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PAINTS AND
COATINGS
SKILL COUNCIL

Participant Handbook

Sector
Paints and Coatings

Sub-Sector
Application

Occupation
Industrial Paint Application

Reference ID: **PCS/Q5108, Version 2.0**
NSQF Level 4

General Industrial Liquid Painter

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PAINTS AND COATINGS SKILL COUNCIL

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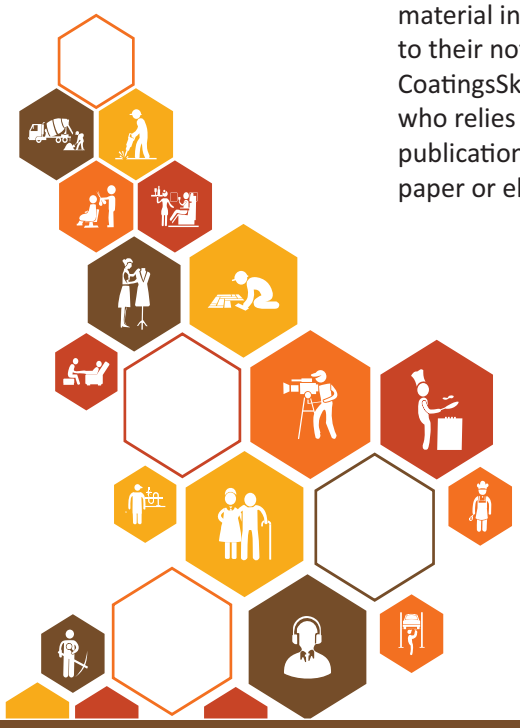

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Prime Minister of India

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PAINTS AND COATINGS SKILL COUNCIL

for

SKILLING CONTENT : PARTICIPANT HANDBOOK

Complying to National Occupational Standards of
Job Role/ Qualification Pack: **'General Industrial (Liquid Painter)'** QP No. **'PCS/Q5108 NSQF Level 4'**

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Authorised Signatory
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We would also like to acknowledge here the long hours spent by our colleagues in editing and improving the drafts to make the final work more reader friendly and compact

Paints and Coatings Skill Council

About this book

This Participant Handbook is designed to train participants for the job 'General Industrial (Liquid Painter)', a NSQF approved level 4 qualification covered by QP reference no. PCS/Q5108.

The individual at work assesses the metal section, understands colour, chemistry and finish required by the customer, prepares part for liquid paint application and coats it using recommended tools and machines to achieve the desired finish as per company's standards or customer's requirements.

This QP consists of 8 NOS, each dealt under a separate unit as follows

1. PCS/N5105 Prepare for coating.
2. PCS /N5106 Pretreat the section to be coated.
3. PCS/N5107 Apply the topcoat and finish the surface.
4. PCS/N5108 Maintain jigs, tools and machines.
5. PCS/N9901 Coordinate with colleagues and/or customers.
6. PCS/N9902 Maintain standards of product/service quality.
7. PCS/N9903 Maintain Occupational, Health and Safety standards and follow environmental norms.
8. PCS/N9904 Maintain IPR of organisation and customers.

Symbols Used

Key Learning Outcomes

The key learning outcomes are listed at the beginning of each module. These outline the focus areas that the learners will cover in every module.

Tips

Wherever possible, tips are included in every module. They provide additional insight to learners on a particular topic being discussed.

Steps

These provide step-by-step instructions for a specific process.

Notes

Notes at the end of each module is a space for learners to list down their key points related to the topic.

Summarize

These provide the summary or the takeaways of the unit.

Unit Objectives

These are listed at the beginning of each unit under every module. They highlight the focus areas that the learners will cover in every unit.

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PAINTS AND
COATINGS
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1. Introduction

Scan the QR code for video

Key Learning Outcomes

At the end of this module, you will be able to:

1. Know about the sector: Discuss the Paints and Coatings sector in India and its sub-sectors
2. Know about General Industrial (Liquid) Painting, its benefits and features.
3. Study the drawing and production plan, the coating required, verify the details with the customer and prepare for jigging.
4. Demonstrate how to clean the substrate, load the sections/ components on the conveyor and perform pre-treatment.
5. Demonstrate how to prepare the paint for application, apply the paint on the surface and finish the surface.
6. Maintain pre-treatment baths and paint booth, tools, equipment and materials required.
7. Demonstrate various skills: Performance of behavioural, professional, technical and communication skills
8. Understand safety: Work in a safe manner without endangering your health and that of your colleagues
9. Secure company's IPR and respect customers' copyright.

UNIT 1.1 About Paints and Coatings Sector in India

Unit Objectives

At the end of this unit, you will be able to:

1. Explain what paints and coatings are
2. Describe the purpose behind the use of paints

Paints are present all around us. Wherever we look we see paint in some form – on walls, doors, floors, furniture, fans, cell phones, gas cylinders, cars, computers and laptops, motorcycles and scooters, trains and buses, shop signage and road signs, bridges, electric poles, pipelines — the list goes on. As you see, there are very few articles or items that we see or use in our daily lives that do not carry some coating orthe other. You will be surprised to know that even metal cans that are used to pack food and beverages, glass bottles carrying soft drinks and other products, metal tips of shoe laces, door knobs and handles, airport runways and factory rooftops, aeroplanes and ships – all have coatings applied on them for protection, indication or decoration. The paint industry adds so much colour and convenience to our everyday lives that it would be difficult to imagine a world without it! As you look around and see the universal presence of coatings everywhere, you would also realise that the paint and coatings field is quite complex.

What is the purpose behind the use of paints? Decoration is certainly one important reason why paints are used. They lend colour and beauty to objects on which they are applied and greatly increase their visual appeal. An equally important reason for the use of paints is protection. The life of products, especially those made of metal or wood is enhanced if an appropriate coating is applied on them. The universal use of iron and steel on various industrial and household products would be unthinkable in the absence of coatings to protect them. Likewise, Wooden furniture and articles are known to last centuries if they are protected by regular application of coatings on them. Our ancestors understood this, which explains why varnishes and lacquers are as old as civilisation itself.

Coatings are also used for “indication”. All of us are aware that red is a colour used to indicate danger or fire and hence fire tenders, stop signs and caution/danger signals are invariably painted red. Ambulances and hospital furniture are always painted white while school buses are yellow. You will find that paints help to identify and make life convenient for us. White road marking, red post boxes, green park fencing, black and yellow taxis and auto rickshaws – one can think of many such examples.

Paints also help to improve cleanliness and hygiene. Coatings with antifungal properties help to keep walls in homes and buildings free from fungus especially in damp weather. Coatings used in food cans prevent the contents from spoiling and serve as a protective barrier. Coatings can even help retard fire or enhance the protection against fire. Thus, there are many uses for paints and coatings in our everyday life.

While the common person sees it as being colourful with a great deal of variety, to the technical people formulating and making paint and to those who apply it on surfaces, it is a complex world—of different chemistries and technologies, of a range of demanding and often conflicting requirements of many application challenges and steadily increasing customer expectations.

Fig 1.1: Paints are used everywhere

Notes

UNIT 1.2 Classification of Paints and the Coatings Industry

Unit Objectives

At the end of this unit, you will be able to:

1. List different types of paints

Broadly, paints are of two types, viz. decorative and industrial.

Decorative paints consist mainly of products that go on interiors and exteriors of buildings as well as on furniture items to make them look aesthetically pleasing. Industrial paints include a wide variety and are further classified under various subgroups, such as Automotive OE, Automotive Refinish, Powder Coatings, General Industrial, Coil Coatings, Protective and Marine Coatings, Packaging Coatings etc.

DECORATIVE	INDUSTRIAL
Building Exteriors	Automotive OE Finish
Building Interiors	Automotive Refinish
Furniture	Powder Coatings
	General Industrial Paints
	Coil Coatings
	Protective Coatings
	Marine Coatings
	Packaging Coatings

Notes

UNIT 1.3 Basics of Paint Chemistry and Paint Manufacture

Unit Objectives

At the end of this unit, you will be able to:

1. Talk about the components of paint and their types
2. Explain characteristics of resins/binders used for paints.
3. Explain different paint systems and their features or characteristics

1.3. Components of Paints and Coatings

The success of any coating depends on its nature, chemical composition, the physical condition of the substrate and application techniques. The compositions vary considerably depending on the end applications, economics and the durability expectations of the coated components. A typical paint product is a homogenous mixture of pigments, extenders, resins or binders, additives and solvents.

Pigments: Pigments are powder material insoluble in resin, water, or solvents and impart colour and opacity (hiding power) to the paint. Theymay be organic or inorganic. Combinations of different coloured pigments give a variety of other colours. In metallic colours, aluminium / other metal pigments and effect pigments (pearl mica) are used to impart sparkling/ metallic effect.

Fig 1.3.1 (i): Colour pigments

Fig 1.3.1 (ii): White pigment

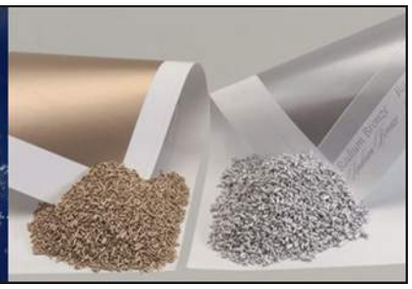


Fig 1.3.1 (iii): Metallic pigments

Fig 1.3.1 (iv): Extender

Extenders: Extenders are economical minerals added to increase the pigment content of the paint and contain the cost. They give filling properties, increase bulk volume and add certain desired properties to the paint. Calcium carbonate is a typical extender.

Resins or Binders: Resins are prepared by a chemical process called polymerisation. The resin helps to bind the pigment particles together and hence it is also called a binder. It is a major ingredient of any paint and is responsible for the film formation in a paint. The paint performance depends mainly on the type and quality of resin. Different resins are used in paints depending on the end use. Resins may be solvent based, or water based.

Fig 1.3.1 (v): Resins used in coatings

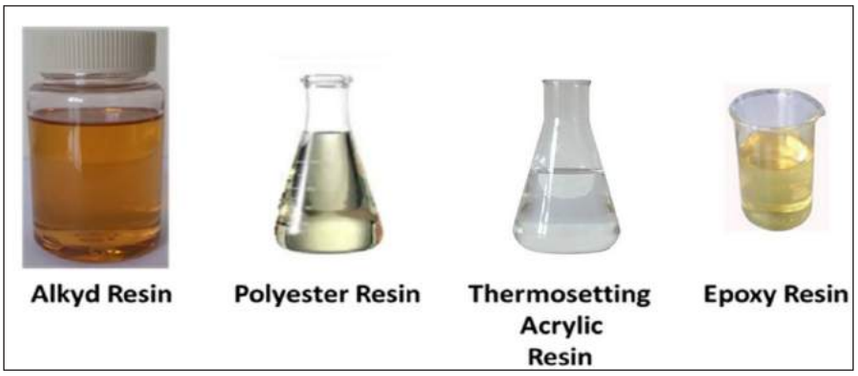


Fig 1.3.1 (vi): Types of resins

Additives: Additives are used in small quantities for enhancing certain desired properties like pigment wetting and dispersion, ease of application, flow and levelling, drying, curing, UV resistance, colour stability etc. In general, additives upgrade the performance properties of paint. Examples – anti-settling agent, anti-skinning agent, anti-sag agent, flow modifier, adhesion promoter, de-foamer, wetting agent, driers, matting agents etc.

Fig 1.3.1 (vii): Additives in liquid and powder form

Solvents: These are liquids used to reduce the viscosity of paint so that it can be easily applied on the surface. Solvents can be classified as aliphatic (mineral turpentine), aromatic (xylene, toluene), alcohols, ketones and esters. For water-based products, water is the solvent.

A solvent may be a true solvent, co-solvent or a diluent. Different solvents have different ability to dissolve resin. A solvent that dissolves a resin is the true solvent for that resin.Co-solvent dissolves the resin in the presence of the true solvent. A diluent is used only to reduce the viscosity. There are fast evaporating, medium evaporating and slow evaporating solvents. Generally, a combination of different solvents is used to achieve the desired film performance.

Powder coating, which is paint in a dry powder form, does not require any solvent during manufacture or application. As we shall see in the next sections, the manufacturing process for powder coating differs from that of liquid paints. The equipment used for powder manufacture are also different.

1.3.2 Characteristics of Different Resins

As we have already seen, resin is a major ingredient in paint and is responsible for making the paint into a film. There are different types of resins that can be used to make paint. It is important to understand the characteristics of each resin type as they determine the properties of the final paint.

