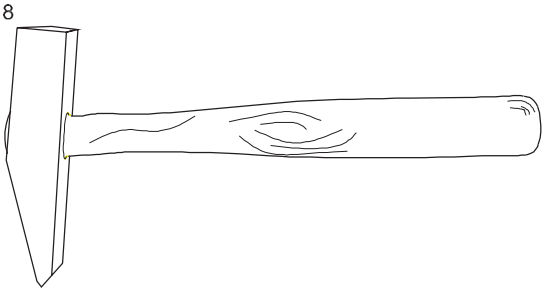

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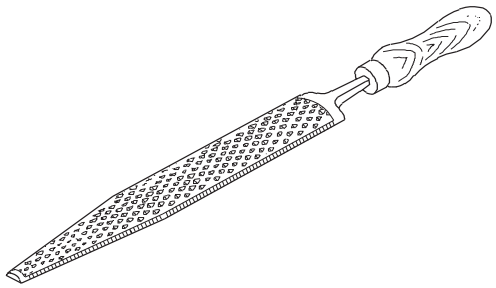
Fig 9



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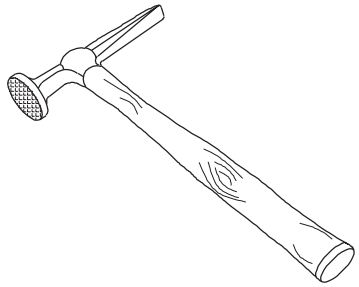
Cross chisel shrine king hammer (Fig 10)

Fig 10



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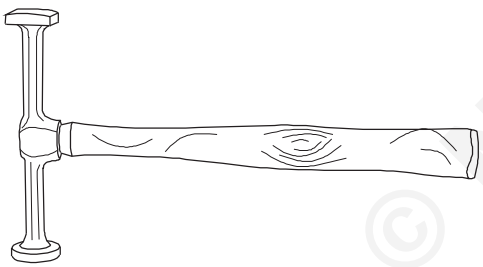
Dinging hammer:(Fig 11)

For removing small dents without removing the panel

Fig 11



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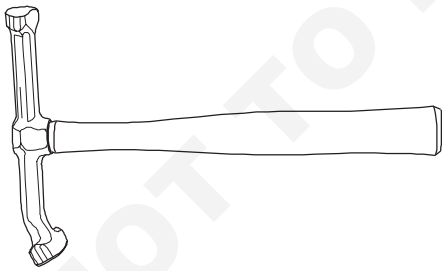
Doorskin hammer(Fig 12)

For use on door- skins

Fig 12



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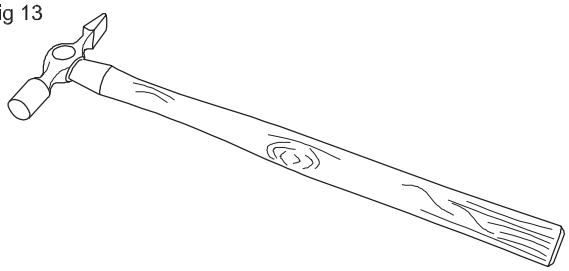
Trim hammers:(Fig 13)

It is used to trim the stainless trim

Fig 13



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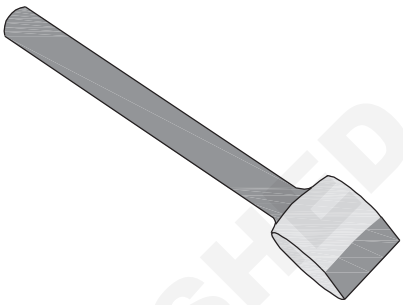
B Spoons and picks

Whilst hammers and dollies are great for repairing the large sized dents, spoons are used to distribute the force of a hammer over a wider area than the hammers head; whereas picks are best used to poke and pry out minor dings and dents from hard to reach places, often while preserving the paintwork.

1 Long handle spoon-Dolly (Fig 14)

It is used as a light hammer for to hard to reach places such as inside door pockets, quarter panels,and fenders

Fig 14



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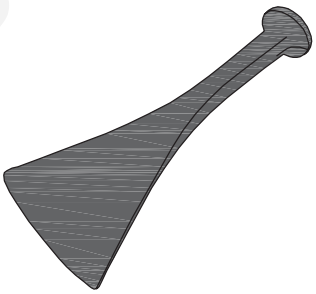
2 Caulking iron

This is useful for finishing wired fender edges or shaping/straightening metal on inside moldings. (Fig 15)

Fig 15



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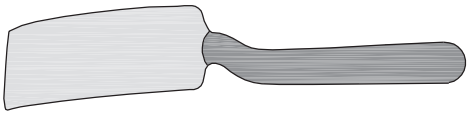
3 Light dinging spoon

It is effectively spreads hammers blows over(Fig 16)

Fig 16



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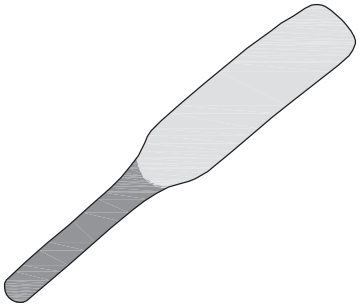
4 Slapping spoon

This works well for smoothing and shaping (Fig 17)

Fig 17



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5 Medium short curved pick

It is access dents inside doors or between inner/outer feners. Use with twisting or prying action. (Fig 18)

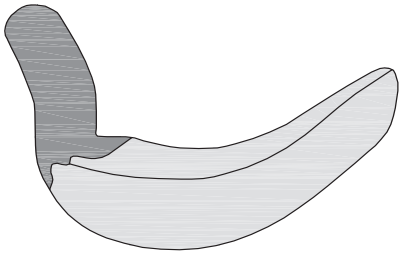
Fig 18

PG20N272023I

6 General purpose fender spoon

It is used as a dolly behind brackets, inner-panels. (Fig 19)

Fig 19



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7 Dollies

A dolly is the name given to a category of tools used in shaping sheet metal.in general, a dolly is a solid piece of metal, small enough to hold in one hand, with a curved or shaped face. Generally a dolly will have more than one surface, each with its own radius of curvature (much like a three- dimensional French curve), allowing the craftsman more flexibility in using the tool.

A dolly can be used either as a hammer, shaping the metal to match the curve of the dolly, or as small anvil to provide a curved surface over which to dome or dish metal. They are commonly used as backers for upsetting metal.

A General purpose dolly (Fig 20)

Fig 20

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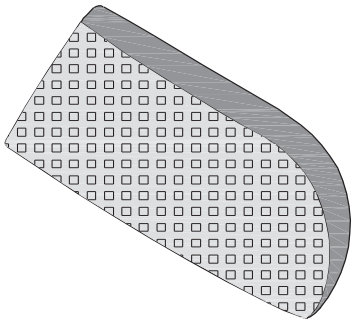
B Shrinking dolly. Note the serrations shrink metal when beaten with a hammer.(Fig 21)

Fig 21



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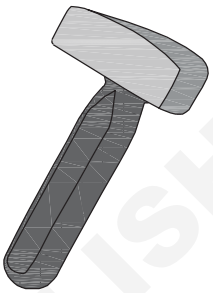
C Anvil dolly(Fig 22)

Fig 22

PG20N272023M

D Dome dolly(Fig 23)

Fig 23



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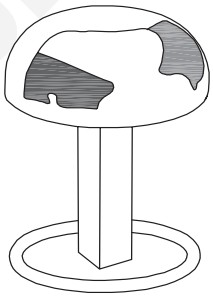
E Round forming dolly(Fig 24)

Fig 24



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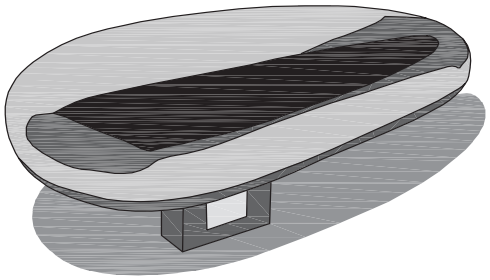
F Oblong dolly(Fig 25)

Fig 25



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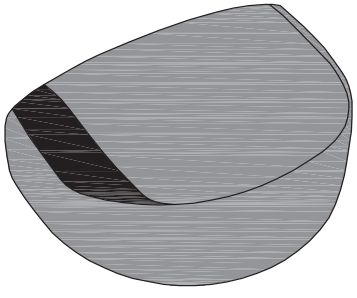
G Heel shaped dolly(Fig 26)

Fig 26



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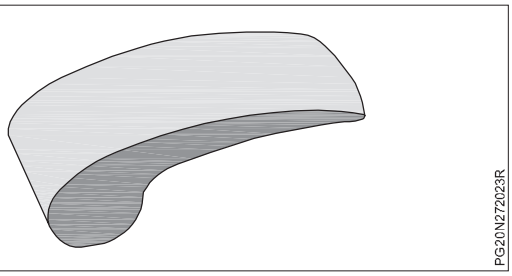
H Curved dolly(Fig 27)

Fig 27



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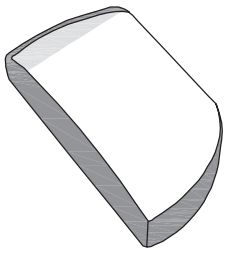
I Toe-shaped dolly (Fig 28)

Fig 28



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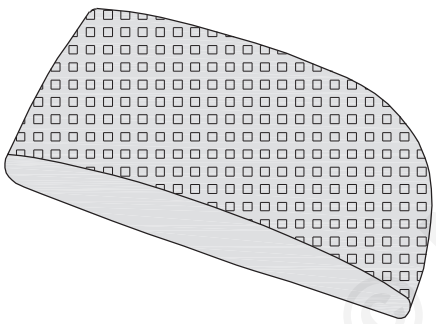
J shrinking body dolly(Fig 29)

Fig 29



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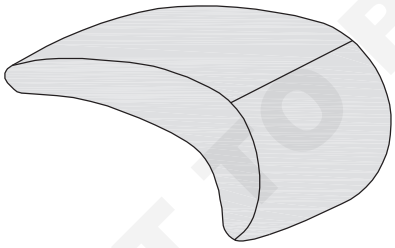
K Wedge shaped dolly(Fig 30)

Fig 30



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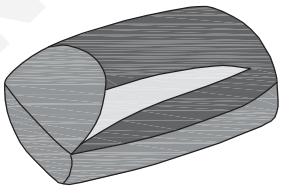
L Egg shaped dolly(Fig 31)

Fig 31



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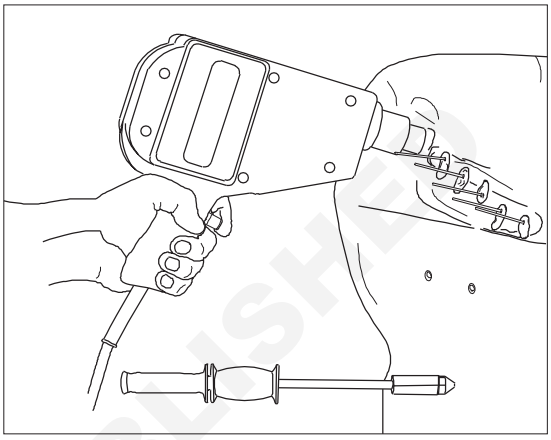
Dents-pullers

Dents-pullers vary in shapes and sizes. There are two kinds – the pneumatic type (vacuum based), and the spot-weld type.