TYPE OF RESIN	CHARACTERISTICS
ALKYDS	Alkyds are economical resins, mainly used in architectural paints. Enamel or oil paint is based on this resin. Technically, an alkyd is an oil modified polyester. By adding driers (special additive) these paints are made air-drying type. Paint film formation takes place at room temperature.
POLYESTERS	These resins are superior to alkyd resins in performance. They are mainly used in automotive/general industrial paints and powder coatings.
ACRYLICS	These resins have good durability against ultraviolet rays. They are mainly used in automotive clear coats, base coats and mono coats.
EPOXIES	Epoxies have good corrosion resistance, chemical resistance and water resistance properties. They are used mainly in protective coatings. These paints are supplied as base and hardener packed in separate containers. Such paints are called two pack (2K) paints.
AMINO	These are melamine formaldehyde (MF) or urea formaldehyde (UF) resins used for curing and achieving hardness of the paint film. These resins crosslink with alkyd, polyester, epoxy resins and give excellent toughness. This reaction starts at high temperature (above 120° C). Hence, such paints are supplied as one pack (1K) paint. MF resin is widely used in automotive paints.
ISOCYANATE	This hardener reacts with alkyd, polyesters and acrylic resins to form Polyurethane coatings. The crosslinking reaction between the -OH of the resins and -NCO of the isocyanate hardener starts at room temperature, once the two are mixed. Hence these paints are supplied as 2K (base and hardener) packed in separate containers.

1.3.3 Manufacture of Liquid Paints

There are five main stages in the manufacture of liquid paints as described below. A product may go through all or only some of these stages.

PRE-MIXING	GRINDING OR DISPERSION	THINNING/LET DOWN	FILTRATION	PACKING
This is the first stage. Measured quantities of raw materials are mixed using a high-speed stirrer. Agglomerates of pigments and other powder materials break down to give a uniform and homogeneous slurry	This is the most important stage in paint manufacture. Here the pre-mixed slurry passes through a mill that helps to break down the pigment agglomerates into primary particle size of the pigments. The output from this stage is finely ground pigment particles dispersed in the resin solution. It is referred to as the mill base.	The finely dispersed mill base is thinned down to the required viscosity. Adjustment for colour and other properties is also done at this stage. The quality of the paint is then tested for adherence to specifications	The paint is filtered to remove any foreign matter and/ or larger agglomerates before packing	This is the last stage where the product is packed, labelled as required for final sale

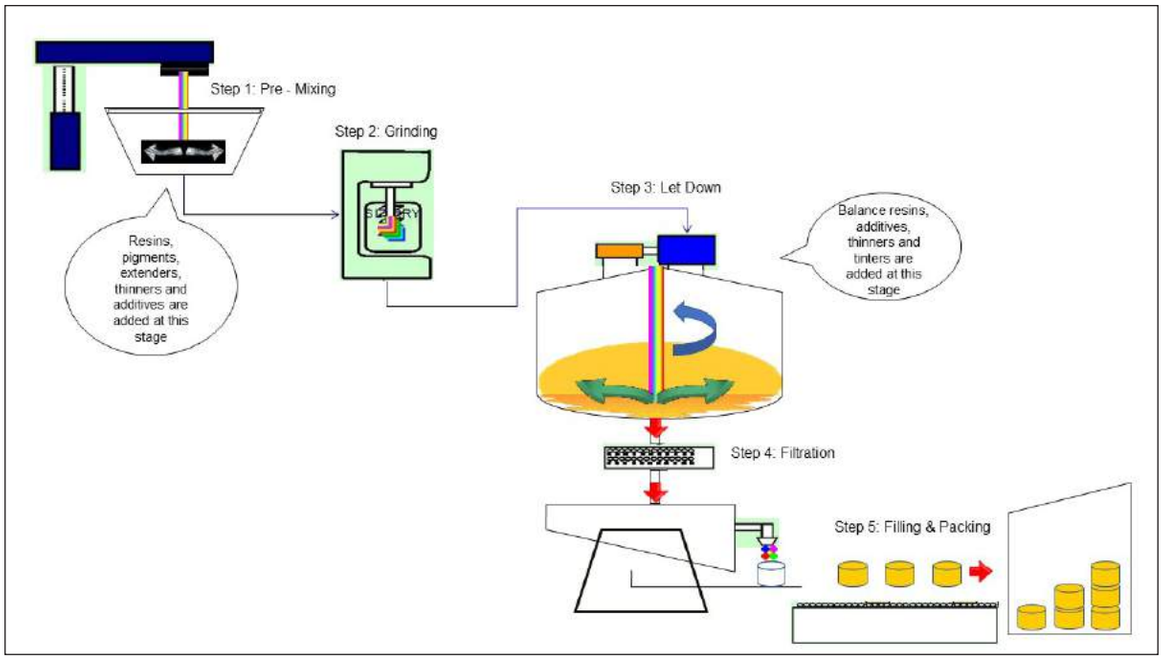
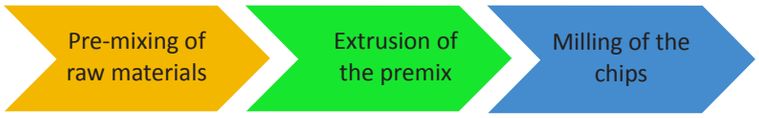


Fig 1.3.3: The main stages in the manufacturing process

1.3.4 Manufacture of Powder Coatings

The three principal steps in manufacture of powder coatings are illustrated and described as below.



PRE-MIXING RAW MATERIALS	EXTRUSION OF THE PREMIX	MILLING OF CHIPS
Measured quantities of resins, pigments, extenders and additives are added into a premix vessel. The homogenous mixture of all raw materials is referred to as the premix. After requisite adjustments and quality checks, it is sent to the next stage.	This stage helps convert the premix into chips (also called flakes). The premix, is homogenised by passing it through an extruder. In the extruder, the premix is heated to melt the resins and the pigments, extenders, additives etc. are dispersed in the molten resin. The compounded molten mass is forced out of the extruder and cooled. It then solidifies to form a thin sheet which is broken into flakes or chips.	Milling or pulverisation refers to the chips being ground to a powdered form, i.e. the final product.

Note: For some powders, a fourth step is also required after milling, called post blending or tumble blending. This is required for metallic and effect finishes. The metallic or pearl pigments are added with the powder and after homogeneous mixing, the finished product is packed.

Fig 1.3.4 (i): Powder extruder

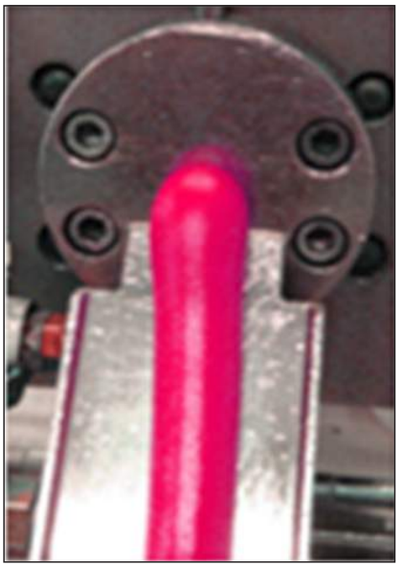


Fig 1.3.4 (ii): Powder extrudate

Fig 1.3.4 (iii): Chilled rollers

Fig 1.3.4 (iv): Flattening + cooling

Fig 1.3.4 (v): Powder chips

Fig 1.3.4 (vi): Powder pulverisation

1.3.5 Paint Systems

The beautiful smooth or textured walls in our homes and the gleaming cars that we see on a day-to-day basis are painstakingly achieved by applying layer after layer of different paint systems. Additionally, bridges and building exteriors withstand years of damage caused by natural elements such as sunlight and rains because of careful and scientific application of several layers of anti-corrosive paints.

A paint system is essentially a (usually pre-specified) systematic multi-layer application of paint products to various substrates. Each layer in the system has a specific function. Different products are applied in a defined sequence to achieve best results for each substrate. The paint system and the products employed depend on the following:

1. Substrate
2. The service to which the final product is put, extent of wear and tear with exposure to natural elements that it will be subjected to
3. Handling

A surface to be coated is referred to as a substrate. The coating on the substrate must work towards it's protection and over all visual appeal. Commonly coated substrates we encounter everyday are wood, plastic, metals and masonry.

A typical paint system is illustrated below.

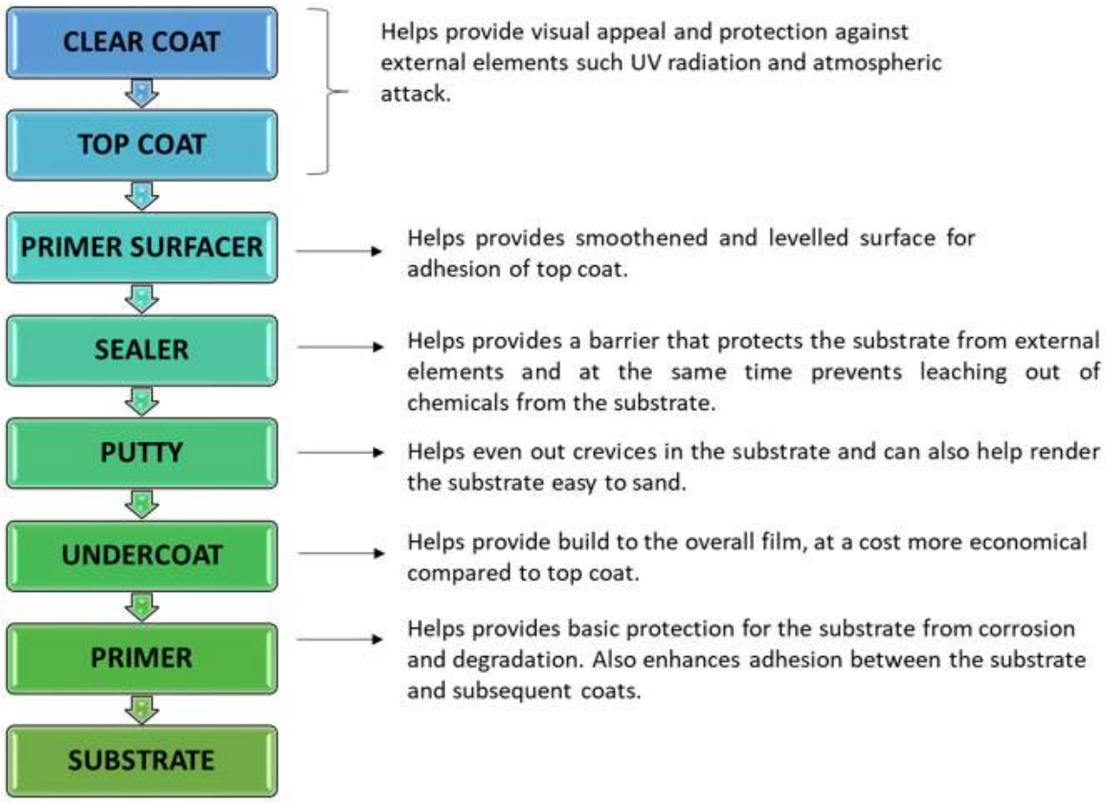


Fig 1.3.5: A typical paint system for automotive coating

1.3.6 Comparison of Paint Systems

We have already seen that there are many different types of resins that can be used in the manufacture of paints. Paint technologists refer to these as different paint chemistries. Thus, a paint chemistry is defined by the binders or resins that are used to make it.

Paints from different chemistries vary in properties such as curing time and temperature, appearance, mechanical properties, durability, chemical resistance, cost etc. Thus, depending on the end use requirements of the painted product / surface, the right chemistry is chosen.

Paints are classified based on the type of resin used such as alkyd-based paints, polyester paints, acrylic paints, epoxy paints, alkyd-amino paints, polyurethane paints etc. Further, paints are classified by:

- The physical state - liquid paint, stiff paint, powder coating
- Mode of thinning: water thinnable / solvent thinnable
- End use: architectural, industrial, protective coatings, automotive coatings etc.
- Mode of drying: air drying, forced drying, baking / stoving, UV cured
- Order of application: Undercoats (primer, primer surfacer) and top coats

In the case of powder coatings, the types of powders based on resin chemistry include epoxy, epoxy-polyester, pure polyester, polyurethane and acrylic powders.

1.3.7 Comparison of Different Liquid Paint Systems

We have already seen different resins that are used in paint under section 1.3.2. As indicated there, each type of resin lends different characteristics to the paint where it is used. Paints also differ in terms of their curing pattern. Thus, a paint could be either one component (1K) or two component (2K). The two component paints are supplied as a base and hardener in separate packs.

DRYING/CURING	PAINT TYPES
AIR DRYING	• Enamel (IK) • Emulsion (IK) • Acrylic (1K) • Polyurethane (2K) • Epoxy (2K) • Chlorinated rubber (1K) • Bituminous Paint
STOVING	• Stoving Enamel • Thermosetting Acrylic • Epoxy Esters • Blocked Isocyanate • Polyesters • Powder Coating
MOISTURE CURED	• Polyurethane (IK) • Epoxy (IK)

1.3.8 Comparison of Different Powder Systems

The advantages and disadvantages of different types of powders are enumerated in the table below.

POWDER SYSTEM	ADVANTAGES	LIMITATION
EPOXY	• Good chemical resistance • Best corrosion resistance • Better surface hardness • Better mechanical properties	• Poor UV resistance • Sensitivity to colour variations when exposed to heat or sunlight
EPOXY POLYESTER	• Good flow • Good application properties • Low colour variation • Flexibility in formulation	• Slightly better UV resistance than epoxy.
POLYESTER	• Good outdoor durability • Good mechanical properties • Good colour stability	• Lower chemical and solvent resistance than epoxy.

POLYURETHANE	• Good mechanical properties • Good chemical resistance • Better outdoor durability • Good flow and smoothness	• High cost • Emission of blocking agent during curing
ACRYLIC	• Best flow and clarity • Good chemical properties • Best hardness • Better outdoor durability • Best for clear powders	• Severe incompatibility with other powders • Storage stability • Poor pigment wetting • Expensive

Fig 1.3.8 (i): Pure Epoxy (PE) usage on coated pipes and valves

Fig 1.3.8 (ii): Pure Polyester (PP) usage on wheel rims and stand of a car's rear view mirror

Fig 1.3.8 (iii): Epoxy Polyester (EP-Hybrid) used on lockers and shock – absorbers

Fig 1.3.8 (iv): Polyurethane (PU) or Acrylic (Ac) applied on industrial parts

1.3.9 A World of Many Products and Opportunities

It would thus be seen that both in the case of liquid paints and in the case of powders there is a wide variety of products to choose from. Paint professionals needs to be aware of the different types of products and their properties. They should also be able to explain the advantages and disadvantages of different types of products. Further, the correct product as specified by the customer or in the technical specifications must be used.

You will thus notice that paint is a fascinating product. Just think of this one example: today a motor car made almost entirely of steel, a metal that corrodes easily and rapidly when exposed to normal weather, can, when correctly painted with good quality paint available in India, take the highly corrosive outdoor environment of coastal cities such as Mumbai or Kochi with hot summers and wet monsoons and not show any sign of corrosion even after ten years.

Several job opportunities exist in the making, packing, distribution and sale of paints, broadly referred to as the manufacturing sub-sector of the industry. You can acquire skills required by paint factories – for example in processing, colour matching, filling and packing or quality control; or in sales outlets, mixing and tinting colours to customer specifications.

However, the bigger part of the paint sector is the application sub-sector. It offers a much larger scope for employment - in the application of paints: be it architectural paints, wood finishes or industrial paints.

Notes

UNIT 1.4 Colour

Unit Objectives

At the end of this unit, you will be able to:

1. Explain the concept of colour
2. Talk about different categories of colour
3. Discuss how we perceivecolour

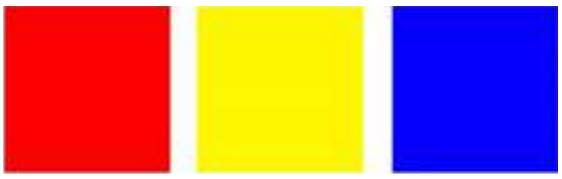
1.4.1 Colour Concepts

When we speak of paints, the first thought that comes to our mind is that of colour. We always associate paints with colour. We see the colour of an object when light falls on it and gets reflected. In darkness, we see no colour. Similarly, under different light sources such as sunlight, fluorescent light or sodium vapour street lights the same object will appear different in colour. Sothe colour that we perceive depends on the light source. When we speak of colour, we normally refer to what is seen in day light. The colour of an object that we perceive changes with the light source.

Colours can be classified as follows:

Primary colours:

- Red, yellow and blue are called primary colours.
- They cannot be obtained by mixing other colours.



Secondary colours:

- Orange, green and violet are called secondary colours.
- They are obtained by mixing in equal amounts two adjoining primary colours

Mixing of colours:

- Yellow + Blue = Green
- Red + Yellow = Orange
- Blue + Red = Violet

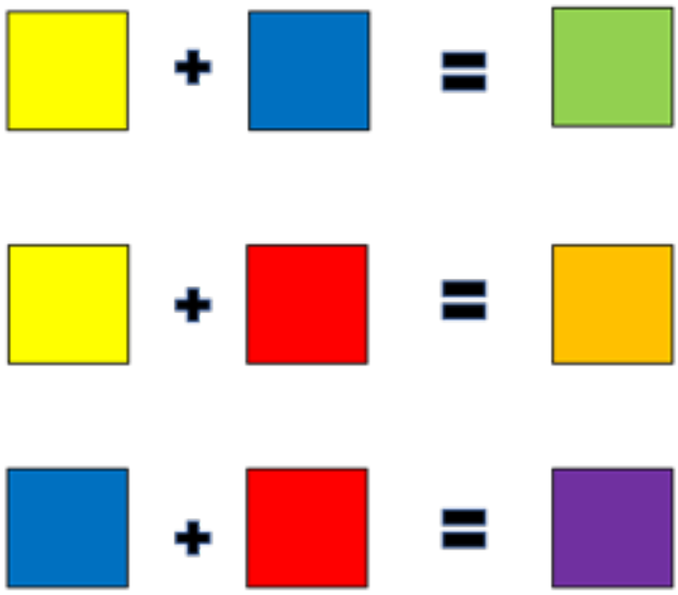


Fig 1.4.1 (iii): Mixing of colours

Intermediary colours

When the primaries are not mixed in equal amounts, intermediary colours are formed, such as yellow-green (chartreuse), green-yellow (apple green), etc.

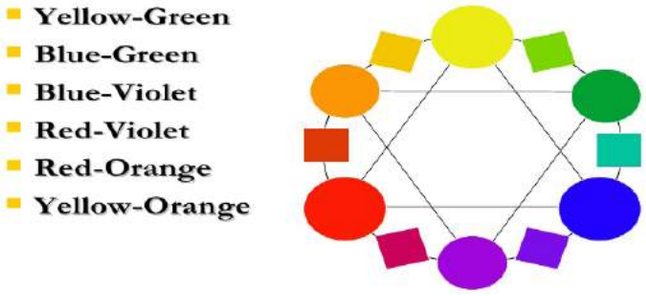


Fig 1.4.1 (iv): Intermediary colours (pinsdaddy.com)

Tertiary Colours: Tertiary colours are obtained by mixing two secondary colours, such as orange with green (olive), green with violet (slate) or violet with orange (russet).

Fig 1.4.1 (v): Tertiary colours (firstascentdesign.com)

Complimentary Colours: Colours that appear opposite each other on the colour wheel are called complimentary colours. Complimentary colours include: red and green, yellow and blue etc. A complimentary colour is often used to reduce the chroma (brightness or intensity) of its opposite. When two complimentary colours are mixed in equal parts, although theoretically they should produce black, they produce neutral a greyish dark brown.

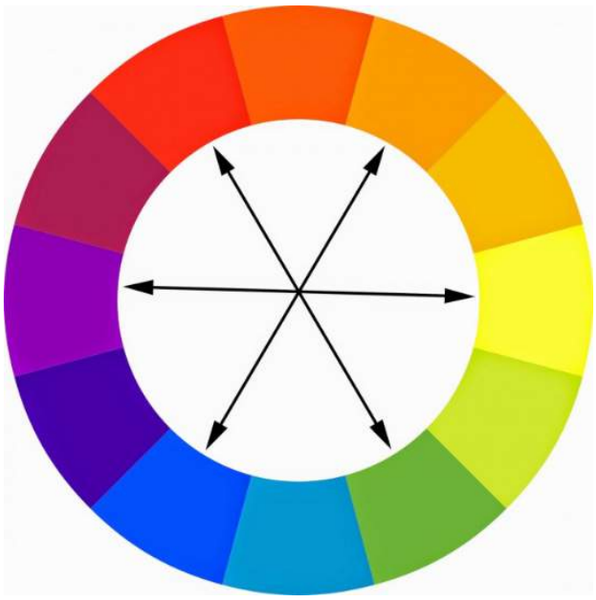


Fig 1.4.1 (vi): Complimentary colours (copicmarkertutorials.com)

	Warm Colours	Cool Colours
HUES	Reds Yellows Oranges Red violets	Blues Blue-greens Blue-violets
NATURE	Vivid, bold	Calming, soothing
USUALLY DEPICT	Sun, fire, heat, warnings	Water/water bodies, cold environs, freshness

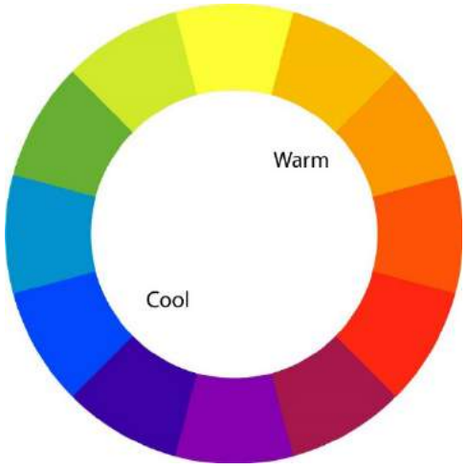


Fig 1.4.1 (vii): Warm and cool colours (webflow.com)

UNIT 1.5 Colour Standards

Unit Objectives

At the end of this unit, you will be able to:

1. Explain what are colour standards and why they are useful

Fig 1.5: RAL shade card

RAL is used for information defining standard colours for paint and coatings. It is the most popular central European Colour Standard used today. The colours are used in architecture, industry and road safety. The human eye distinguishes about ten million colour shades. How can we tell exactly which colour we mean? With the use of RAL colour charts!

Since 1927, RAL has created a uniform language when it comes to colour. It has standardised, numbered and named the abundance of colours. These standards are easily understandable and applicable - worldwide. Some example colours from the RAL colour chart are mentioned below. The first digit relates to the shade of the colour:

1xxx Yellow RAL 1000	Green Beige - RAL 1034 Pastel Yellow (27)
2xxx Orange RAL 2000	Yellow Orange - RAL 2012 Salmon Orange (12)
3xxx Red RAL 3000	Flame Red - RAL 3031 Orient Red (22)
4xxx Violet RAL 4001	Red Lilac - RAL 4010 Telemagenta (10)
5xxx Blue RAL 5000	Violet Blue - RAL 5024 Pastel Blue (23)
6xxx Green RAL 6000	Patina Green - RAL 6034 Pastel Turquoise (32)
7xxx Grey RAL 7000	Squirrel Grey - RAL 7047 Telegrey 4 (37)
8xxx Brown RAL 8000	Green Brown - RAL 8028 Terra Brown (19)
9xxx White/Black RAL 9001	Cream - RAL 9018 Papyrus White (12)

UNIT 1.6 Types of Finish

Unit Objectives

At the end of this unit, you will be able to:

1. Explain finish
2. List different types of finishes commonly used

Besides colour there are two other aspects describing the appearance of a finish that you will come across – 'Gloss' and 'Type of finish'. Gloss refers to the shine in the paint film. A high gloss surface appears mirror like whereas a matt finish is dull or flat. The gloss level is expressed as percentage of the light that is reflected from a surface in a mirror like fashion. Since the extent of reflection also depends on the angle at which the surface is held, gloss level is measured and expressed as a value at a specific angle.

FINISH	GLOSS LEVEL
Dead Matt	0-15%
Matt	15-30%
Egg Shell Matt	30-45%
Satin	45-60%
Semi Glossy	60-75%
Glossy	75-90%
High Gloss	90% +

Type of finish refers to the texture or the visual feel of the finish. Examples of common types of finish are illustrated below.