The pneumatic type have limited action and efficacy and are best suited for the amateur action scene. The spot weld type, employ a combination of a spot welded key and a slide hammer assisted puller.

Spot weld dent puller system(Fig 32)

Fig 32



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Electric dent puller:

It is used to remove the dent from the vehicle body. It takes longer for a magnetic field to penetrate through a metal than it does in air. When EDR units coil is placed over the damaged area, the capacitors in it release 36,000 amps of electric current in 1½ milliseconds to produce a magnetic field on both sides of the dent.

Repair dents by using a stud welder gun

A stud nail welder is basically a tool that welds a small stud to the metal surface to perform dent repair. This stud provides something for the T - handle or slide hammers to grab on to. Force can be applied to remove the damage. When using this method you must have the repair area ground to metal as it will not work on painted surface. The tip must make direct contact with the metal to produce the weld. When using this method remember the rules mentioned earlier. First in last out and roll the metal, don't just force it. Starting at the outsides weld studs to the metal.

Then pull the damage as you use a body hammer to top lightly down on the highs. Sometimes the highs may be difficult to find, but there are usually hig spots if not, tapping lightly while pulling to relax the molecules in the metal resulting in the metal being straightened with less force. Once the damage begins to pull out start pulling towards the center of the damage using the same technique use the slide hammer as a last resort it is very easy to over stretch the metal using the slide hammer. After this process need to remove the stud nail. This can be done by cutting the studs with a pair of dykes and grinding the surface smooth don't hold the grinder in one spot too long.

Touch up car's paint

After repair the dents, need to touch up the car's paint follow the method to touch up paint

1 The key here is to keep your hand as steady as possible and to apply a small amount of primer or paint, but removing it is a painful process. Stabilize your hand by pressing the heel of your hand on the surface and using it as a hinge.

2 Use a small brush, toothpick, or other stick- like object to apply a tiny amount of primer to the area you're looking to touch up. Scratches and other small paint chips will only take a drop or two of primer.

3 Let the primer dry. This will usually take an hour or so, depending on how large the primed area is.

4 Make sure the touch up paint is thoroughly mixed by shaking the bottle or stirring with paint mixing stick

5 Use the small Brush or tooth pick to apply touch up paint as evenly as possible care not to apply the paint in a thick coat, which can lead to running or bubbling.

6 Don't sand or treat the painted area for a few days. If you can help it, let the vehicle sit for that period of time to allow the paint to dry and cure.

7 Once the touch-up paint is completely dry, wash the vehicle thoroughly and polish it. This can help smooth out any imperfections in the touch – up paint and may help blend it with your vehicle s existing paint colour.

Removal of defects by polishing:

- After the dent pull repair of a car, you need to paint repair spot. After painting the car follow the steps to removal of defects by polishing the painted surface.
- Clean the vehicle with soap water and wipe out water and dirt, dust with help of microfiber cloth
- Ensure the painted surface is clean and dry
- Inspect the painted surface for paint defects and mark the dent or scraches area
- Select the rubbing compound(liquid/paste)
- Apply rubbing compound on paint defect marked area one by one
- Spread over the rubbing compound on paint defected spot
- Select the rubbing method (mechanical/machine)
- Buffing on rubbing compound applied spot to remove paint defect
- Rotate the buffing pad by slow or high speed as per condition of paint defects rotate buffing pad untile paint defect is rectified.
- Ensure paint defects are clean and again apply fine rubbing compound and use the fine sponge or work buffer to rubbing to bring gloss shine.
- Clean the car body surface and ensure the paint gloss shine without any defects.

Paint defects

Objectives: At the end of this lesson you shall be able to
- **state the paint defects and remedies**
- **state the process of paint defects removal.**

Paint defect:

Paint problems are easy to spot, but in many cases quite difficult to analyse. Paint spraying is the worst possible way to apply on metal surface defects is desired, but it is the only way to obtain the gloss colour defects and outstanding appearance. All defects hurt appearance and some also can interfere with the corrosion or weathering protection aspects of the coating reaping defects can lead to move problems so the paint problems and its remedies are given blow to achieve the knowledge about paint problems and its remedies.

Paint defects and its remedies

S.No	Paint defects	Causes for paint problem	Remedies
1	Paint cracking	- Substrate not at room temperature - Solvent not properly temperature - Coating applied over a previously cracked finish - Improper flash off time	- Substrate at room temperature - Properly mix the paint - Follow the recommended painting procedure. - Allow the paint to dry as rec ommended flash time
2	Delamination	- Contaminated surface - Metal conditioner and operate primer was not used	- Prepare surface preparation - Use proper solvents and mix it used.
3	Dissolution	- Insufficient flash of time	- Allow the paint to dry as recommended by paint manufacturers - Follow the recommended viscosity - Sand the surface smoothly
4	Dry spray	- Improper spray gun distance - Improper gun setting insufficient fluid feed - Gun air pressure regulated to high - Paint viscosity too high	- Properly maintain the distance - Properly set the gun - Properly adjust the paint spray gum air pressure - Properly mix the solvent to achieve the specified paint viscosity
5	Mottling	- Improper gun nozzle size - Improper spray pattern setting - Paint spray application heavy - Holding spray gun too close to surface - Wrong reducer/ ‘thinner for room temperature - Paint improper mixing	- Use the proper size spray gun nozzle - Set the spray gun properly - Paint spray application should be as recommended - Maintain the spray gun distance from the surface as recommended - Use proper equalant room temperature thinner/reducer - Properly mixing and filter the paint before application
6	No hold out	- Unstable substrate - Wrong sand paper grit used - Primer over sanded - Primer uncured - No sealer was used on aged or spot primer finishes	- Use stable substrate - Sand smoothly - Properly sand the primed surface - Let allow the cure the primer - Use the surface sealer before application of base coat/topcoat

7	Poor hiding	- Insufficient film build - Not using basecoat , when required for transparent colours - Wrong amount of thinner/reducer - too much - Insufficient lighting in paint shop	-. Spray sufficient paint film build - Spray the same colour of base coat as well as top and clear coat - Use the recommended thinner/ reduce for proper viscosity of paint - Use proper lighting and paint shop temperature
8	Boiling	- The coats were applied to thick or heavy - The use of unsuitable reducer - Too short drying time between the coats - Too high am objects temperature to accelerate the drying - Too long air drying time for components paints before the objects is placed in the oven - The use of infrared lamps can cause too high a surface temperature if the lamps are close to the objects	- Apply proper thickness of paint film - Use the proper reducer - Let allow recommended trying time between two coats - Maintain the object temperature and room temperature equally - Adjust the oven temperature as recommended - Use the recommended lamp in oven
9	Lifting/swelling edge	- Recoating of solvent sensitive layers with wrong repair materials or too thick - Coats used as a sealer are not thick enough - The filler was sprayed to thick and not allowed to dry sufficient	- Use proper repair materials - Apply sealers on the surface as recommended by manufacturers - Allow enough time to dry as recommended.
10	Poor hiding	- The substrate was not even in colour all over the painted area - The top coat was not thoroughly mixing before use - Incorrect quantity of reducer was used - Paint coats are applied very thinly	- Use even colour all over the painted area - Properly mix the paint before use the paint - Use the correct quantity of reducer - Apply paint coats as recommended
11	seeds	- The use of paint which has been kept longer then the recommended storage life - The addition of incorrect hardner or thinner - The use of re-thinned materials whose pot life has already been excellent - Pigment conglomeration due to insufficiently stirred material	- Use only recommend paint before expire the paint life - Use only recommended thinner/ reducer - Use only recommended viscosity of paint - Mix the paint properly as paint manufactures instructions printed on paint packing.
12	Stone chipping	- Stones or other hard substance hit the painted surface	- If major damages remove the paint and do fresh paint.

Furniture making multiple skills

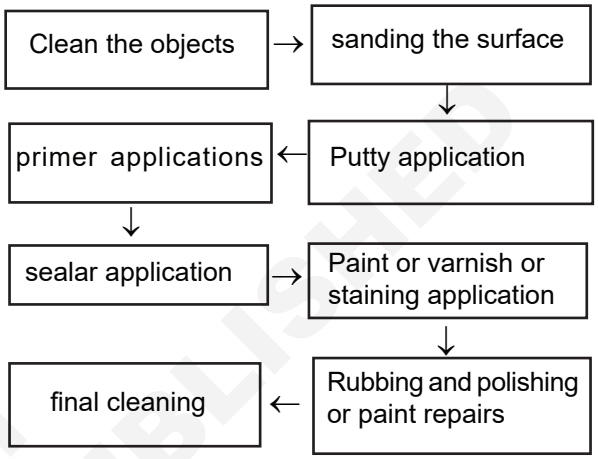
Objectives: At the end of this lesson you shall be able to
- **state the furniture making skills required**
- **state the method of furniture preparation for painting**
- **state the wooden furniture painting, polishing varnishing, waxing, staining**
- **state the method of PU coating textures creating.**

Wooden furniture making skills: A furniture maker is responsible for the furniture design, building and restoration of pieces of furniture like cabinets, tables, chairs, bed frames, shelves and more other items.

Furniture making process used in the manufacture of furniture include the wood cutting, bending, moulding, laminating and assembling of each material as wood, metal, glass, plastic and rattan. However, the production, process of furniture is not solely bending metal, cutting and shaping wood or extruding and moulding plastics. Furniture makers need more skills like, furniture painting, varnishing, polishing, waxing staining and PU coating textures creating on the wood surface, required skill and knowledge for furniture maker.

- Thorough and attention to details of furniture
- Furniture design skills and knowledge
- He has ability works will other co workers
- The ability to work will with his own hands
- should have knowledge of furniture manufacturing production and process
- Furniture maker should know the knowledge of maths
- He should know the ability to use, repair and maintain machines and tools of carpenter trade
- Furniture designer should have the following knowledge
- Creativity and practical ability
- Problem solving skills
- An understanding of properties of range of materials used in furniture making
- Good communication skills
- Able to read the drawing and CAD software skills
- ability to work within budgets
- A furniture designers should be carry out research to help develop ideas
- Work to a brief agreed with a client and able to product new designs or improve the quality and furniture designs.
- He should be able to understanding of the properties of a range of materials used in furniture making
- He/she should be ability to work with in budgets

Furniture painting process



Wooden furniture painting: painting a wood furniture is an economical way to get look as desire without destroying the integrity of the materials. After few years no longer care for the furniture and choose to paint the wooden furniture. For paint the furniture. Easily strip the old paint by sanding and change the colour or decide to stain, polishing, varnishing, waxing, PU coating and textures coating on the furniture as per the following methods.

Preparation of wooden furniture surface for staining: Select the wooden furniture for staining process. Stain can bring out the natural wooden colour and pattern. Start with a medium grade sandpaper 120 grit and gradually increase surface finish with sanding a 220 grit sandpaper. If you are using a power sander, you will need sandpaper disc with grit sizes from 80 to 220. A power sander is much faster. However power sander is used for large and flat surface work only sand in the direction of the grain for a smooth uniform finish and remove all sanding dust using a vacuum, dry paint brush or clean cloth. Look out for dried glue, especially in the joint area.