Fig 1.6 (i): Gloss, semi-gloss and matt finish

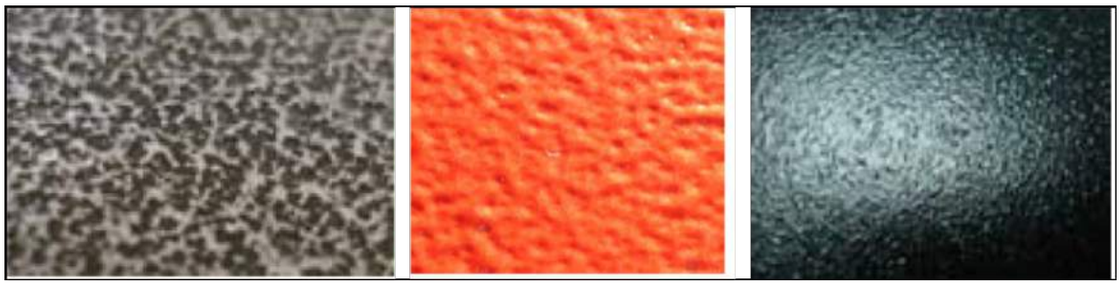


Fig 1.6 (ii): Hammer tone finish, structure finish and coarse texture

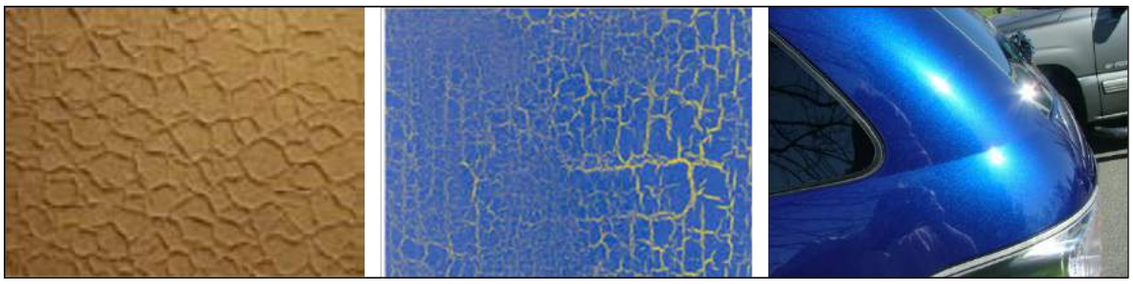


Fig 1.6 (iii): Wrinkle, antique and metallic finish

Notes

UNIT 1.7 Gloss Measurement

Unit Objectives

At the end of this unit, you will be able to:

1. Explain gloss and its measurement
2. Describe how gloss value is expressed

- Gloss is measured by a gloss meter at different angles
- Gloss reading depends on the angle at which it is measured. So, gloss is always expressed as a percentage at an angle (e.g.: 60% at 20°)
- An angle of 60° is most common in the coating industry. Usually recommended for medium gloss levels.
- An angle of 20° is used to achieve a more differentiated result of high gloss surfaces usually recommended for Automotive class "A" finish using liquid coatings
- An angle of 85° is used to achieve a more differentiated result of low gloss surfaces, not so popular in coating industry.

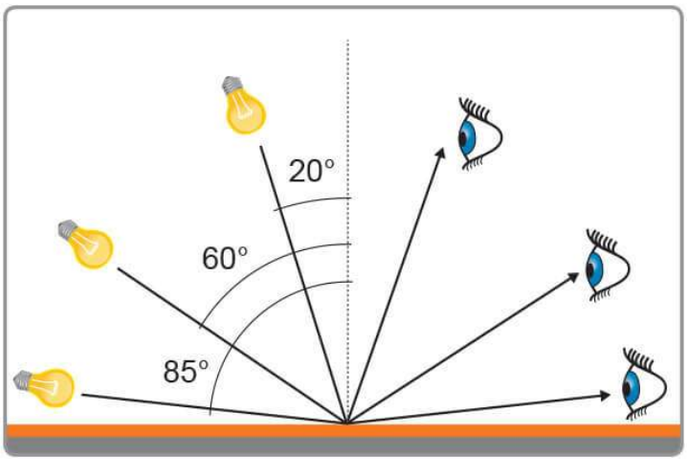


Fig 1.7: Reading gloss at different angles

Fig 1.7.1: Digital Glossmeter

UNIT 1.8 What are General Industrial Coatings?

Unit Objectives

At the end of this unit, you will be able to:

1. Describe what a general industrial (liquid) painter does
2. Discuss different types of general industrial coatings

General industrial coatings are products used for decorating and protecting a wide range of consumer and household products, transport infrastructure and other industrial assets. Appliances, household articles, agricultural and construction equipment, electric fittings, switchgear and transmission equipment, railway assets, metal fabrications and furniture, factory structures and machinery are examples of itemspainted with general industrial coatings.

General industrial coatings comprise the largest group among industrial paints and are applied on a variety of products with varied end uses and customers. The product range in general industrial covers practically every paint chemistry and spans from low cost conventional enamels to expensive 2k systems. Application techniques and facilities also include a wide range from small job shops to sophisticated painting lines in OE factories. It would thus be seen that a wide range of coatings for varied applications are covered under the umbrella of general industrial coatings. The focus is on protection of the substrate and extending the life of the asset that is coated as well as enhancing the product's visual appeal.

With rising industrial production in the country, GI coatings are bound to grow both in volumes and in terms of sophistication. Rising middle class incomes is increasing the sale of mobile phones, computers and consumer appliances. Growth in demand for furniture, infrastructure and industries in general will thus fuel the growth in GI market. In addition, the "Make in India" programme of our government will create new manufacturing facilities for a variety of products that were hitherto imported into the country. Thus, general industrial coatings will see bright prospects in the years to come.

Fig 1.8 (i): Examples of General Industrial painted items

Fig 1.8 (ii): Examples of General Industrial painted items

Notes

UNIT 1.9 Job Role of a General Industrial (Liquid) Painter

Unit Objectives

At the end of this unit, you will be able to:

1. Clearly state different aspects of your job

A General Industrial (Liquid) Painter is a specially trained painter who possesses skills required to apply GI coating products. This is a skilled job and requires special training. Indeed, the value or benefit realised by the customer in terms of aesthetics and protection from a good paint could be severely compromised if the application is not proper. Many customers therefore insist on painters having appropriate training backed by recognised certification.

A person trained in the application of GI coatings could find employment in a variety of industries where such coatings are used, job coaters who paint products for OE or industrial product manufacturers, maintenance departments of large public or private organisations in the infrastructure sector, railways etc. A skilled painter with some experience could also look at opportunities outside the country.

Building infrastructure is currently a key priority for India. Significant investments are being made in expanding highways, metro projects, water supply, rail network, power generation and distribution and green energy. Such investments will continue to expand in the foreseeable future as our country is still at a very early stage of development. Hence the need for persons qualified in the application of GI coatings is expected to keep rising for several years to come, providing excellent opportunities to trained and experienced painters.

Persons skilled in this area can, over time, look forward to growth opportunities to supervisory and managerial levels in contract painting organisations or in the paint shops of large user factories. They can also consider becoming entrepreneurs themselves by establishing a job coating organisation for carrying out painting contracts for other factories.

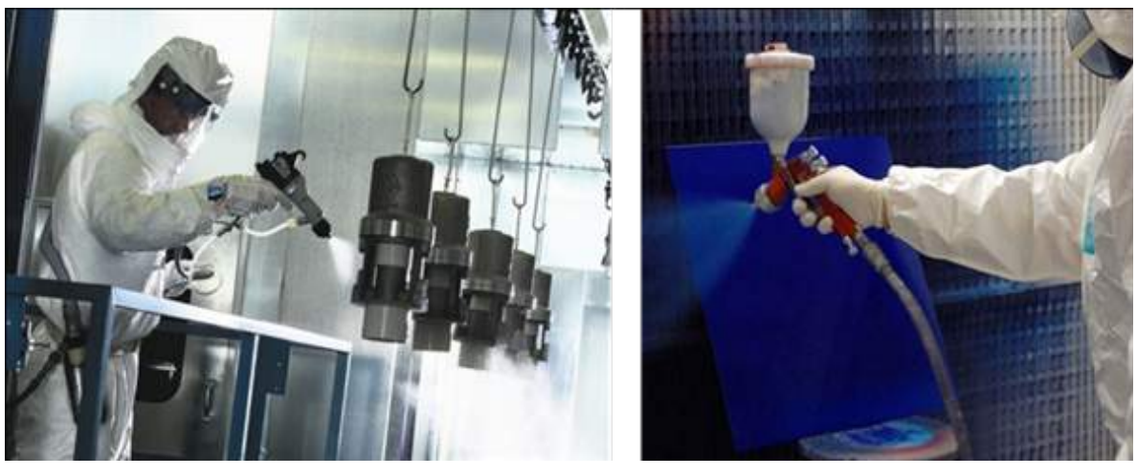


Fig 1.9: General Industrial Painter at work

Tips

Liquid painting is a fast-growing product group in industrial paints.

Notes

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2. Prepare for Coating

Unit 2.1 - Coating Process in a Typical Paint Shop
Unit 2.2 - Job to be Coated, Specifications and Production Plan
Unit 2.3 - Study the Coating Required
Unit 2.4 - Prepare for Jigging
Unit 2.5 - Masking

Scan the QR code for video

Applicable NOS – PCS/N5105

Key Learning Outcomes

At the end of this module, you will be able to:

1. Explain the coating process flow in a typical paint shop
2. Identify the pretreatment process and the stages involved. Assess the quality of the incoming components before commencing the pretreatment process.
3. Adapt the correct preparation and painting process for primer, primer surfacer and topcoat.
4. Explain the drawing and production plan and the customer specification for General Industrial (Liquid) Painting
5. Identify the type of jigging required based on the shape and size of the component
6. Identify the masking requirement and carry out proper masking.

UNIT 2.1 Coating Process in a Typical Paint Shop

Unit Objectives

At the end of this unit, you will be able to:

1. List the overall process flow in a typical paint shop
2. Assess the component quality before pretreatment
3. Identify the pretreatment process and the stages involved
4. Adapt the correct preparation and application process for primer, primer surfacer and topcoat
5. Explain the paint mixing/ circulation system and paint preparation procedure

Before we proceed further it is a good idea to get an overview of the overall process flow in a typical paint shop. A component or a job which is taken up for coating application goes through various stages in the coating process before it is finished and is ready to leave the paint shop. Typically, a paint shop will have some or all of the following stages:

1. Inspection
2. Pretreatment
3. Primer / primer surfacer application
4. Post primer surfacer stage
5. Top coat application

Each of these stages is explained below:

Inspection: To achieve satisfactory results from the coating process and the coating system, it is important that the articles meant for painting are in a good condition before being taken up for painting. This is the primary purpose of inspection. Further, the parts are also examined to see if there are any special aspects to be addressed during the coating process. Thus, the inspection stage checks if the incoming articles meet the basic paint shop requirements listed in the chart below:

BODY COMPONENTS	
SHEET QUALITY	• Must be free from rust and other defects. • If not these need to be rectified before they can be taken up for painting.
TOOLING QUALITY	• The quality of tooling of the parts must be good • No surface coating can take care of deformities in component due to poor quality tooling.
WELDING QUALITY	• Smooth, uniform welding will lead to better finish. • If not grinding of such welding through an appropriate process is suggested for good results.

ANTIRUST OIL QUALITY	The antirust oil used on any steel should have the following properties: • Give temporary protection during storage when applied at low thickness • Should not react with the substrate • Should be easily removable using standard degreasing cleaners • Should be non-drying type
PROVISION FOR DRAINAGE	• The components, especially large tubular components, should have provision for easy drainage. • Additionally, jigs should be designed to achieve proper drainage of pretreatment chemicals.

Before an article is taken up for pretreatment, it is important to thoroughly inspect it for weld defects, sharp edges, spatters, excessive oil, grease etc. These must be removed as they would affect coating quality.

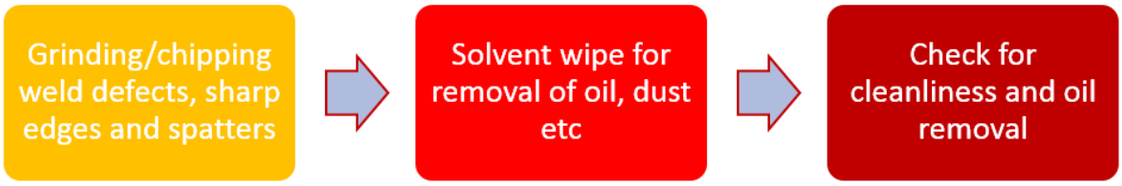

Fig 2.1 (i): Pretreatment preparation

Inspection before pretreatment

1. Check for excessive or dried residues of oil, grease, fingerprints, chemical salts and mud/ dust deposits on the surface as their presence can cause poor adhesion and uneven coating
2. Smoothen and grind rough welds, sharp protrusions and edges. A smooth and clean surface is a prerequisite for an even and uniform coating
3. Removing oil/grease is mandatory before blasting

The recommended solvent for solvent wipe is MTO / Xylene or other slow drying solvents.