Compare the different types of grain patterns, try to match grains patterns in boards that will be used next to one another before purchase the wood, measure the wood to be needed to make a furniture and then buy the wood for furniture.

Wood finishing: There are a number of items frequently used in wood finishing furniture. Most commonly used tools are required for wood surface preparation.

- Rags
- Sandpaper

- stir sticks
- Rubber gloves / latex gloves
- Foam sanding block
- Brushes
- Paper towels
- Safety glasses
- Drop cloths or news papers
- Tack cloth
- Masking paper
- Microfiber cloth
- Microfiber staining cloth
- Shop vacuum cleaner

Materials Required: - stain, clear coating, sandpaper.

Choosing the application: wood finishing products may be applied with clean rags, brushes and other applications. For best results when using brushes make sure, it is a high quality one. When selecting the brush, good quality is certainly important depend upon the work based whether it is water based or oil use only. Brushes made with synthetic bristles for water based stains and finishes. Natural bristles brushes will soak up water, causing the filements to swell and become floppy oil based will apply smoothly and easily with a good quality natural bristle brush.

Surface preparations: Wood surface sanding is one of the most important steps in wood finishing. A through sanding is often. Start with 120 grits finish it with 220 grits for smooth finish. Ensure thoroughly removed by sanding, it will interfere with the staining process. End grains, such as the front side of the furniture tend to soak up more stain than the surfaces out with the grain, with additional sanding to end – grain areas.

Choosing a stain colour: The final colour results is determined by three main factors

- The colour of the stain selected
- The species of the wood and how porous it is
- How long the stain is left on.

Remember different species of wood absorb stain differently. Always test the colour on a hidden section of the furniture wood. You have prepared for stanning select the suitable colour stain and do not mix more than three wood tones at a time. That way, it is easier to control and replicate the outcome and be sure to mix enough stain to complete the entire furniture.

Wood finishing system consists of applying a wood stain and clear protective finish in individual steps. The staining method permits independent control over each step. The depth of colour and level of protection and is used to obtain rich professional looking finishes on small and large surface. while applying stain on the wooden furniture surface

- Prevent wood swelling and warping due to changes in temperature and moisture finish all of the exposed surfaces of the wood item.
- Allow the stain to dry the recommended amount of time before applying the first coat finish applying the protective finish before the stain has completely dried may results in chipping peeling or bleeding of color.
- When using a clear finish, tip off each section, hold the brush at a 45 degree angle and lightly run the bristles over the length of the finish to remove all evidence of brush strokes and break any bubbles that may have occurred.
- Apply additional coats of finish, the bottom coat must be dry before recoating, lightly sand between coats with 220 – 280 grit sandpaper to improve coat to coat adhesion and carefully remove all sanding dust before recoating. Failure to follow these. May results in adhesion problems
- Remove any dust by using a cloth or vacuum cleaner, repeat this process until you get the desired result (usually 2 – 3 times) always apply the finish, like the stain, with the grain not against it. Make sure each brushes stroke applies the finish evenly.
- Sanding is not required for the final coat of finish, once it has dried use a cloth or rag to remove any blemishes or particles left after the finishing you will also need to leave the wooden piece untouched and unused for curing, which can take a couple days to week in most cases
- Wipe the can rim so that the products does not dry and so that rust does not form on the can after sealing store cans away from heat.
- Clean brushes soiled with oil – based finishes by using mineral spirits. soap and water are all that is needed for brushes used with water based products.
- Remember, adding excess stain will cause the colour to change. The colour should be even on the entire surface for aesthetic reasons.

PAINTING ON WOOD WORK

The main objectives of applying paints to wooden surfaces is to provide a smooth protective cover of the desired colour, with improved aesthetic of wood structure. The good quality painting makes the woodwork:

- More durable
- More decorative with smooth finish, and
- Free from bacterial and fungus formation, which are unhygienic and gives ugly look.

Different types of paints are available in the market for providing opaque coating. However, enamel paints are widely used due to their superior surface finish and durability.

Process of painting

1 **Surface preparation:** The process of making the surface fit for paint application.

- The surface to receive the paint should be smooth, free of surface imperfections and thoroughly clean of all dust & dirt. The important facts to be kept in mind are as follows

A General attention: on entire surface

For new wood surface: The wood should be well seasoned, dried and cleaned of scales, smoke and grease.

- Entire surfaces shall be sandpapered along the grains to make it smooth
- Knots excreting resin in the wood cause cracking, peeling and brown discoloration. they shall be treated properly by:
- Lime knotting: apply a coat of hot lime and scrape it after 24 hours. Then apply primer of red lead and hot glue with one coat of knotting varnish suitable for deodar and other resinous wood.

(or)

- Ordinary size knotting: apply first primer coat of red lead and hot glue, on drying followed by second coat of red led grounded in oil and thinned with boiled oil and turpentine.

(or)

- Patent knotting: apply two coats of varnish consisting of 250 gms. Pure shellac, 1.0 liter methylated spirit and 25 gms. Red lead.

For old wood surface: If the old paint is sound and firm and its removal is considered unnecessary. The surface shall be rubbed down with sandpaper to remove all dust and loose paint after it has been cleaned of all smoke and grease. If required, grease shall be removed by washing with lime/washing soda and rinsing with water.

If the old surface is blistered or flaked, it should be removed completely with sharp glass piece/stripping knife, sandpaper and by use of either:

- Patent paint remover: remover solution is applied with brush and when the paint films lifts and wrinkles, it is scrapped thoroughly. After removal of paint, surface shall be washed down with turpentine.
- Caustic soda solution: (1 part soda + 48 parts water) soda solution is applied with brush and when the paint film lifts and winkles it is scrapped thoroughly. After removal, surface should be rinsed with little acetic acid/vinegar in final rounds of rinsing.
- Blowlamp: Flame is moved over the paint coating just enough to soften it without charring the paint and /or background. The softened paint is removed completely with scrapping knife/ glass piece. Burning off shall be carried out from bottom to upward on vertical surfaces.Blowlamp shall not be used on narrow/carved/undercut surfaces or where there is a risk of damage to adjoining material.

B Special attention:

- Any surface imperfection must be rectified by applying wood filler by putty knife or by muslin cloth pad in a circular motion with sufficient pressure to force the filler into the pores. The excess filler must be removed by strokes along the grain pattern.
- Allow 2-3 hours drying time before sanding and applying subsequent coats of wood filler.

Primer coating: Applied to fill the pores of wood & to provide adhesive between the paint film and the surface. It smoothes the surface, makes it less absorbent and increases the spreading capacity of the paint. It shall have no turpentine as it impairs the firmness of paint.

Primer shall be either prepared at site or readymade paint of approved brand/manufacturer shall be used.

- First primer coat: after surface preparation and thorough drying of wood, 1st primer coat shall be applied.
- Stopping & filling: after the priming coat is applied the holes indentations on the surface shall be stopped with glazier s putty (1 part white lead + 3 part fine powdered chalk + boiled linseed oil to form stiff paste) or readymade putty of reputed brand. Stopping shall not be done before the Priming coat is applied as the wood will absorb the oil the stopping and the latter is, therefore liable to crack
- Second primer coat: this is applied to sandwich putty between two primer coats, since painting directly on putty leads to a patchy appearance.

Application of paint:

A Preparation of mix: Readymade enamel paint of reputed brand confirming to IS specification, of desired colour/ shade shall only be used.Paint as supplied shall be used for painting if required; thinning can be done with mineral turpentine oil to the extent as recommended by manufacturer (max 5-10%)

B Paint coats: Generally one coat should be adequate or old work and two coats (Excluding priming coat) for new work to get the desired finish and colour. In case the earlier paint shade is significantly darker than the new shade, an additional coat of paint is recommended.

C Process of paint application:

- Paint application shall be carried out with proper painting brush, paint shall be applied evenly and smoothly by means of crossing and laying off, the later in the direction of the grain of wood. The crossing and laying off consists of covering the area with paint, brsushing the surface hard and then brushing alternately in opposite directions, two or three times and finally brushing lightly in a directions, at right angles to the grains, in this process , no brush marks shall be left after the laying off is finished. The full process of crossing and laying off will constitute one coat.

- The Subsequent coats shall be applied only after the previous coat has dried application of next coat, previous coat shall be lightly rubbed down with sandpaper and dust shall be cleaned.
- The finish surface shall be even and uniform and shall have no brush marks

General precaution:

- Use only reputed brand and ISI mark paint/primer.
- Do not use very old paint, normally shelf life of paints is 3 years in original tightly closed containers kept away from direct sunlight and excessive heat.
- Do not add thinner unless. Prescribed by manufacturer.
- Thinning shall not be done beyond as prescribed by manufactures, as over-thinning will affect the paint performance. Normally surface coverage of enamel paint is 90-120 sq.ft/ ltr/coat.
- Paints should be thoroughly stirred before application and shall be of proper viscosity for application.
- The painting area should be well ventilated and free from dirt and dust.
- Do not paint on humid or on rainy days or when it is too cold.
- Use proper brush only. For enamel paints, hog brushes are preferred. Normally 5-10 cm wide brushes are used.
- Check that all nails, cracks or other defects are properly filled and smoothened, nail shall be punched well below the surface and the holes shall be filled with wood filler.
- All the furniture's and valuables should be covered with damp clothes to guard against any possible damage due to spillage of painting.
- Ensure proper application of each coat of paint for uniformity of thickness.
- It shall be ensured that the painted surface is the free from paint drips, waves and is of uniform colour, texture and finish.
- After painting paint, which falls on floor and wall, etc, shall be completely cleaned along with cleaning of glass panes.
- The drying time of enamels is longer hence care must be taken to ensure free environment while the paint film is drying.

APPLYING FINISHES BY BRUSH

Spraying produces the most professional – looking finish, but it is expensive to build and equip spray booth that complies with health and safety recommendation. Consequently applying clear finishes and paints with a brush is the only viable option for many amateur woodworkers. However, provided you use well-maintained, good-quality brushes and exercise care and patience, you can achieve more than satisfactory results employing ordinary workshop facilities. Buy a rage of brushes- ½ ,1 and 2inc (12,25 and 50 mm) wide – for general work, and a 4 inc (100mm) brush for coating large flat surface.

Brushing cellulose lacquer

It requires a certain amount of experience to apply a brushing lacquer without leaving brush marks or ridges that are difficult to rub down. First, using a soft cloth or a brush, apply lacquer thinned by 50 percent to act as a sealer coat. Load a soft brush with full-strength lacquer and, holding the bristles at a shallow angle to the horizontal surface, lay the finish onto the surface with long straight strokes.don t attempt to brush it out like varnish, and avoid going back over the same area twice. Quickly pick up wet edges with fresh lacquer and allow the brush marks to flow out by themselves. Build up two or three coats of lacquer, rubbing down with very fine silicon-carbide paper in between. Each coat usually takes about an hour to dry – but check the manufacturer s instructions, if you are unhappy with the appearance of the final coat, flatten it with sandpaper again and apply a commercial rubbing compound with a soft cloth to buff the finish.