- Pour solvent on a cotton rag
- Wipe the surface
- Clean with a dry cloth

Do not

- Use fast drying solvent / thinner
- Dip the cloth in solvent container as it willcontaminate the solvent

SHEET QUALITY

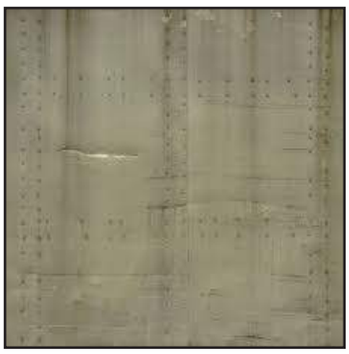

Fig 2.1 (ii): Unpainted metal sheet with dents and nail

WELDING QUALITY

Fig 2.1 (iii): Defect in welded component

ANTIRUST OIL QUALITY

Fig 2.1 (iv): Antirust oil should provide protection during storage

PROVISION FOR DRAINAGE

Fig 2.1 (v): Tubular metal component should temporary have provision for easy drainage

After inspection, depending on the nature of the job and the volume of production to be handled, a paint shop will have a suitable arrangement for moving the parts from one stage to another. Where the throughput is high, the job will move from one station to another on a conveyor.

A brief description of the various stages from pretreatment to top coat application is given below.

Pretreatment: This is a very important stage where the job to be coated is cleaned either mechanically (wire brush cleaning, shot blasting or grit blasting) or chemically. This prepares the surface to receive the coating layers. The quality of pretreatment has a significant influence on the coating quality and its life. Some of the important preparatory steps to ensure good pretreatment are listed below. These will be covered in detail in Module 3.

METAL PRETREATMENT STAGE	
PROCESS CONTROL	Process parameters such as pointage (concentration) temperature and time should be maintained.
RINSING EFFICIENCY	Chemical carry over will result in contamination and change the chemical reactions. Efficient rinsing will avoid chemical carryover and provide a clean substrate for further processing.
CIRCULATION/ HEATING/OILREMOVAL/ DESLUDGING	Auxiliary system for achieving uniformity of bath composition and temperature through circulation will ensure consistent quality of coating. Oil removal in degreasing and sludge removal in phosphating will ensure longer bath life and better coating quality. Nano coatings do not generate sludge.
WATER QUALITY	Recommended water quality should be used for bath preparation and rinsing

POST PRETREATMENT STAGE	Minimum hold up time: Components should be painted soon after pre-treatment. Storage for long is not advised.
MINIMUM HANDLING	The components should be transported preferably on conveyer to avoid manual handling and consequent surface contamination. If manual handling is necessary, use of cotton gloves is recommended to avoid transfer of perspiration/ body oils, while holding the components.

Primer/ Primer Surfacer: The primer and primer surfacer are the layers that provide basic corrosion protection and help in adhesion of the topcoat. Conditions critical for good primer application are adequate film thickness, dust free environment and correct curing. These are explained below together with the post surfacer activities.

Fig 2.1 (vi): Defects that must be checked before pretreatment - Weld spatters and sharp edges.

Fig 2.1 (vii): Rounded edged item is ready for pretreatment

Fig 2.1 (viii): Vacuum cleaning after blasting operation

Fig 2.1 (ix): Solvent wipe before blasting

PRIMER / PRIMER SURFACER STAGE	
PRIMER/ PRIMER SURFACERSTAGE	Understand the production plan per shift, check availability of the required paint and thinner.
DRY FILM THICKNESS	Any coating will give desired results only if applied at specified dry film thickness. Dry film thickness control is also critical, depending on the surface roughness, to achieve the best paint film appearance.
DUST FREE CONDITIONS	Dust free conditions in all stages of painting process will ensure better film appearance. In the case of undercoats, dust free conditions will ensure minimum sanding by avoiding bits in the film.
FLASH OFF TIME / BAKING CONDITIONS	Flash off time will ensure release of solvents before the components move into the heated zone. The paint film will blister If proper flash off is not maintained. Stoving paints can be cured completely only if baked at specified temperature and time. Under-cured film will be inferior in performance. The oven should be designed to achieve the desired baking conditions.
POST SURFACER STAGE	
WET SANDING	Non-sanding primer/ primer surfacers are preferred to reduce dust. Wet sanding is preferable for better film appearance. Wet sanding provides smoother surface, avoids sanding marks, and also reduces dust.
QUALITY OF EMERY PAPER / WATER QUALITY	To avoid sanding marks, use standard quality emery paper of specified grade. Contaminated water will result in salt deposition and entrapment between paint films, affecting system performance.
DRYING	Dry component thoroughly after wet sanding to avoid defects during finish painting due to water interference.

Top Coat: The top coat is the layer that provides weather protection to the painted article. It also plays the role of giving a decorative finish. The job generally goes through a preparation stage before being top coated.

PREPARATION FOR TOP COAT	
FINE SPOT SANDING	This is required especially for larger components. This can be done by dry sanding with smooth emery paper and other devices but should be limited to bare minimum by improving efficiency at wet sanding stage.
TACK RAGGING	The following aspect should be considered in this operation: Quality of tack rag – both cloth and varnish. Tack ragging operation – the strokes should be soft and straight and directed towards component edge.
AIR BLOW	Before finish painting, the components should be cleaned by air blow to ensure dust free surface.

TOP COAT STAGE	
DUST FREE CONDITIONS	Complete dust free conditions should be ensured in stages such as: • Preparation area • Spray booth • Flash off zone • Oven
TEMPERATURE/ HUMIDITY CONTROL	For best performance, temperature/ humidity control inside spray booth/ flash off zone should be ensured.
PAINTING SEQUENCE	The sequence of painting, especially while painting larger area, should be designed to achieve better efficiency, lower over spray, optimum wet edge time, proper merging and optimum intercoat interval.
PAINTERS SKILL	Painters skill is very important for achieving best results. This can be achieved by proper training.

Types of spray equipment: A large variety of spray equipment is available for paint application. Selection of application equipment is made keeping in view the product used, component to be painted, expectations on finish and production rate.

Application parameters: As already mentioned the following application parameters should be controlled within the specified limits.

- Viscosity of application
- Dry film thickness
- Flash off time
- Baking conditions
- Temperature, humidity in spray booth
- Paint pressure
- Paint temperature
- Booth air velocity
- Air pressure
- Type of paint
- Skill of painters

Thinner quality: The solvent composition in any thinner will determine the flow properties and hence the film appearance.

Baking conditions: The following aspects need control:

- Air quality
- Temperature distribution

Paint Kitchen: Paint kitchen is where the paints received from the supplier are made ready for use by adding thinner /solvents and sent to the various work stations. The following areas need attention in paint kitchen.

- Filtration
- Viscosity control
- Temperature control
- Circulation

The paint shop should be designed for "quality". Compressed air used for paint application should be free from water, oil and other contamination.

The other aspects which need special attention for a good finish are:

- Cleanliness
- Discipline
- Training – one of the training techniques is a Tool Box Talk (TBT). It gives a platform for sharing each other's experience and information on operations, problems and solutions.

Fig 2.1 (x): Mixing room

Paint circulation system:

Use appropriate filter types and sizes.

Paint Type	Filter Size
Primer	50µ / 75µ
Solid Mono coat	25µ
Metallic Basecoat	75µ / 100µ
Pearl mica Basecoat	150µ
Clear	10µ / 25µ

Ensure pump strokes are set for required minimum flow speed (paint velocity) in circulation.

Paint Type	Paint velocity in circulation line
Primer	35 – 40 metres / minute
Solid Mono coat	35 – 40 metres / minute
Metallic Basecoat	25 – 30 metres / minute
Pearl mica Basecoat	25 – 30 metres / minute
Clear	25 – 30 metres / minute

Notes

UNIT 2.2 Job to be Coated, Specifications and Production Plan

Unit Objectives

At the end of this unit, you will be able to:

1. Explain the drawing and the production plan for General Industrial (Liquid) coating
2. Describe the customer specification for General Industrial (Liquid) coating

We have already seen that industrial coatings are applied on different types of products and surfaces using a variety of application techniques. As a General Industrial Painter, you could be a painter in any such factory. You could also be in a job coating plant doing painting work for products of several manufacturers.

Regardless of your specific situation, you will need to undertake certain preparatory activities before taking up a new job for painting. There may be variations from one situation to another but by and large the steps described in this module will apply in most cases.

As in any service the first step is to get a good understanding of the customer's requirement. For this, it is necessary to study the customer's drawing for the job and standards for the coating operations. Nature of the article or component to be coated, its composition, profile, service requirements and other characteristics and what the customer requires in terms of coating should be understood very clearly. The paint manufacturer's recommendations for the type of thinner to be used, application viscosity and application parameters should also be understood.

Customer requirements are generally contained in the specifications. The specifications would cover:

1. Visual requirements, like colour, gloss, finish and appearance.
2. Mechanical strength related requirements like dry film thickness (DFT), impact resistance, hardness, bending or flexibility.
3. Performance requirements like salt spray resistance, humidity resistance, durability, resistance to acid/alkali/chemicals, etc.

Quality specifications also include method of testing where there are multiple tests or measuring devices. The purpose of studying customer drawings, specifications and production plan is to:

1. Understand clearly what needs to be done
2. Review customer's specifications for completeness and consistency
3. Determine quality standards for the application
4. Determine the nature of jigging required
5. Clarify and confirm from the customer/supervisor about the specifications
6. Determine number of jobs to be completed in a shift

The number of jobs that can be taken up in a shift depends not only on the capacity of the facility but also on the nature of the jobs. For example, parts requiring extensive cleaning and pretreatment will slow down the rate of production. Likewise, heavy components which take long to heat up in the oven, intricate parts which reduce the loading density on a conveyor and assemblies that need to be dismantled before coating and reassembled later—all of these will affect the production rate adversely.

UNIT 2.3 Study the Coating Required

Unit Objectives

At the end of this unit, you will be able to:

1. Define the production plan with regards to pretreatment process, colour and production quantity
2. Implement the recommended process for preparation of the paint for application

Even in a line with a regular on-going production, it is important to go through certain preparatory activities at the beginning of each day and shift. The important steps in this regard are listed below. In the subsequent sections you will find more detailed instructions and tips.

- Check the production, painting and colour plan at the beginning of the shift. Ensure all the required paints, thinners and other consumables are available to meet the production plan.
- Ensure that the chemical pretreatment bath parameters are maintained as per recommendation of the chemical supplier. In case of mechanical pretreatment, ensure the right tool and condition is maintained for its use.
- Study the Technical Data Sheet for the paints to be used and understand the recommended thinner and application viscosity indicated by the paint supplier.
- Check the SOP for painting to understand the sequence of painting, the required dry film thickness (DFT) to be applied, paint delivery, air pressure, number of coats of paint, etc.
- Check the recommended PPEs to be used. Ensure their availability in good usable condition.
- Check the paint hose, air hose and spray gun condition. Ensure there are no leakages in the hoses and guns. The recommended filters must be used in the circulation line and guns.
- In case of electrostatic spray, follow recommended process for its safe use.
- In case of a two-pack system, ensure mixing of the base and hardener in the recommended ratio. If using a multi component mixing machine, ensure the mixing ratio of the base and hardener is maintained as recommended throughout the application.
- Use recommended thinner/s for adjusting the paint to the recommended application viscosity. Maintain the application viscosity as per the viscosity temperature chart of the paint supplier.

Notes

UNIT 2.4 Prepare for Jigging

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the parameters for selection of the right jig type for the components

Selecting the correct jig for hanging the component is very important. This will ensure that the complete surface is evenly coated with correct thickness of paint film and there are no marks or bare areas left. Fabricated sections or parts of the components are jigged and racked for efficiency in coating and ease of handling.In case of electrostatic application, ensure that the jig and the components are properly earthed. This will help apply the right thickness of coating and reduce paint wastage.

Fig 2.4 (i): Examples of conveyorised lines

Fig 2.4 (ii): Empty jig storage

Fig 2.4 (iii): Jigs rack

Notes

UNIT 2.5 Masking

Unit Objectives

At the end of this unit, you will be able to:

1. Adopt the right procedure for masking

Masking is done when only a specific area of the surface of a part must be exposed to a process. Parts of surfaces which are not to be pre-treated or coated are masked. Masking of areas, which are indicated in the component drawing and painting plan, is carried out.

Masking before pretreatment is generally carried out for tubular components to prevent water/ chemical solution entering the component. The masking is this case is generally done using metal/ rubber/ plastic plugs.

Masking with tapes is generally carried out before the painting process.