Some experienced woodworkers prefers to use a pull – over solution made from one part cellulose thinner mixed with three parts mineral spirits to put the final shine on nitrocellulose lacquer. This is not an easy technique to perfect and you must take care to avoid stripping the surface by applying too much solution, having flattened the lacquer with silicon carbide paper, moisten a cloth pad with pull – over solution and apply it to the surface, using overlapping circular strokes followed by straight ones in the direction of the grains, as when applying French polish.

Applying acid – catalyzed lacquer

Chemical composition and balance is crucial to the curing of acid – catalyzed lacquer, so it is essential to follow the manufacturer s recommendation for mixing the components and preparing the surface of the wood. Clean the wood well, since the presence of grease of wax, for example, can delay curing for days.

Mix just enough lacquer for your needs, and don't return the residue to the original container or the entire contents will become un usable.

The specific method of application may differ from product to product, but as a rule you can brush a liberal coat of lacquer onto the wood, spreading it with straight parallel strokes along the grain. There is no need to brush it out like varnish – just leave the film to settle naturally. When you are coating a large area, work relatively quickly to blend wet edges before the lacquer starts to set. This will probably take between 10 and 15 minutes .apply a second coat about two hours later and, having rubbed it down lightly with very fine coat two hours after that. For perfect adhesion between coats, try to apply all three in the same day.

If you want a mirror finish, leave gloss lacquer to harden for 24hours, then buff it with a polishing compound on a soft cloth. For a satin finish, rub the gloss lacquer with 0000 steel wool dipped in wax polish then buff with a clean, soft rag.

PREPARING THE SURFACE

Wood must be smooth clean and free from blemishes before you apply a surface finish. Paint may cover minor imperfections, but a clear finish will exaggerate every defect, including fine scratches across the grain. Preparing the surface is the first essential stage of finishing wood.

FILLING HOLES AND CRACKS

When selecting wood you should reject poor – quality materials exhibiting cracks, holes and dead knots, but occasionally it is necessary to accept a less- than perfects sample ,especially when buying wood that is rare or temporarily in short supply even when you have chosen carefully, cracks can open up at a later stage and must be dealt with before you apply a finish.

Using fillers

Press fillers into the blemishes with a small flexible blade, such as an artist s palette knife, or even the tip of a chisel. When the fillers has set had, sand it flush with the surface of the wood isn't satisfactory, touch in the filler with minute quantities of artist s oil paint, using a fine paintbrush. Let the paint dry thoroughly before applying a surface finish.

Removing patches of glue

When gluing joints always wash away excess adhesive from the surface using a cloth dampened with a hot water. If you let the glue set, it seals the wood and will show as pale patches after staining or polishing. Use a cabinet scrapper to remove any spots of hardened glue before finishing.

Sealing knots

Resinous knots will bleed through paint work leaving dark stains on the surface before you apply a primer , pick off any hardened resin, then paint the knots with two coats of shellac- based sealer.

Wood putty

A commercial hole filler is a stiff made to fill small holes and cracks before applying a clear or opaque finish. Although fillers are made in a range of colours resembling various common species of wood , at best you can only expect a close match and the match will hardly even be perfects. However, you can adjust the colour of the filler with a drop of wood stain – but since hole fillers may be water lacquer – or oil – based, make sure you always use a similarly constituted stain.

Cellulose filler

If you are planning to apply an opaque finish, you can fill blemishes with ordinary paint finish, you can fill blemishes with ordinary spackle or water putty mixed to a stiff paste.

shellac sticks

sticks of solidified shellac are ideal for repairing a crack or small knot holes before applying any type of finish. they are made in dozens of wood-like colours.

Wax sticks

Filling sticks of carnauba wax mixed with resins and colouring pigments are used to disguise small worm holes and hairline cracks in wood. It is advisable to use them only for work that is to be wax – polished, as most finishes will not dry over a wax – filled hole. Special wax crayons are made for retouching scratches in polished surfaces.

RAISING A DENT

If dent a work piece, lay a damp cloth over the blemish and apply the tip of a heated soldering iron. The heat generates steam which causes the wood fibers to swell locally lifting the dented section flush with the surrounding surface. Allow the wood to surface before sanding.

Finish is on furniture

While apply any finish to fresh wood, you need to identify the existing finish for reviving the old ones. Knowing what the old finish is makes it easier and more effective to restore it.

Use different solvents to identify what finish has been used on a piece wood as they can dissolve even cured finishes. Make sure to perform the test on the inconspicuous parts of the furniture or items either add a few drops of solvent or chemical on the wood surface or use a swap or dipped in them to perform the test.

Solvent /testing method	Reaction	Type of Finish
Acetone	The swab becomes tacky	Shellac
	The swab becomes beady	Polyurethane
	Finish dissolves	Lacquer
Denatured Alcohol	Finish dissolves slowly	Varnish
	Finish dissolves quickly	Shellac
Lacquer thinner	Finish dissolves	Lacquer, shellac and water – based finishes
	No pronounced	Urethane, alkyd, or Phenolic varnish
Oil	Oil beads on the surface	Shellac ,lacquer, varnish, or polyurethane
Xylene	Removes the coating	Water –based finish
	Doesn't remove the coating	Oil-based finish
Paint thinner/Naphtha/Turpentine	Finish dissolves	Wax
Mineral oil	Waxy yellowish-brown stain	Wax
Simple scratch test	Scratch marks	Wax

Safety precautions for furniture painting & polishing

- Never work without your satery gear
- Aviod wearing baggy or loose clothes as they are more likely to get in the way
- Remove any dangling jewelry or bracelets and ring before starting your work
- Work in a well – ventilated area. The fumes released by the solvents can make you fell suffocated.
- Avoid distractions, especially when you are using power tools
- Make sure to close cans of finishes and thinner immediately after use as they can be highly inflammable
- Label all your finishes and stains to ensure safety
- Use flammable finishes and thinners in small quantities
- Place oily rags, steel wool, and cloths in a metal container with water to avoid causing an accidental fire. Seal the container and dispose it according to local regulations.
- Keep the floor free of cutter and debris.

Wooden Furniture varnishing:

Prepare the wooden surface for varnishing process. The wooden furniture surface preparation method is same for, painting, polishing varnishing, waxing, staining and PU textural creating.

Sanding the wooden surface and apply putty/ sealer if need and then sanding it for levelling the surface of wood select the wooden varnish or tinted varnish. First apply a sealer coat thinned by 10 to 20 percent with sprits. Clean the furniture wooden surface by tack cloth and then use a soft cloth pad to rub it into the wood in the direction of the grain or use brush on the sealer coat. Apply second coat by brush not less than six hours later

Remove the wood dust, using a cloth dampened with mineral spirits (spirits) before brushing or the varnish, apply a third coat varnish by brush as direction given by the varnish manufactures instructions printed on the varnish packing label.

Paint the varnish on to the wood , brushing it in different directions to spread the finishes evenly and blend each new coat with the wet edges of previous applications finally lay off with light strokes in the direction of the don't brush over a coat of varnish.

If the dust particles settle on final gloss surface either rub down and varnish again or modify the finish with steel wool and wax. Dip 0000 steel wool in wax polish and burnish the surface in the direction of the wood grain. Buff the treated surface with a rag to raise an attractive soft sheen free from obvious imperfections.

Furniture polishing:

Wood cleaners and polish can be used to restore the look of wooden furniture. Thoroughly clean the wooden furniture before applying furniture polish on it, wood polish is a great way to remove dust, grime and add moisture back into the wooden furniture. Polish is by combining equal parts white vinegar and lemon juice in a spray bottle vinegar removes greasy finger prints and grime from the wood while lemon juice works as a disinfectant and imparts an appealing fragrance to the wood polish use applied cider vinegar on the dark wood.

Select the wood polish and shake the mixture before application because olive oil and lemon juice have the tendency to separate into two layers always create a fresh mixture of polish , do not store the mixture as it may turn ramlid over a period of time. Only make a small batch of polish which can be used for present work.

Before you polish the furniture, divide the furniture into small section. Add a small quantify of polish on a clean cloth and apply it on one section of the wooden grains and buff the surface to achieve a shine.

Now work on the next section of the furniture do not use too much oil or polish on the furniture as an oily surface woks a dust magnet

The lacquer wood polishes are best varieties of wood polish, the polish deemed as an all rounder. The polish finishes provides for better surface protection and also dries up faster.It also make the wood more durable, and add richness and good looks to it. There are two type of polish mainly used for wooden furniture. They are as follows the surface wooden finish and patching wood finish other type of polishes (1) water based wood polish (2) lacquer wood polish (3) polyurethane polish (4) varnish polish (5) shellac polish (6) oil based wood polish (7) wax based wood polish

Polyurethane polish:

This type of wood finish is considered to be ideal for the kitchen cabinets, cupboard, doors, windows and almost all kinds of furniture and even the flooring this is because of its water resistant properties. The finish is also durable and positively affects the longevity of wooden items. This polish is adding sheen, gloss shine and even the satin and natural aesthetics and appearance to the wooden furniture . This type of polish resist the water and moisture it can be adversely affected by the ultra violet sunrays. Because the finish will turn into a yellow colour in the presence of sunlight after prolonged exposure , its use is not recommended on the outdoor furniture. The finish may also be a cause of cracks

Wax based wood polish:

The wax finishes for wood are available in both paste and liquid forms. They can be obtained from a variety of plants, minerals, and animals sources surface finish may protect the wood from moisture and other adverse agents and enhance its life may to be dissolved in oil before application.

The different wood polish offer different benefit and may suit varying circumstances of the application apply wax polish by warp your fingers with a small piece of denim, vigorously wipe the surface on the wood in 6 inch circle, until the wood and the tenim become warm in your fingers, when wood becomes shinny and warm, move to another spot and rub with authority, overlapping the previous circle until it becomes shiny continue over the entire furniture surface of the wood, burnishing it until the wood is glossy and shiny.

Wipe a thin coat of wax onto the wood every six months to keep it protected. Apply more thin coats with soft cloth and allow 10 – minutes for each coat dry to polish each coat by hard rubbing with soft cloth until desired gloss is obtained

PU coatings:

Polyurethane is protective coating that forms a solid layer of plastic , when applied on a wooden furniture surface. This finish primarily comprises resins that makes it much stronger than standard varnishes or lacquers. It is highly flexible so it works well even on curved surface PU coating gloss goes well with wood, metals, plastic and glass furniture. This coatings help to protect substances from various types of wood defects such as corrosion, weathering, abrasive and other deteriorating process PU polish furniture will last more than 15 years.

Wood textures painting:

With two shades of latest paint and simple acrlic glaze, can apply paint that looks like texture design to all of your favourite accents.

Materials and tools required to wood texture painting

The following tools are required to use painting work

- Painters tape
- Sanding block
- Fine grit sand paper
- Microfiber cloth
- Oil based primer
- Natural bristle paint brush
- Paint roller
- Paint roller cover
- Latex paint (2 shades)
- Synthetic bristles brush
- Paint mixing jar
- Clear acrylic glaze
- Paint pans
- Wood grain rocker
- Paper towels

Prepare the work space for texture paintings cover all surroundings areas with painters tape. Lay down the old news paper beneath the works space to keep sanding debris and paint drops off of floors and furnishings

Use sanding block to lightly sand the project surface sanding will slough off any upright fibres in the board and level out any bumps choose the sand paper in the grit range of 120 to 220 for already smooth surface start with medium grit sandpaper in the grit range of 60to 100 for coarser engineered woods. Use a dry cloth to wipe away the sanding dust when sanding is finished.