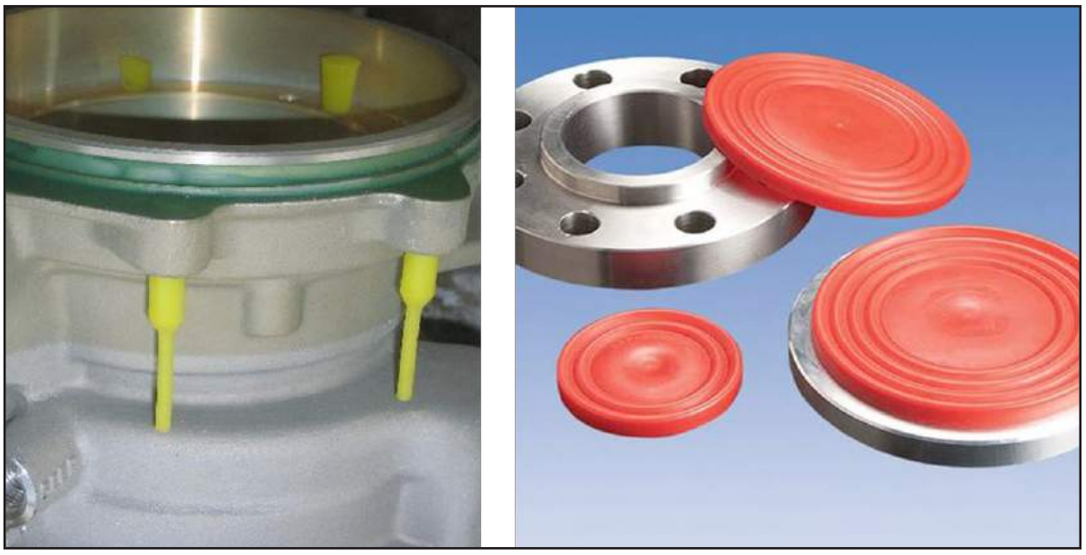

Fig 2.5 (i): Masking with plugs

Fig 2.5 (ii): Masking with tapes

Tips

- Many aspects need to be monitored during the process of preparation and coating. An SOP is a useful way of ensuring that quality is maintained.
- Visual examination of the surface to be coated is very important.

Notes

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3. Pretreat the Sections to be Coated

Unit 3.1- Pretreatment Process

Unit 3.2 - Follow company's policy and work instructions on quality standards.

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Applicable NOS – PCS/N5106

Key Learning Outcomes

At the end of this module, you will be able to:

1. Describe the pretreatment process for General Industrial (Liquid) Coating

UNIT 3.1 Pretreatment Process

Unit Objectives

At the end of this unit, you will be able to:

1. Explain the importance of the pretreatment process before General Industrial (Liquid) Coating
2. Describe the pretreatment process flow

One of the most important steps preparatory to coating an article is pretreatment. Pretreatment is the foundation of the paint system. It prepares the surface and enhances the adhesion of the coating to the substrate thus improving its resistance to corrosion. In chemical pretreatment process, components made of cold rolled sheet can be directly loaded on the line. Hot rolled sheet components will need to go through blasting/ acid pickling offline to remove mill scales, before being loaded on the pretreatment line.

The purpose of pretreatment is to clean the article, remove grease, oil and other surface contaminants and provide a surface suitable for painting.

The pretreatment can be of two types:

1. **Chemical Pretreatment,** wherein a phosphate coating is deposited on the metal to enhance corrosion protection and improve adhesion of the subsequent coating. Chemical Pretreatment involves passing the job through multiple baths containing various chemicals for cleaning and treating the component. The surface of the metal is converted to a phosphate layer and hence this type of coating is also called a "conversion" coating.
2. **Mechanical Pretreatment,** wherein the surface is prepared for coating by using mechanical means such as emery paper, wire brush, grit/ shot blasting etc. In the mechanical process, the oil/ grease and other contaminants present on the surface is first removed by a solvent wipe. The presence of rust/ mill scale is removed by mechanical means and the surface is roughened for better adhesion of the paint film.

The coating is then applied on the prepared surface in the paint shop. The masking is then removed before the coating is dried/cured. Thereafter, the article is unloaded, inspected and is ready for dispatch. The entire process can be schematically represented as follows:

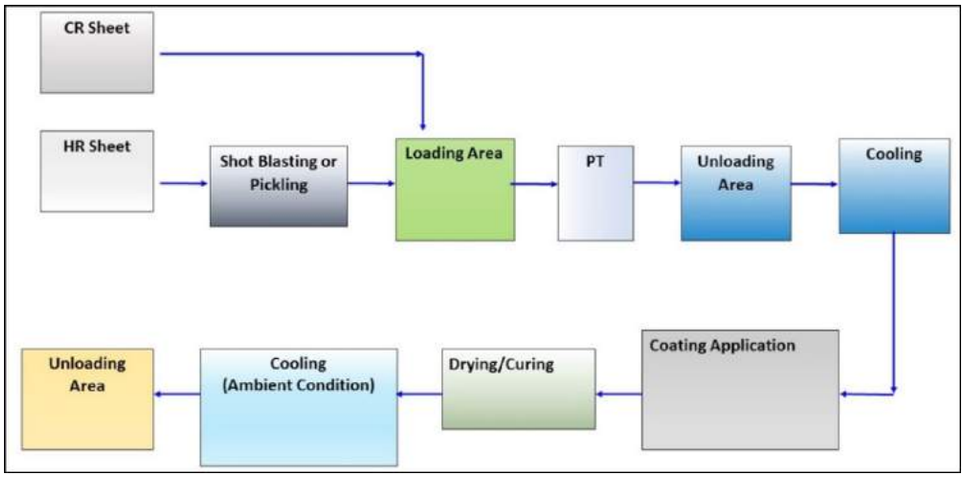


Fig 3.1: Coating process flow diagram

3.1.1 Pretreatment Methods

As we have already seen, there are 2 types of pretreatment methods as illustrated below:

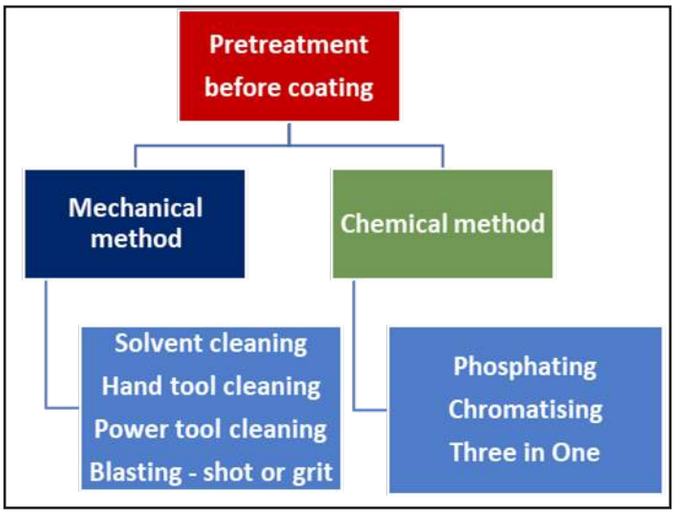


Fig 3.1.1 (i): Pretreatment methods

Selection of a pretreatment method will depend on type and shape of articles, and performance specifically corrosion resistance requirement.

- Mechanical pretreatment is preferred for HR (Hot Rolled) steels and castings.
- Chemical pretreatment is preferred for CR sheets and HR pickled materials.

Chemical pretreatment is carried out using multiple tanks with different chemicals in each tank e.g. alkaline chemical for degreasing, phosphoric acid based for multimetals like zinc, iron, manganese etc. in the phosphating stage. This process offers the best chemical conversion coatings with good adhesion and corrosion resistance. The process can either be by dipping the components in the chemical baths or spraying the chemical solution onto the components.

Mechanical Pretreatment Methods:

Mechanical or abrasive cleaning is suitable where steel surfaces have been subject to abuse such as severe corrosion, rust, and oxidation. It is appropriate for steel surfaces which exhibit large amount of mill scale or controlled oxidation and loosely adherent accumulations found in hot rolled steel of poor quality. Mechanical cleaning:

- Removes scale
- Removes rust
- Provides adhesion

Mechanical cleaning by shot/grit blasting may result in material wear and deformation if the substrate is thin.

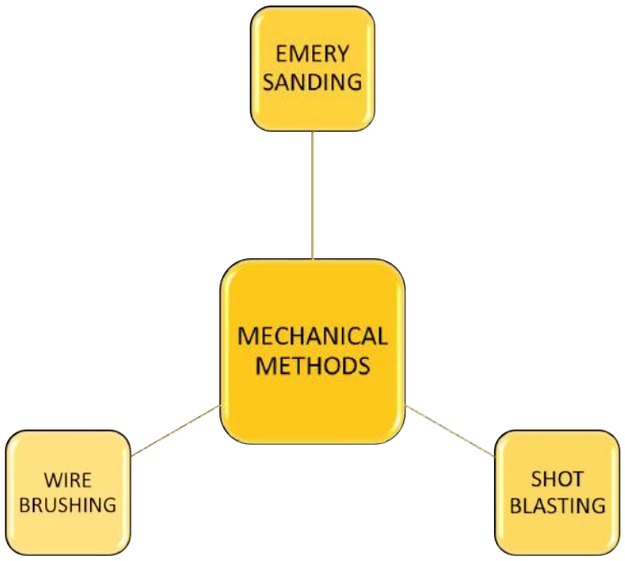


Fig 3.1.1 (ii): Mechanical pretreatment

Fig 3.1.1 (iii): Mechanical pretreatment methods - emery sanding, wire brushing, blasting

Fig 3.1.1 (iv): Shot blasting chamber

Fig 3.1.1 (v): Emery sanding

3.1.2 International Standards

There are international standards for mechanical surface treatment issued by the following organisations:

SSPC USA: The Society for Protective Coatings, is focused on the protection and preservation of steel and other industrial surfaces through the use of high-performance industrial coatings. SSPC is the leading source of information on surface preparation, coating selection, coating application, environmental regulations, and health and safety issues that affect the protective coatings industry.

ISO (International Organisation for Standardisation) is an independent, non-governmental membership organisation and the world's largest developer of voluntary International standards.

TS16949 applies to the design/development, production and, when relevant, installation and servicing of automotive-related products. The ISO/TS16949 is an ISO technical specification aimed at the development of a quality management system that provides for continual improvement, emphasising defect prevention and the reduction of variation and waste in the automotive industry supply chain.

3.1.3 Chemical Pretreatment

Chemical pretreatment is carried out on metal as well as plastic components. For steel and/ or multimetal (steel, GI, aluminium) composition, iron phosphate or, zinc phosphate is used. For pretreatment of only aluminium and galvanisedsteel, chromatising is used. Typical phosphate line sequence can be shown as follows.

Chemical pretreatment process can be either by dip or spray application. The selection of the chemical pretreatment process depends on the job shape, production volumes, type of oil on jobs and condition of jobs.

Below you will find the step by step explanation of pretreatment process.

STEP 1	
DEGREASER (CLEANING STAGE)	• The bath is generally alkaline in nature and consists of a solution of alkali metal phosphates, carbonates, silicates or hydroxides in water, along with surface active agents (detergents, emulsifiers), chelating agents, biocides and defoamers. • In this stage, all antirust oils /lubricants/ greases/ coolants are removed. These oily depositions are removed by the mechanism of displacement, emulsification, and saponification, dissolution of metal oxides or combination of these mechanisms. Heat and shear (circulation) accelerate the cleaning. • Proper cleaning is confirmed by “water break test”. After degreasing stage, generally two stage water rinsing is carried out. When the part is coming out of water rinse stage, one should observe the flow of water on metal sheet. If water flows continuously in a uniform film (no voids or break), there is no break in the water film, it means the surface has been properly cleaned. • Complete cleaning at this stage is important as chemicals during further process should have intimate contact with the metal surface. Manual solvent cleaning or additional cleaning stages like hot water spray are provided before degreasing stage If required, to loosen the dried oil film on metal sheet. • Process time, bath temperature, spray pressure and concentration (pointage) are the factors that affect cleaning. Oil separator helps in remove excess oil from the bath.

STEP 2	
SURFACE CONDITIONER (SURFACE ACTIVATION)	• The purpose of surface conditioner is to increase the number of activation sites. This facilitate the formation of a dense microcrystalline phosphate coating. • Surface activation is carried out at room temperature in a pH range of 8-9.5. Surface Activation bath is prepared in deionised water (DI water)/ demineralised water (DM water). The bath discard frequency is weekly.
STEP 3	
PHOSPHATE BATH	The composition of the phosphate bath consists of phosphoric acid, zinc primary salts, oxidising agent neutraliser. The mechanism involved in phosphating can be divided into three stages: • Electrochemical attack on metal substrate. • pH rise in zone of limited diffusion (immediate vicinity- metal liquid interface) • Crystal formation and growth.
STEP 4	
WATER RINSES	• In some cases, passivation /sealer stage is added. Where there is no passivation stage, the components are rinsed with fresh DI water and dried. • Chromium based passivation or sealer chemicals are banned for environmental reasons. Instead, chrome free sealers are used. • Last stage of phosphating process is DI water rinse. To protect CED bath from contamination, multiple DI water rinses are required and final DI water mist spray (virgin DI water) with conductivity less than 25 µmhos is used. • After pretreatment, the part moves for primer coating. The primer may be spray coated or deposited in a CED bath.