- Apply white primer or oil based primer and coat both the top and underside of the furniture surface. Dry the primers completely as per the manufactures instructions.

- Apply base coat of paint that looks like your desired design use a synthetic bristles brush to cover the entire surface in paint. When paint dries apply a second coat and then allows the coat to dry completely.
- In a paint mixing jar combine equal parts clear acrylic glaze and second latest paint pick shape the contents to create a translucent tined glaze latter on apply the glaze.
- Pour the glaze into a paint pan and load a synthetic bristles brush with the glaze apply a thin layer of the glaze that extends the entire height of the project surface.
- Create the desired texture design in the fresh glaze position the texture design a hand tools that create a texture design on painted surface at a top edge of the wood surface. Then slowly drag the rockers down vertically, rocking the desired design curved head of the tool from the top to bottom through the wet glaze until you reach the opposite end of the surface. To change the direction of the texture simply flip the rocker and drag it in the opposite direction. To create variety with larger arches and fine straight grain position a graining comb – a grain texture – along the edge of the sections completed and pull the comb either straight down through the glaze or straight angle.
- Use paper towel to wipe the glaze from the rocker and comb. Then move to the next place of surface and repeat the same steps as mentioned above, if you make a mistake, simple re-glaze the offending area and re-apply the desired design texture continue the process until desired texture covers the entire wooden surface. Allow the glaze to dry completely lastly replace any hardware on the surface and step back to to painted texture finish. (Fig 1)

Fig 1

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Paint on wood texture:

Prepare textured wood surface. Apply wooden primer on the textured surface. Select the paint colour to be applied on the textured wooden surface. Well shake the paint before use it. Use the painters tape to cover the un painted area of the wooden surface. Use the sponge or brush to apply paint for each colour separetely. Apply the paint one by one colour allow dry off time for each colour applications. (Fig 2 & 3)

Fig 2

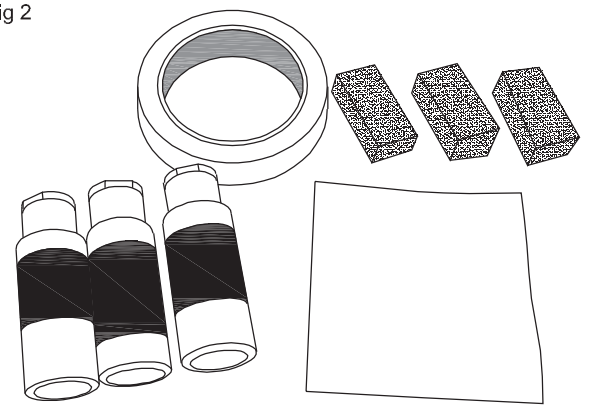

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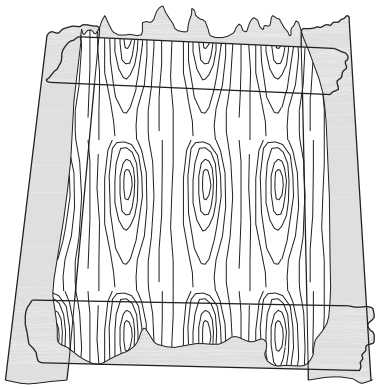
Fig 3



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Powder coating technique

Objectives: At the end of this lesson you shall be able to
- **state the chemical cleaning process**
- **state the type of powder coatings**
- **state the powder coating technique**

Chemical cleanings process:

Surface preparation of the materials to be painted is very important. As high as 80% or more of all coatings adhesion failures can be directly attributed to improper surface preparation. A substrate must be clean before a coating is applied improper cleanings leads to a lower quality painting. The most common forms of surface debris are oils grease that originated from mechanical processing or by chemical processing. Proper surface preparation improves the bond between the coating materials and the surface.

Chemical cleanings methods include wiping the part with a rag dipping the part into a solution or using a spray cleaning system. The cleaner may be alkaline, acidic, neutral, solvents or an emulsion. The particular cleaner and process used will depend on the soils to be removed, the size and substrate materials of the part, the type of coating to be applied and quality goals for the products.

Hand wipe cleanings:

This would involve hand wiping parts with a solvents. Hand wiping of parts is rarely done expect on a spot basis. Hand wiping with clean cloth does not require any capital investment, but it is not effective at soil removal it has a high labour consistent is in content, and any create health and safety problems.

Immersion cleaning:

Cleaning by immersion in solution is often used for small parts in a batch system. Immersion cycle times are typically longer than spray cleaning method chemical immersion systems aids in the overall speed of reaction taking place between the systems aids in the overall speed of reaction taking place between the cleaning compound and the soil. Agitation may be achieved in the tank through air addition or blade mixing. Some dip systems may also use a hoist to lift a basket of parts up and down in the tank to provided agitation. Dip systems require higher chemical concentration than spray systems.

When the parts are lifted up from the chemical solution they may retain some residual chemicals or oil that may float to the surface of the solution. Cleaners used in dip system should be products designed to emulsify oils and allow them to float to the surface. The immersion products are fully wetted and dirt is loosened inside and outside of the part. The use of immersion with spray stages can enhance overall performance.

Hand held spray wand cleaning system:

This system is used to clean parts in a batch powder coating operation and it is used for larger parts that cannot be easily transported through automated systems. This system is used inside a booth . The booth encloses the process, so that the water vapours is captured and exhausted to atmosphere.

Spray wand systems provide flexibility for contact time and angle and the high pressure can remove heavy greases. Higher foaming surfactants may be used, because foam is generally not concern and higher temperatures are possible so it may be easier to melt waxes and greases. This systems cycle times are long and spray wands are not suitable for higher volumes of small parts.

Ultrasonic cleaning:

This type of system utilizes high frequency sound waves to increase the effectiveness of the cleaning chemicals and the agitation at the soil substrate interface on the materials.

Ultrasonic cleaning works very well for cleaning metal surface and they are multimetal safe. This system clean the part throughout these are not line of site devices ultrasonic cleaning method is much higher than conventional cleaning methods as well. cleaning occurs on all surfaces of the object for the entire duration of process. In this system is particularly effective for some porous metals. In this system larger loads cannot be clean as well as smaller loads given the same time frame due to energy absorption.

Recirculating spray washers systems:

Spray washers are the most common way to chemically clean treat a part for application of coating a spray washers uses a series of spray stages that feature different solutions for different task. Each stage of a spray washer consist of the solution tank, the recirulating pump, plumbing for delivery of the solution, a tank heating system, and the gauges and control that operate the system.

The recirculating spray washer is the most efficient process for continuous productions flows. It can handle large volumes of products and provide excellent cleaning and treatment of most parts. The number of stages of a spray washer depends on the substrates to be processed the type of cleaning and other process that will be used, space availability and cost more stages will improve cleaning and finish performance.

Powder coating:

Powder coating is dry finishing process used to apply a dry coating materials. The coating materials is made up of finely ground particles of resin and pigment for colour, along with other additives for specific functions such as gloss or hardness. The dry powder coatings is delivered to a spray gun tip that is fitted with an electrode to provide an electrostatic charge to the powder as it passes through a charged area at the gun tip. The charged powder particles are attracted to a grounded part and are held there by electrostatic attraction until melted and fused into a uniform coating in a curing oven powder coated finishes resists scratches, corrosion ,abrasion, chemicals and detergents and the process can cut coats improve efficiency and facilitate compliance with environmental regulations.

Powder coating requires no air drying or flash off time parts can be racked closer together than with liquid coating systems and more parts can be coated automatically. It is very difficult to make powder coating run drop or sag , resulting in significantly lower reject rates for appearance issues

Powder coating is widely used for office furniture and equipment including file drawers, computer cabinets and desks. Parents use powder coated baby strollers, cribs, playpens, car seats and toys: consumers also own electronic components, bathroom scales, toolboxes, laptop computers, cell phones and fire extinguishers with powder coated components.

Functional powder applications are an ever-growing market where powders are applied to rebaptize used to strengthen bridges, buildings, Retaining walls and roads. Fusion-bonded epoxy powder coatings are applied to protect both the inside (ID) and outside (OD) diameter of gas and oil transmission pipe, valves, potable water applications and springs.

Applications for powder coatings are expanding. More applications continue to develop in the areas of powder on plastic and powder on wood, specifically medium-density fiberboard. Ongoing development in powder coating materials and new methods of applying powder promise even more uses that may be unimaginable today.

Types of coating powders:

There are many different types of powder used, each with their own characteristics and applications making sure the right type of powder and then choose the colour is very important for a successful application. The following types coating powders are used for powder coating

1 **Epoxies**: It is very durable and offer excellent hardness and have arguably the best chemical and corrosion resistance of all available powders.

2 **Polyesters**: It is offers good mechanical resistance, flexibility and impact resistance and good chemical resistance, low cure temperature.

3 **Super durable polyesters**: It is designed to hold their colour and gloss to within set limits for 5 to 10 years it is provide better humidity and corrosion resistance.

4 **Epoxy - Polyesters hybrids:** Epoxies and polyesters are often mixed together to form hybrids, it offer superior weather degradation proper it reduce the corrosion and chemical resistance hybrids are used in some of the same areas that epoxies are used.

5 **Flucro polymers:** It is typically used in architectural items due to their phenomenal weathering properties and world glass colour and glass retention it is good corrosion resistance and excellent weather ability make them extremely popular for exterior architectural applications (windows doors)

6 **Urethanes:** It is similar to polyesters with a difference in curing agents urethanes offer a very smooth finish and very good exterior durability as well as excellent chemical and corrosion resistance urethane paint is that at higher mil thickness it can begin to outgas and become bristle.

Most commonly used powdered metals:

Various industries are used the different kind of coating materials. Most commonly used powder metals as follows.

- Zinc powder
- Tin powder
- Back and red cupric oxide
- Nickel powder
- Iron powder
- Granular powder
- Cadmium oxide powder
- Various industries will use different kinds of coating materials most commonly used powdered metals.
- Bismuth powder
- Aluminium powder

Varying particle size distributions are wide ranging when it comes to the application of these sprayed powders.

The thermal spray coating process though commonly associated with the spraying powders can involve the application of non-metallic materials, plastic, ceramics,allows and composites can also be thermal sprayed onto a surface.

Thermal sprayed variations:

Various substance that can be thermal sprayed. These are include the following

- Cold spraying
- Warm spraying
- High velocity air fuel spraying
- High velocity oxy- fuel coating spraying
- Flame spraying
- Wipe arc spraying
- Detonation spraying
- Plasma spraying

Types of powder coating: Systems

There are two types of powder coatings system used in industry

They are as follows

1 Thermoplastic powders melt flow system

2 Thermosetting powder coatings

Steps to powder coating

The first step in the powder coating process is to prepare or pretreat the parts. The product to be coated is exposed to cleaning and pretreatment operations to ensure that surfaces to be coated are clean and free of grease, oils, dust, rust and other contaminants. Chemical pretreatment normally takes place in a series of spray chambers. Parts are cleaned by using chemicals after the chemical pretreatment process is complete.The parts are dried in a low-temperature dry off- oven they are then read to be coated.