Water break test: Water break test is performed to ensure that oil and grease has been completely removed from substrate. The test involves spraying clean water at random locations on the job with the aid of a spray bottle.

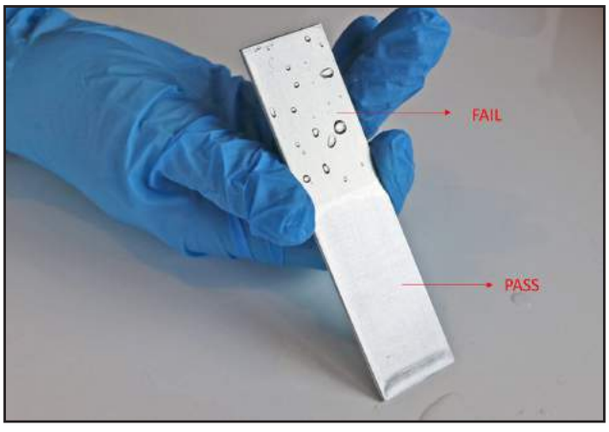


Fig 3.1.3 (i): Water break test (btglabs.com)

Before blasting, check compressed air quality using blotter test as described below

Compressed air quality (blotter) test: This is a test for checking oil and water in compressed air. A clean white absorbent cloth is attached to a rigid frame and the compressed air exhausted on to it. The nozzle shall be kept at a distance of approximately 18" for approximately one minute. The cloth or blotter paper is then visually examined against light for oil or water.

Checking the condition of the abrasives to be used: Only dry and clean steel grits/shots are to be used for blasting. Broken down grits and dust shall be sieved and extracted. Metallic abrasives shall conform to SSPC AB2 (recycling and cleanliness), SSPC AB3 (use of ferrous metallic abrasive) standard.

Vial test: To conduct the vial test for dust particles and oil, fill a clear plastic bottle one-third with the abrasive, then fill to two-thirds with clean water. Shake the bottle vigorously, allow the abrasive to settle for 20-30 minutes, then observe the top surface of the water for an oil film and the entire liquid portion for colour and turbidity (cloudiness).

Checking for the dust level on the job

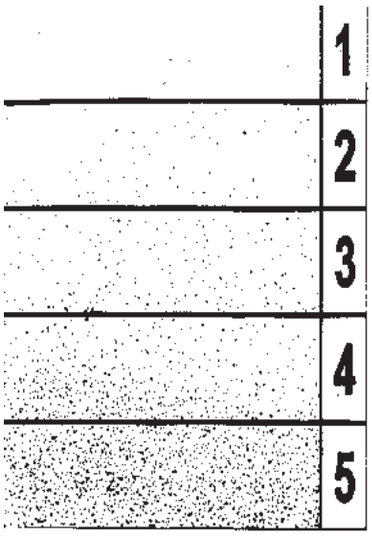
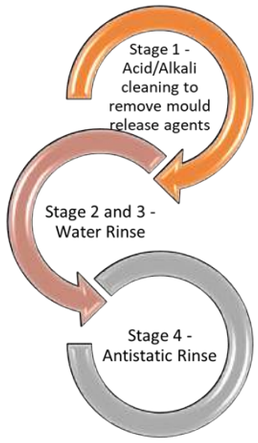


Fig 3.1.3 (ii): This chart is used to check the dust level.

After blasting dust level shall be checked and reported before the next coat. The dust test kit can be used in accordance with the recommendations of either as a pass/fail test or as a permanent record. To perform the dust/debris removal test, a clear adhesive tape (25 mm wide), magnifier and a white board is needed.

3.1.4 Chemical Pretreatment for Plastic Components

Chemical treatment is also possible for plastic components and it generally involves these four stages.



- Degreasing tank uses a mild alkali for cleaning the plastic components.
- Antistatic rinse eliminates static charges from the plastic surface and prevents dust attraction. The effect of antistatic charge remains only for a short duration and hence it is necessary to paint treated plastic immediately.
- Pre-treated parts (metal or plastic) should not be touched or sanded after pretreatment and must be painted immediately. Being very thin, phosphate coating alone cannot protect the metal substrate from corrosion, but it adds to corrosion resistance if painted immediately.
- For plastics such as TPO and PP, treatments like Corona Arc, Flame Burning and Plasma Treatment are also used to ensure paint film adhesion. The basic principle is to increase surface energy of plastic to improve adhesion of paint.

Other Pretreatment Methods

A three-in-one chemical – combining degreasing and phosphating in a single chemical, is also being used. The performance in this case is not as good as a multi stage system. It is mainly used for repainting structures and components which cannot be pre-treated through a multi stage system.

- In addition to zinc phosphate, iron phosphate and manganese phosphate are selectively used in industry. Iron phosphate has inferior performance. It is used for frames of heavy commercial vehicles and in furniture industry, while manganese phosphate is used for nut-bolts and pipe lines.
- Chromatising is a pretreatment process for zinc and aluminium. Both these metals can also be phosphated using multi-metal phosphating chemicals, which requires fluoride addition. Aluminium wheels and engine parts are blasted or anodised before painting.
- Nano technology-based pretreatment chemicals are being introduced. Nano chemical-based phosphating has the advantage of “no sludge generation” in the pretreatment process.

3.1.5 Chromatising Process

Usually, this process is used for chemical pretreatment of aluminium, GI and hot dip galvanised components.

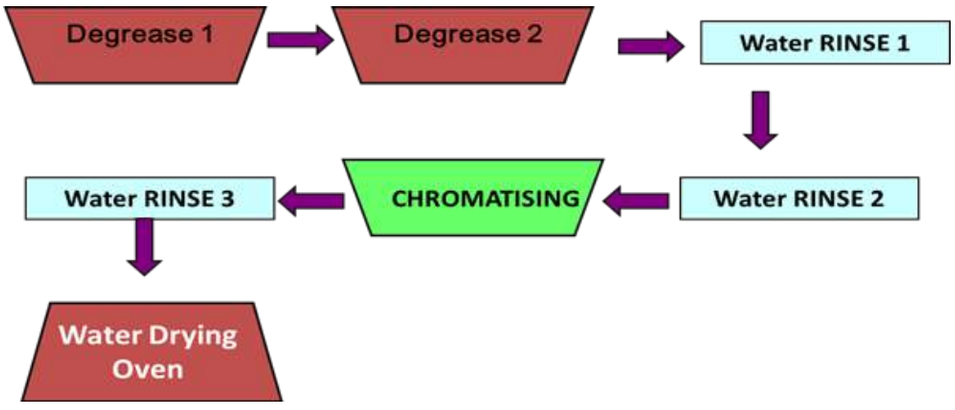


Fig 3.1.5: Schematic chromatising process chart

Incoming material check:

- If light white rust is found, it should be removed offline mechanically with sand paper of 400 grit or finer.
- In case of GI, if you find red rust, please do not take the jobs for further processing, inform the customer.
- In case of handling damage, specifically for aluminium, the job should not be taken for further processing.

Since the chemicals, concentrations and operating conditions vary from supplier to supplier, prepare the following chart for all the processes as a ready reference.

Step	Stage	Chemical Name (as applicable)	Pointages Concentration Range (as applicable)	Temp. C	Dip Time
1	KOD				
2	Degreasing				
3	Water Rinse 1				
4	Water Rinse 2				
5	Chromatising				
6	Water Rinse 3				
7	Oven Drying				

The loading of the job should be done as indicated in step 1 of phosphating process. The steps in the chromatising process are:

Knock-off degreasing, degreasing	This process is same as degreasing in phosphating, only difference being here we use of mild alkaline salts and more of surfactants.
Water rinsing 1,2, and 3	All water rinse stages would have the same function as above
Chromatising	This step helps the surface of aluminium or GI to react with the bath solution and create a light roughness and a chromate layer which improves the adhesion to coating.
Water drying oven	Water or chemicals from the components should dry completely. Maintain the drying time based on the job loading while ensuring complete water removal happens.

3.1.6 Factors to be Considered for Pretreatment Process

To get the optimum result from any pretreatment process it is essential to control all the components of the process.

PRETREATMENT CHEMICAL QUALITY	• To get consistent result from pretreatment process, chemical must be of consistent quality. To ensure this, regular titration must be done every shift and a record maintained. These titration values are called pointages. • The chemical supplier will recommend the titration details and the pointages for baths. • Ask the chemical supplier to give a detailed description of operating parameters in the form of an Operating Manual. • This manual should contain all the information pertaining to the process. • Generally, the chemical supplier provides training on the system covering the basics of each process and how to monitor the system.
BATH TEMPERATURES	• To get consistent results from the pretreatment process, chemicals must be at the temperature recommended by the supplier. The process may be carried out at room temperature, but a hot reaction process is preferred by many industries as it gives faster and better-quality production.
DIP/SPRAY TIME	• The chemical contact time in the tanks also plays an important role. The recommended time for the process must be followed and it should not be altered in any situation. • In case of manual system, a timer should be used by the operator for maintaining the recommended time at each stage. Timers can be attached to hooters for indication. It is important to ensure that the jobs are not allowed to dry between the stages and should dry immediately at the end of the process.
WATER QUALITY	• Quality of water is very important. Only water meeting recommended quality is to be used at each stage.

Pretreatment Process Control Chart

The stages in the table below would change as per the process details. The chemical supplier would help to fill this chart.

Step	Stage	Chemical name (as applicable)	Pointages / Concentration / Range (as applicable)	Temp. C	Dip Time
1	Hot Water Rinse				
2	Knock-off Degreasing (KOD)				
3	Degreasing				
4	Water Rinse 1				
5	Water Rinse 2				
6	De-rusting				
7	Water Rinse 3				
8	Water Rinse 4				
9	Surface activation				
10	Phosphating				
11	Water Rinse 5				
12	Water Rinse 6				
13	Passivation				
14	Water Drying Oven				

3.1.7 Major Problems During Pretreatment

1. Improper degreasing: Water break is observed all over the component or locally.
2. Yellow/rusty coating: Yellow coloured coating is observed during drying.
3. Powdery coating: White powdery coating can be observed, and the powder comes off when touched by hand.
4. Incomplete phosphate coating: Phosphate coating is not formed completely on the surface. Base metal or blue colour is visible.
5. Phosphate sludge: During phosphating, the reaction produces a white precipitate, called sludge. The sludge being heavy, settles at the tank bottom when the bath is standstill, this has a tendency to stick to the surface while the phosphate layer is forming, and these crystals get entrapped within the phosphate crystal structure, making it loose/not adhering properly to the surface.

Fig 3.1.7 (i): White powder formation on phosphate layer *Fig 3.1.7 (ii): Oil separators for degreasing bath*

Removal of sludge: A filter press of about 20 microns filtration capacity can filter sludge on line to solve this problem. The oil / grease after removal, would accumulate and float as a layer on top of the degreasing tanks. It is important to remove it at a regular frequency. Else, an oil film may get redeposited on the degreased jobs. Also, the circulation would induce this oil back into the system where it will react with chemicals to reduce their potency.

Fig 3.1.7 (ii): Filter press for online sludge removal

3.1.8 Loading Jobs in Baskets for Pretreatment

Fig 3.1.8: Incorrect and correct way of stacking baskets for pretreatment

- The jobs loaded in a basket should not touch/mask/cover each other or should not be loosely hung whereby they damage each other.
- The water/chemical should be in contact with the entire job surface and should drain quickly when taken out from the baths.
- The jobs should not dry during the process at all.
- The orientation of the job hanging / placing should not permit any holding / trapping / clogging of water as it will carry over the chemical solution to the next tank and contaminate it.
- Air pockets should not be formed, else the chemical/water will not reach the surface and no reaction will take place.
- Regular industrial water / DI water test certificates should be maintained for records.