Mechanical pretreatment such as sand or short blasting can be used. In this method high velocity air is used to drive sand grit or steel short towards the substrate, developing an anchor pattern on the part that improves the adhesion of the powder coating to the substrate mechanical cleaning is useful for removal of inorganic contaminants such as rusts mill scale and laser oxide.

mechanical blasting can be used along with a chemical treatment. The blast operation create an excellent surface for bond, best does not add any additional corrosion protection.

Powder deliver system:

Powder coating materials uses a spray device with a powder delivery system. Use a powder spray booth with a powder recovery system is used to enclose the application process and collect any over sprayed powder. Powder delivery systems consist of a powder and air into hoses or feed tubes. Some feed hoppers vibrate to help prevent clogging or clumping of powders period to entry into the transport lines electrostatic powder spray system.

Electrostatic powder's spray system:

Electrostatic powder spray guns direct the flow of powder. They use nozzles that control the pattern size, shape and density of the spray as it is released from the gun. This type of spray gun can be either manual or automatic. The charge applied to the powder particles encourages them to wrap around the part and deposit on surfaces of the product that are not directly in the path of the gun. The insulator strips electrons from the powder, producing positively charged powder particles powder coating can also be used by a bell or rotary atomizer the powder bell provides a high level of charging efficiency and transfer efficiency. The large pattern from the bell is very efficient for coating larger parts.

Dip powder coating:

In addition to powder spray applications with electrostatic guns, powder coatings materials can be applied by a dip method or fluidized bed method. In this system parts are preheated to 450°- 500°F and then dipped into a tank filled with powder materials that has been fluidized by addition of compressed air through a porous membrane at the bottom off the tank. Some cases the powder is eletrostatically charged

Flame spray applications: The flame spray, is used to apply thermoplastic powder materials, powder is propelled through the flame in a heat gun using compressed air. The heat of the flame melts the powder, eliminating the need for ovens.

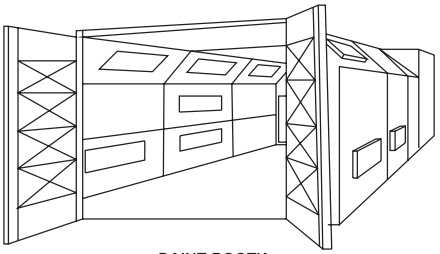
Hot flocking method:

In this process, the part to be coated is preheated so that the sprayed powder will gel when it comes in contact with the hot part surface. Hot flocking is often used for functional epoxy applications. Because it builds a thick film that will provide exceptional performance these fusion- bond epoxy products are often used to coat valves and pipe used in extreme conditions such as oilfield or offshore application.

Powder spray booths:

powder spray booths are designed to safely contain the powder over spray. Booths entrance and exit openings must be properly sized. Booths air flows through must be sufficient to channel all over spray to the recovery system but not so forceful that they disrupt powder deposition system retention on the part. (Figs 1- 5)

Fig 1



PAINT BOOTH

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Fig 2

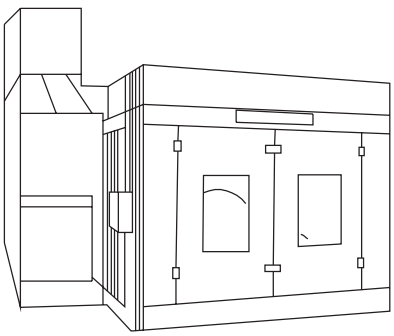

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Fig 3

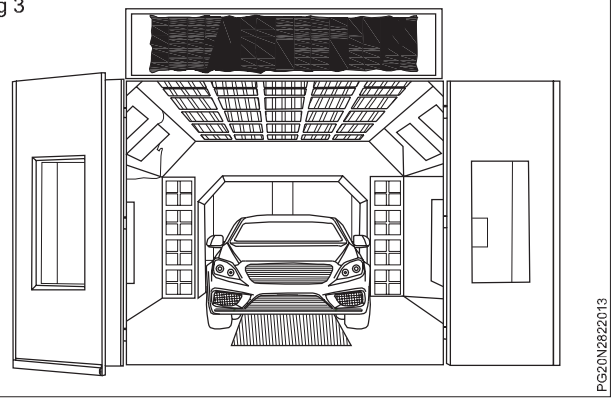

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Fig 4

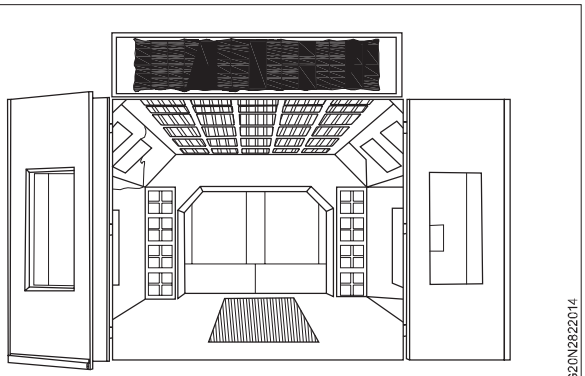

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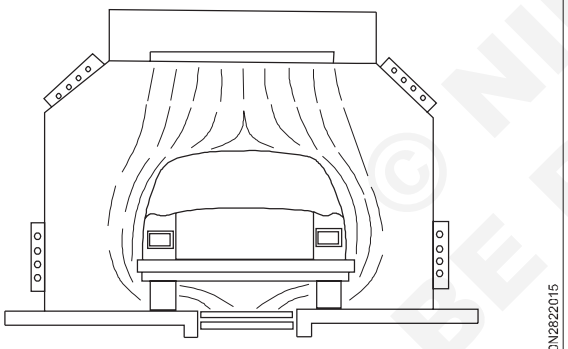
Fig 5



AIR FLOW IN A DOWN-DRAFT BOOTH

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Powder spray booths designed for limited protection batch operations, where parts are conveyed through on some type of hanger. Batch booths are used for coatings individual parts or groups of parts that are handled hung in a single hanger, rack or cart, conveyorized booths can provide continuous coating of parts hung on an overhead conveyor line in medium – to high protection operations

Flat line booths and conveyor systems are used for one sided coating of sheet metal and similar parts of minimal thickness. Flat line booths use a horizontal conveyor that passes through the powder booths carrying the part to be coated on its surface.

Properly designed, operated and maintained powder systems can allow colour changes in anywhere from 45 minutes to less than 15 minutes. Booths can include spec features that facilitate colour changes such as non-conduction walls that repel rather that attract powder, curved booth walls to discourage powder accumulation and automated belts or sweepers that brush powder particles to the floor and into the recovery systems.

Fast colour change can also be facilitated using blow-off nozzles set up at each gun barrel and easily changed connections at the back of the gun outside the booth. Guns can have the outside of the barrels blown off automatically and also use an automated purge system for the interior of the hoses and gun barrels.

Powder recovery

Thermoset powder materials require a certain amount of thermal energy applied for a certain time to product the chemical reaction needed to crosslink the powder into a film. The powder materials will melt when exposed to heat, flow into a level film and then begin to chemically crosslink before ultimately reaching full cure. Various methods can be used to supply the energy needed for cure.

Convection ovens that use a heat source, usually natural gas, a fan and air distribution duct to circular air inside the oven and heat the part, are the most common type cure oven used for powder. as the part reaches peak temperature it will conduct heat into the coating and cause the powder to cure.

Infrared (IR) ovens, using either gas or electricity as their energy source emit radiation in the IR wavelength band. This radiated energy is absorbed by the powder and substrate immediately below the powder without heating the entire part temperature. This allows a relatively rapid heat rise, causing the powder to flow and cure when exposed for a sufficient time. Parts can be cured in less time in an IR oven but the shape and density of the part can affect curing uniformity.

Combination ovens generally use IR in the first zone to melt the power quickly. The following convection zone can then use relatively higher airflow without disturbing the powder. These higher flows permit faster heat transfer and a shorter cure time.

A variety of radiation curing technologies are available, including near- infrared, ultraviolet (UV) and electron beam (EB). These process have the potential to open up new applications for powder coating of heat-sensitive substrates such as wood, plastic parts and assembled components with heat-sensitive details.

UV curing requires specify formulated powders that can be cured by ultraviolet light. The powder first needs to be exposed to enough heat so it is molten when exposed to UV energy: the initial heat source is typically infrared but convection heating can also be used. The coating is then exposed to a UV lamp. A photo-initiator in the coating materials absorbs the UV energy and converts the molten film to a solid cured finish in a matter of seconds.

Near-infrared curing also uses specially formulated powders coupled with high-energy light sources and high –focusing reflector systems to complete the powder coating and curing process within several seconds. Heat-sensitive assembled parts such as internal gaskets, hydraulic cylinders, and air bag canisters can benefit from this technology.

Powder coating process:

- Sand blast the materials and clean the parts and ready to hang in the powder coating unit.
- Preheat the part if required for five minutes. This is typically only necessary for thicker steel pieces and allows the 20 minute time frame for heating after the powder coat has been applied.
- Take the receptacle and pour in an appropriate amount of powder coat for job.
- Turn the knob variable (KV) adjustment knob and powder feed adjustment knob all the way down (bottom of the powder spray gun), turning both counter – clock wise as far as they can go.
- Plug in powder coating gun
- Attach the ground clamp firmly to the rack that the parts will hang from covering as much surface area as possible.
- Attach the receptacle with the powder coat to the gun and screw on the receptacle as right as possible.
- Attach the powder feed line to the powder spray gun.
- Adjust the KV adjustment knob and the powder feed adjustment knob you net right disbursement of powder coat. Ensure for a good cloud of powder coat when the trigger is depressed and make sure the fan is on.
- If the parts are preheated, remove them from the oven if they were not preheated there is not need to wear heat gloves to handle them. Hang the parts on the rack
- Turn the parts around and spray on it, there will be a fair amount of powder coat applied because the powder that passed the part would be attached to the back. spray the remaining areas of the part
- Transfer the parts from the rack to the oven latch the door and wait for 20 minutes.
- After 20 minutes, remove the parts from the oven and hang them to cool down. Likely on the powder coat racking ensure the powder coating finish have a nice smooth finish
- Connect the air and dry spray the parts to remove excess powder coat from all equipment ensure the powder coating is easily blown away.

Paint surface testing

Objectives: At the end of this lesson you shall be able to
- state the different types of paints
- state the paint surface testing equipments
- state the paint surface testing methods
- state the use and care of the testing equipments.

Paints: Paint usage has environmental impacts at all stages of all life cycle, including manufacturing application and eventual disposal. This lesson reviews different types of paints, coating applications painted surface testing equipments and its usage. Types of painted surface testing methods and care of the testing equipments

General steps for paintings and coating applications

- Substrate surface preparation
- Application of the coating
- Drying of the coating.

Functional of paint:

Paint is used for protect the metal/wood/ plastic or any other type of materials based objects from corrosion weather condition decoration purpose. The paint is widely used as materials for covering surfaces for decorative in different colours and protective purpose only

Properties of ideal paint:

- Ease of application
- Good flow out application marks
- Forming continuous protective film
- High opacity
- Quick drying
- Corrosion resistance
- Water resistance
- Heat resistance

Types of paint:

There are various types of paints are used for surface coating they are as follows

- Water based paints
- Oil based paints
- Acrylic paints

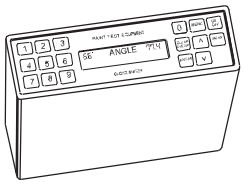
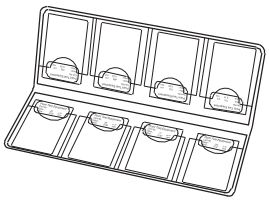
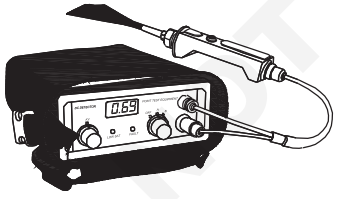
These paints all have different method and have different techniques used for paint coatings water colour are so easy to explore and they are easy wash off by hands and cloths.

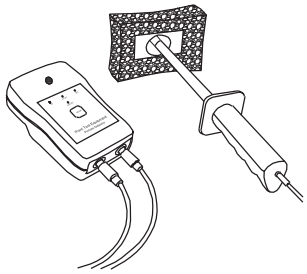
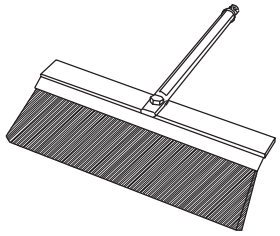
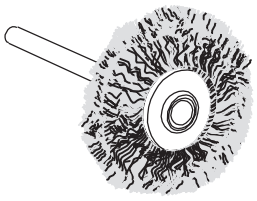
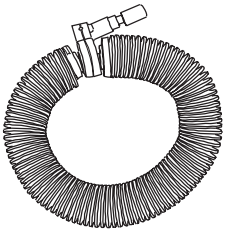
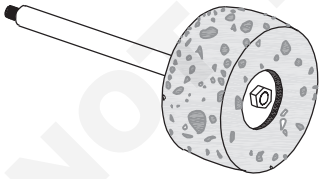
Acrylics are good and easy to work and thicker than water colour, It is easy to control when painting. Acrylic paint is dry quickly.

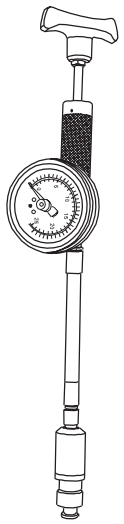
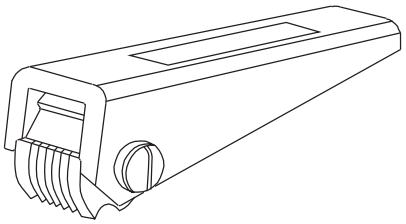
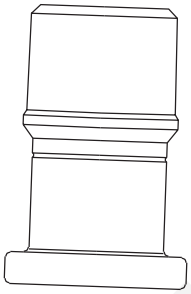
Oil paints are the thickness paint and easier to control. But it takes much time to dry

Paint testing equipments:

Various types of painted surface testing equipments are used for testing a quality of paint coating on the objects surface. The following equipments are used for painted surface testing.

List of Paint Testing Equipment		
1	Coating thickness Meter	DETERMINATION OF FILM THICKNESS
	ISO 2808: PAINT AND V ARNISHES	ISO 19840: CORROSION PORTECTION OF STEEL STRUCTURES BY PROTECTIVEPAINT SYSTEMS
		MEASUREMENT OF, AND ACCEPTANCE CRITERIA FOR, THE THICKNESS OF DRYFILMS ON ROUGH SURFACES
		The paint test equipment coating thickness meter easily measures all coatings on metallic substrates using the magnetic induction or eddy current principles, ensuring the correct coating thickness has been applied.
		It is one of the most advanced coating thickness meters on the market, using up-to-date technology in a robust portable instrument and incorporating all the following user functions through a menu – driven back-lit display.
2	Gloss meter	DETERMINATION OF SPECULAR GLOSS OF NON-METALIC PAINT FILMS AT 20 DEGREES AND 60 DEGREES
	ISO 2813 Paint and varnishes	Gloss and haze measurement is essential where an aesthetic appearance of the coating finish is required and to ensure uniformity of the surface finish.
		
3	Calibration foils	Calibration foils are required for the calibration of coating thickness meters.
		Each individual calibration foil is measured in the centre and the value is printed on the attached label.
4	Holiday detector	CORROSION PROTECTION BY PROTECTIVE PAINT SYSTEMS.
	ISO 29601: PAINTS AND VARNISHES.	ASSESSMENT OF POROSITY IN A DRY FILM
		SO 27466: VITREOUS AND PORCELAIN ENAMELS.
		ENAMELLED ARTICLES FOR SERVICE UNDER HIGHLY CORROSIVE CONDITIONS.
		HIGH VOLTGE TEST
		The holiday detector is a DC voltage holiday detector for detecting pinholes and flaws in insulated coatings on conductive substrates.
		Where coatings have to provide an effective safeguard against corrosion, it is essential that any pinholes or flaws that will eventually lead to corrosion are detected at the earliest possible stage, preferably immediately after the coating application.
		The test voltage is of high impedance, enabling safe testing, and does not damage or cause burn marks to the coating.
		Operation is by the test voltage being applied to the coating by moving a brush electrode across the surface and where there is either a pinhole or flaw, the voltage will spark through the coating, a red indicator will flash and an audible alarm will sound.
		The detected flaw can be marked for subsequent repair, and testing resumed for the remaining surface area.

5	Pinhole detector	ASSESSMENT OF POROSITY IN A DRY FILM
	ISO 29601 : PAINTS AND VARNISHES.	ISO 8289:VITREOUS AND PORCELAIN ENAMELS.
		LOW VOLTAGE TEST FOR DETECTING AND LCOATING DEFECTS.
		The pinhole detector uses the wet sponge principle to detect through pinholes, cracks and damaged areas on non-conductive coatings on conductive substrates
		These flaws would eventually lead to corrosion and premature failure of the coating.
6	Broad brush	Brass –filled brushes for the testing of coatings on large flat areas using the holitech holiday detector.
		
7	Circular brush	Brass-filled circular brushes for the testing of coatings on the internal diameter of pipes using the holitech holiday detector
		
8	Rolling spring	¾ phosphor bonze rolling spring for the testing of coatings on the external diameter of pipes using the holitech holiday detector.
		
9	Circular sponge	Circular sponges for the testing of coatings on the internals of pipes using the pintech pinhole detector.
		
10	Adhesion tester	
	ISO 4624: PAINTS AND VARNISHES.	ASSESSMENT OF, AND ACCEPTANCE CRITERIA FOR, THE ADHESION /COHESION (FRACTURE STRENGTH OF A COATINGS.
	PULL OFF TEST FOR ADHESION	Part 1 : PULL –OFF-TESTING.
		The adhesion tester is one of the most accurate and versatile adhesion testers currently available
		It is measures the adhesion bond strength of applied coatings with ease and precision.

		he adhesion is measured by the tensile pull on a dolly glued to the coating surface
		The force is applied through the centre of the dolly by a hydraulically loaded pin.
		This ensures an exactly central point-loading of the force
11	Cross hatch cutter	
	ISO 2409: PAINTS AND VARNISHES.	ASSEMENT OF, AND ACCEPTANCE CRETERIA FOR, THE ADHESION/COHESION (FRACTURE STRENGTH) OF A COATING
	CROSS –CUT TEST	CROSS-CUT TESTING AND X-CUT TESTING
		The cross hatch cutter is a multi-blade cutting tool which enables an assessment to be made of the adhesion resistance of coatings to separation from substrates when a right-angled lattice pattern is cut into the coating and penetrates through to the substrate.
		The coating thickness determines the cutter size used.
		The 1mm cutter is suitable for coatings under 60 microns. The 2mm cutter is suitable for coatings over 60microns.
12	Flat Adhesion dolly	Stainless steel adhesion test dolly for flat surface testing using the hate adhesion tester.
		

Testing and Inspection of paints:

The paint users are attach much importance to choice of paint schemes and the quality of paints they approaching to identify the coating material quality and the surface coating testing, whether the paint is properly applied by the applicator, so that the user achieves the expected performance of the coatings. Different types of testing equipments and test methods are used for painted surface coating.

Paint surface testing methods:

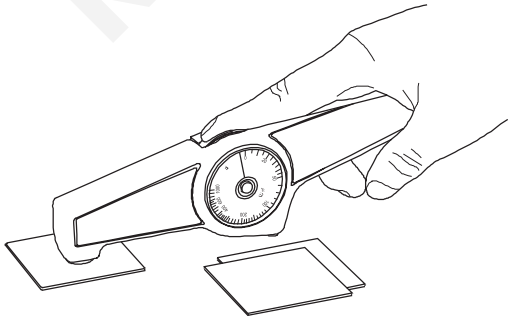
The following test method are used to provide basic information, which can be useful in determining the current condition of the applied paint system.

- Paint thickness test
- Salt spray test
- Pull off test
- Cross cut test
- Wear resistance test
- Abrasion resistance
- Condensing humidity test
- Scratch resistance test
- Scrape adhesion test
- Paint hardness test
- Impact resistance test
- Gravel damage test
- QUV test
- Outdoor exposure test

Checking paint thickness

When preparing a surface in a poor condition, one of the first steps to take to measure the thickness of paint film. The thickness of paint is very important because the application of excessively thick top-cots, a practice that is prevalent in many areas, may result in the paint film wrinkling or cracking. Low gloss, water spotting , poor dry, and many other film effects that spoil what could be a first quality refinish job. A thick top coat could cause the vehicle to be restore, which will be very costly due to difficulties in removing the excessively thick top coat by stripping or standings.(Fig 1)

Fig 1

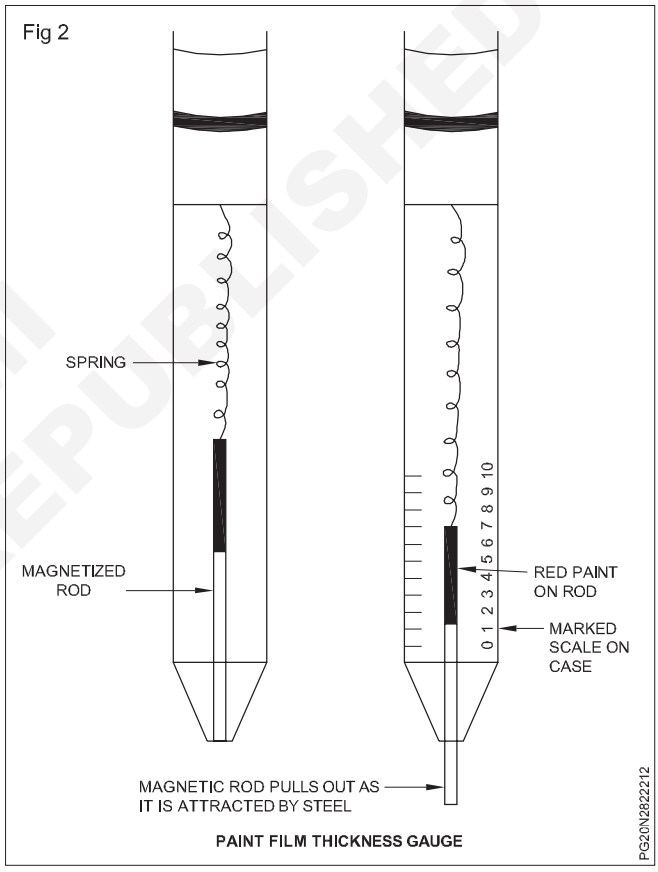


Paint thickness gauge

Paint thickness gauges are important tools in a paint shop because they are used to measure the thickness of the paint film on a vehicle. How else can an estimate be properly done but by measuring the film thickness. If the film is too thick, extra funds will be required to cover the cost of stripping the vehicle before repainting.

Many different types of gauges are sold by industry, but very common and inexpensive is the gauge with a magnetic rod that is attracted to ferrous metals, to use, the protective cover is removed: a window on each side of a housing is exposed in which a magnetic rod is attached at the end to the housing by a spring (Fig 2). One side of the rod is marked in thousands of an inch (Or mils): the other side is marked in the SI equivalent.

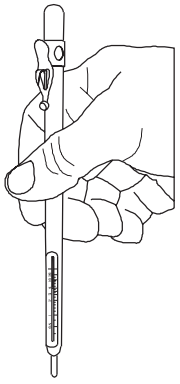
Fig 2



The gauge is held at right angle to the surface as in Fig 3. The area to be tested must be free of dirt, grease, oil, or ferrous metal chips. The magnet end of the rod in the gauge is touched to the surface, and the gauge is then lifted smoothly and slowly away from the surface. The rod making must be watched as the gauge is pulled up. When the magnetic end releases from the surface, its location shows how thick the paint film application is on the metal underneath the paint film. On heavily coated metal, the magnet attraction is less and the rod will let go sooner. On bare of very thinly covered metal, the magnetic strength is greater: therefore, the housing will have to be pulled higher before it releases and registers the mil thickness. The paint should be measured in several areas.

Paint film thickness gauges are available from some paint jobbers and for different prices depending on their construction.

Fig 3



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Humidity testing

Water vapour is one of the most severe agents to which a paint film is exposed. Because water molecules are small and binder molecules are constantly vibrating, moisture can easily penetrate lightly pigmented paints. Water also penetrates heavily pigmented primer penetrate lightly at a much slower rate.

Moisture in a paint film can be warmed by sunlight or other sources of energy. When warmed, it will tend to vaporize and exert a pressure that causes the film to swell, if the film is flexible or if the water occurs near a spot of grease or salt crystal under the paint, the swelling will be more severe, possibly causing failure or discoloration of the film.

The condensing humidity test is widely used to measured humidity resistance. In this test, water vapour is allowed to condense on sample panels. The condensed water drips off the panel and is revaporized by means of an evaporative heater in the bottom of the test chamber. A typical test involves water at 60° C (147°F) for 24 h. After testing, panels are checked for blistering, colour changes, and loss of gloss.

Another humidity test involves exposing the panels to 100% relative humidity at 38°C (100°F) for 24 h.

Neither of these tests can provide service life predications. However, they are useful for determining the best paint form a series of formulation

Salt spray testing

The use of salt solution spray testing in an attempt to accelerate the corrosion process and cause early paint failure. Panels are usually exposed for up to 14 days to a mist of 5% (w/v) sodium chloride solution at 33-35°C (92-97°F). The mist is producted by blowing hot saturated air though a 5% salt solution.

The panels are evaluated for two types of corrosion:

1 Rust – through – the percentage of the surface, which has rust visible through the paint

2 Creep – the distance in 1/32 of an inch (0.8mm) from the center of the scribe line that the paint film breaks down and separates from the substrate.

The results are measured on scale with a predetermined point described as failure in number of hours of exposure. Sometimes, acetic acid is added to the salt spray solution to accelerate the corrosion.

Salt spray testing has been used as a standard for performance by many coaters from all different types of industry. It is poorly understood and not necessarily reliable as a predictor of field service. The most important value of salt spray testing is comparison of different pretreatment methods and coatings to see what appears to be the best combination for corrosion resistance. In all cases, the salt spray comparison should be done with same steel panels and the same test cabinet.

One weakness with the results of a salt spray test is the substrate itself. Steel quality varies substantially and the failure in the salt spray test may be due to poor steel, not pretreatment or the paint film. For this reason, it is very important to always run standard quality panels as a control.

Another factor to consider when evaluating the pretreatment or paint film is the cure cycle. If the paint film is not fully cured, it can cause failure in the salt spray test that may be blamed on the pretreatment process or the paint. the cure of the film should be confirmed before the panels are tested in salt spray.

Scrape adhesion test

The scrape adhesion test measures the determination of the adhesion of organic coatings when applied to smooth, flat panel surfaces. It is helpful in giving relative for a number of coated panels showing significant differences in adhesion. The materials being tested are applied at uniform thickness to flat panels, mainly some sort of sheet metal. When the materials have dried the adhesion is determined by pressing panels under a rounded stylus that is loaded with increasing amounts of weight until the coating is removed from the substrate surface.

Pull – off test

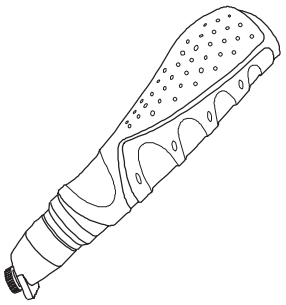
The adhesion of a coating or several coated sample of any paint product is measured by assessing the minimum tensile stress needed to detach or rupture the coating perpendicular to the substrate. Unlike the other methods, this method maximizes the tensile stress therefore results may not be comparable to the other. The test is done by securing loading fixtures (dollies) perpendicular to the surface of a coating with an adhesive. Then the testing apparatus is attached to the loading fixture and then aligned to apply tension perpendicular to the test surface. The force that is applied gradually increases and monitored until a plug of coating is detached, or a previously specified value is reached.

Cross – cut test

The cross-cut test is a method for determining the resistance of paints and coatings to separation from substrates by utilizing a tool to cut a right angle lattice pattern into the coating penetrating all way to the substrate.

A Quick pass/fail test can be accomplished through this method. When testing a multi – coat system,

Fig 4



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determination of the resistance to separation of different layers from one another can be accomplished.

There are two methods described in the ASTM specification:

ASTM D 3350 test method A

An X- cut is made through the film with a carbide tip tool to the substrate, pressure –sensitive tape is applied over the cut. Tape is smoothed into place by using a pencil eraser over the area of the incisions. Tape is removed by pulling it off rapidly back over itself as close to an angle of 180°. Adhesion is assessed on a o to 5 scale.

ASTM D 3359 test method B

A crosshatch pattern is made through the film to the substrate. Detached flakes of coating are removed by brushing with a soft brush. Pressure –sensitive tape is applied over the crosshatch cut. Tape is smoothed into place by using a pencil eraser over the area of the incisions. Tape is removed by pulling it off rapidly back over itself as close to an angle of 180° .Adhesion is assessed on a o to 5scale. (0- greater than 65% area removed & 5 is 0% area removed)

Paint adhesion testing

Paint adhesion testing is often used to determine if the paint or coating will adhere properly to the substrates to which they are applied.

Wear resistance test:

The undesirable painted surface appearance is often cause due to the expose to the external elements, scratches not only greatly reduce the surface aesthetics of a coated product but can lead to premature failure of the substrate.

The resistance of a coating to scratch and mar is called abrasion resistance. The abrasion resistance of coating provides information about the ability of coating to with stand damages due to abrasive materials such as sand, dirt, chipping and scouring brushes.

Abrasion resistance is a basic factor in the durability of a coating abrasive resistant coatings are widely used to reduce or eliminate wear and thus extend the life time of coated parts.

Abrasion testing of coatings should be done routinely and used as the basis for comparison of a coatings mechanical performance. These tests assess the ability of a surface coating to with stand scratching and overall durability.

Many types of abrasive media and treatment are used for testing. Fast and slow movement, smaller or large load, high and low temperature, constant or intermittent contact. Commonly following methods are used for abrasive resistance test

- Rotating wheel method
- Falling sand method
- Abrasive blast method
- Gardner wet abrasive method (used with emulsion paints)

Abrasive blast test method covers the determination of the resistance of organic to abrasive produced by abrasive blasting on coating applied to a plane, rigid surface common standards associated with abrasive blast method.

- ASTMD 7127 standard test method for measurements of surface roughness of abrasive blast cleaned metal surfaces using portable stylus instrument
- ASTMD 7055 standard practice for preparation of hot rolled carbon steel panels for testing of coatings.

Scratch resistance test method:

Scratch resistance tests asses the ability of a surface coating to withstand scratching. A needle with a spherical steel point ,carrying a predetermined weight is lowered onto the paint film and drawn across the surface at a set speed.

This method has been used in the paint industry for many years. The common standard associated with scratch resistance test method

- ASTMD7027 standard test method for evaluation of scratch, resistance of polymeric coatings and plastic using an instrumented scratch machine.
- ASTMD 7187 standard test method for measuring mechanistic aspects of scratch behaviour of paint coatings by nanoscratching.

ASTMD = American standard test materials damage

Paint hardness test: Paint hardness of paint film is important because it is related to brittles and water permeability. Films that have been cured or under cured can often be detected by harness testing.

Pencil hardness tests measure resistance hard to indentation by a series of increasingly hard pencils that have been sharpened to a chisel points . The higher hardness of the pencil lead required to make a gauge into the paint harder the film indentation hardness tester measure film penetration in a specified time by a metal tip under certain mechanical loading condition. The time factor is important since many points deform gradually under load.

Impact resistance test:

Impact resistance testing usually involves striking a painted panel with a hard object. Such as a steel ball or hammer and measuring the identation that results in this

method a standard weight is dropped from height onto a coated panel the identation is inspected to detect if the coating has cracked the weight can be dropped from different height and the result are then measured inch-pounds. The goal is to see how many inch-pounds the coating can take without cracking.

Quality ultraviolet (QUV testing):

In this test coated surfaces are placed inside the chamber and subjected to alternating cycles of light and misture at controlled elevated temperatures painted surface can be measured for resistance to chalking fading, colour fastness ,cracking blistering ,embrittlement strength loss and oxidation.

The QUV test chamber provides a more accurate comparison of different process and materials than slat spray testing alone. This type of test more helpful in evaluating the affect of outdoor exposure on different coating materials and a somewhat better predictor of actual field life.

Outdoor exposure test:

Outdoor exposure tests are slow but they are the best way to predict weather ability. The most common defects turned up by exposure testing are fading cracking ,chalking, blistering and peeling. Often a portion of the panel is buffed after testing to see to what extent the original appearance can be restored.

Exposure tests are usually conducted in a sunny climate to get the maximum ultraviolet radiation effect painted surface are usually exposed 5° from the horizontal facing south. The test panel is held in a clamp that shield the top portion of the painted surface panel from exposure. Mirrors and mechanical devices are sometimes used to accelerate the exposure and produce earlier results.

Gloss test:

Gloss is often measured with photo electric device the light reflected is converted to an electric signal by a photo tube the strength of the signal proportional to the amount of light reflected. The reflected light when compared to the original light falling on the surface is measure of gloss. There are a number of test variations the angle of reflection may be 20°45°, 60°,90° or some other value usually, the gloss value is compound with a previously established ISO standard.