3.1.9 Trouble Shooting

PROBLEM	TEST	CAUSE	SOLUTION
POOR CLEANING / IMPROPER DEGREASING	Visual Water Break Test	• Variables such as pointage, pH, process time or temperature not at recommended levels. • Poor circulation in tanks • Mustard oil used in the earlier process	• Set the variables to recommended level. • Check the condition of the eductors, clean, or replace as necessary. Check filters • Request to change oil.
FLASH RUSTING	Visual	• Dry off after degreasing and surface activation • Phosphate bath not maintained at recommended parameters. • Low, recessed area on parts retain excessive moisture / Dampness	• Bring phosphate bath parameters to the recommended pointage • Check for Free Acid Values and Total Acid values and ratio to be maintained • Reduce temperature of degreasing stage • Introduce water sprinklers to prevent drying • Rerack parts to promote proper moisture runoff

WATER SPOTTING	Visual	• Contaminated rinse • Poor raw water quality	• Dump, clean and recharge rinse stages, increase overflow • Check total dissolved solids(TDS) in the rinse tank, dump and clean rinse tanks or increase overflow
SOLIDS DRIP LINE	Visual	• Contaminated final rinse	• Compare TDS of rinse and raw water. Dump and recharge the final rinse to reduce TDS, DM Water quality
SMUT AND INORGANIC SOOT	Visual	• pH too high • Poor Cleaning of KOD, Degreasing • Poor quality steel, improper storage of steel • Poorly regulated dry-off combustion leaves residue	• Lower pH • Prequalify incoming steel, store steel correctly-indoor and away from plating line • Check for proper ignition and combustion; check air to fuel ratio
OIL BLEED OUT	Visual	• Oil entrapped in metal gaps • Pretreatment variables out of control	• Check the metal precleaning condition • Reduce soil amount • Control fabricating gap • Recheck all the process variables particularly temperature

RECOMMENDED WATER QUALITY

Sr. No.	ITEM	STANDARD
	PHYSICAL	
1	APPEARANCE	CLEAR
2	COLOUR	COLOURLESS
3	TURBIDITY	2.0 MAX
4	ODOUR	ODOURLESS
5	pH VALUE	5.8 - 8.0
6	TOTAL DISSOLVED SOLIDS (TDS)	300 MG/LIT MAX.
7	CONDUCTIVITY	100 uS / CM.
	CHEMICAL	
1	TOTAL HARDNESS	150 MG/LIT MAX.
2	SULPHATES	5.0 MG/LIT. MAX.
3	CHLORIDES	25.0 MG/LIT MAX
4	NITRATES	10.0 MG/LIT MAX
5	DISSOLVED IRON As Fe	0.3 MG/LIT. MAX.
6	CHROMIUM	0.05 MG/ LIT.
7	CHEMICAL OXYGEN DEMAND	MAX. 5.0 MG/LIT.

3.1.10 Importance of Company's Policy and Work Instructions to Ensure Quality Standards

A company's policy defines and ensures adherence to quality standards. What kind of durability must the finished product meet? What criteria are laid out for the quality assurance program? What are the customer's specifications? Based on these a Standard Operating Procedure or SOP is generated with specific work instructions.

An SOP is a procedure specific to the operation that describes the activities necessary to complete tasks in accordance with industry regulations, legal requirements, and quality standards.

3.1.11 Follow SOP for Pretreatment Process

SOP is a set of step-by-step instructions compiled to help workers carry out routine operations. It aims to achieve efficiency, quality output and uniformity of performance, while reducing miscommunication and failure to comply to quality regulations.

foodsafetyhelpline.com

Why is following an SOP important?

- To save time and avoid mistakes
- To ensure consistency in the process
- To reduce training costs
- To support quality goals

Fig 3.1.11: SOP displayed at the plant floor

- Understand company policy and strategy.
- Follow all safety norms.
- Understand all work instructions clearly and follow them.
- Read the parameters to be maintained for all pretreatment baths, painting booth and painting process.

If bath parameters are maintained properly, the coating quality will always be good and consistent.

Tips

- Pretreatment ensures and enhances the proper adhesion of the coating to the substrate. It is hence important to do pretreatment carefully to get the optimum coating performance. Pretreatment method and process would depend on the nature and quality of substrate and customer specification.
- Do remember to watch – water, action, time, chemical, heat during the pretreatment process.

Practical Activity

Preparation of surface of a steel job with sanding with a Emery paper /Sand paper

Notes

Notes

Scan the QR code for video

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PAINTS AND
COATINGS
SKILL COUNCIL

4. Apply Top Coat and Finish the Surface

Unit 4.1 - Process of Mixing - Prepare the Paint for Application
Unit 4.2 - Apply Paint on the Surface
Unit 4.3 - Finish the Surface

Scan the QR code for video

Applicable NOS – PCS/N5107

Key Learning Outcomes

At the end of this module, you will be able to:

1. Adapt the paint mixing/ preparation process recommended by the manufacturer
2. Describe the application process for General Industrial (Liquid) Paint
3. Explain the spray application process and control parameters
4. Follow guidelines to check the quality of the coated components
5. Describe the process of curing the coated component
6. State the care to be taken during packaging and assembly

UNIT 4.1 Process of Mixing - Prepare the Paint for Application

Unit Objectives

At the end of this unit, you will be able to:

1. Identify the paint storage condition, preparation of the paint for application as per TDS of the manufacturer.
2. Mix the paint with the recommended thinner to achieve the application viscosity suggested by the manufacturer

It is important that the paint is in proper condition for application. Before paint application follow these recommended practices.

Storage

- Store paint at moderate temperature (15-30 °C), in a cool, covered place away from direct sunlight.
- Use earlier batches first; this is referred to as FIFO system (First In First Out)
- Reverse containers at regular intervals to avoid excessive settling and to make mixing easier. It is better to apply panels in laboratory and check opacity and finish, before using the paint.

Fig4.1 (i): Correct way of paint storage

Mixing

- Mix the paint properly. The supernatant liquid and settled pigment should be completely mixed and homogenised. Mix clear/varnish thoroughly, even though it may appear to be clear.

- Use only recommended thinner for thinning.
- Use a stopwatch for checking the viscosity of the paint with a viscosity cup.
- Clean the Ford cup properly before and after checking viscosity.
- Adjust the viscosity as per temperature. Refer viscosity temperature graph and then record the application viscosity and the temperature.
- Ensure paint level in the tank sufficiently above stirrer, so that excessive foaming does not take place.
- Maintain cleanliness; regularly carry out general and preventive maintenance of equipment

Fig 4.1 (ii): Different types of paint mixing stirrers

Fig 4.1 (iii): Paint mixing

Fig 4.1 (iv): Ford cup to adjust viscosity

Use recommended size of filter as specified by the supplier for filtration.

In OE market, the colour (shade) is fixed and paint supplier will send every batch of the material matched to standard shade panel. After thoroughly mixing the paint, the colour can be checked on a colour computer and shade difference (delta-E) can be recorded.

4.1.1 Mixing Thinner and Hardener in the Recommended Ratio

In the OE paint kitchen, paint is mixed with thinner to a specific viscosity, which is called application viscosity. This can vary from paint to paint and between different paint shops. Application viscosity is finalised after the initial line trials. Single pack paints do not require hardener, as it is already mixed by paint supplier.In a two-pack paint system, the base and the hardener are supplied separately and mixed in the recommended ratio at the time of application. The base and hardener of a two-pack system can be first mixed, thinned and then applied. This method is called “hot pot” mixing. It has a limited pot life and the mixed paint should be consumed within the pot life period.

Fig 4.1.1 (iv): 1k and 2k packs

A second method for two pack systems is supply of the base and hardener, thinned appropriately to achieve the application viscosity after mixing, separately to the tip of the gun. At the tip of the gun, the thinned base and hardener are mixed and then sprayed onto the surface. This type of system does not have a limitation of the pot life.

4.1.2 Your Responsibility as an Applicator

Your responsibilities may vary from job to job, but general duties require you to:

- Obtain, read and understand the coating technical specification, specifically application parameters and MSDS.
- Follow the recommended application process and sequence as per SOP. Maintain records of work done, the conditions under which it was done, and any other items required to be reported.
- Maintain cleanliness/ hygiene of the booth, hose and guns.
- Clean the paint application system at the end of painting every day/ as per recommendations.
- Carry out a check on the paint and air hose for any leakage before commencing painting.

- Follow the preventive maintenance schedule.
- Ensure that the areas not to be painted/ coated are masked. Masking can be done using masking tape and paper and by using plugs for tubular components, threaded areas, etc.
- While preparing paint colour for 2K PU paints, maintain the correct base to hardener ratio. This is very important.
- Read the instructions given on the container.
- Understand the importance of pot life. At higher temperature pot-life is drastically reduced.
- Clean all lines and equipment before paint pot life period ends.
- Adjust viscosity as per temperature -viscosity chart.

Note

UNIT 4.2 Apply Paint on the Surface

Unit Objectives

At the end of this unit, you will be able to:

1. Explain the process flow for General Industrial (Liquid) Paint
2. Identify the factors that affect paint application and control the same
3. Describe the different methods of application
4. Explain the spray application process, it's type and parameters
5. List the paint system for different substrates/ industry
6. Identify the cause of defects due to application

4.2.1 Important Guidelines for Painting

GUIDELINES FOR PAINT APPLICATION	Paint application should be carried out between 100C and 350C temperature of the paint and surface to be painted. Ambient Relative humidity should be below 80. A booth having a controlled environment with respect to temperature and relative humidity is ideal for painting.
	Only recommended thinner should be used and application viscosity adjusted as per the viscosity temperature chart. For brush application, addition of thinner is restricted up to 5-10% by volume.
	All two pack paints should be consumed within the pot life period.
	The sequence, number of coats, air pressure, paint volume, etc. should be maintained as per the SOP for painting.
	Use PPE and follow safety measures recommended by the manufacturer and customer's SOP.

4.2.2 Factors Affecting Paint Application

APPLICATION VISCOSITY	• Viscosity should be properly adjusted before application • Very high application viscosity will reduce paint atomisation and flow levelling will not be proper, whereas very low viscosity will give problems like low DFT and problems like sagging /run downs.
PAINT TEMPERATURE	• Increase in temperature causes reduction in viscosity • Refer to viscosity temperature graph, while thinning the paint to avoid paint application problems like runs / sags or dry spray
AIR TEMPERATURE	• At high air temperature solvents evaporate faster giving poor flow and at low air temperature solvents evaporate very slowly causing sags/runs • To avoid such problems booth and flash off zone temperature should be monitored

HUMIDITY	• At very low humidity solvents evaporate faster giving poor flow and at very high humidity solvents evaporate very slowly causing sags / runs • To avoid such problems booth and flash off zone humidity should be monitored
AIR VELOCITY	• Lower air velocity reduces rates of solvent evaporation giving wet film whereas higher air velocity reduces transfer efficiency causing paint wastage • Proper air velocity in the booth avoids problems like over spray dust
AIR PRESSURE	• At high air pressure solvents evaporate faster giving poor flow and at low air pressure solvents evaporate slowly causing sags / runs • Use the lowest pressure which will atomise the paint sufficiently. This will reduce the bounce back of the spray
PAINT PRESSURE	• Check paint pressure before application • High paint pressure gives higher paint delivery and hence high film build up
THINNER	• Very fast evaporating thinners give poor flow, dry spray etc. whereas very slow evaporating thinners give wet film, mottling, runs / sags etc.
TYPE OF PAINT	• Two pack paints (polyurethane and epoxy) should be mixed just before paint application and should not be applied after completion of the "pot life" period. If not followed can lead difficulty in paint application and inferior film properties after baking • Prepare the required quantity such that, thinned material will be consumed within half of the pot life time. If pot life is 4 hrs., prepare the paint which will be consumed within two hours • Never add extra thinner to extend pot life. It will affect the performance properties

4.2.3 Paint Application Methods

ATOMISED	NON-ATOMISED
Conventional air spray	Dip
HVLP Spray	Electrodeposition
Airless Spray	Flow/Shower coating
Air assisted airless Spray	Roller coating
Electrostatic spray	Curtain coating
Electrostatic high-speed rotary application	Barrel coating
	Brushing

4.2.4 Spray Concept

- In spray application, a liquid paint is transformed into a spray of fine droplets. This is called atomisation, wherein droplets with high energy emerge from the spray gun. It is a physical

mechanical process. These atomised droplets appear as a spray cloud. Atomisation Energy (AE) and Coating Flow (CF) are important components of spray process.

- Plural component spray guns, have two or more suction hoses for the base and hardener respectively, which are then mixed at the tip of the spray nozzle. This eliminates the limitation of pot life.
- Paint flow/ delivery means volume of paint coming out from spray equipment. It is expressed in ml /minute.
- The air pressure/ bell or disc speed, fan width/ shaping air and paint flow rate are important application parameters to be controlled for consistent quality of deposition of the coating. These are more important in the application of coatings containing metallic/ pearl mica pigments.
- The metallic/pearl mica pigment orientation must be perfect hencecolour is influenced by the evaporation rate of the solvent from the deposited film. The evaporation rate is dependent on the booth conditions like temperature, % relative humidity, air velocity, etc. To achieve a consistent orientation and colour in such paints, the thinner composition is determined by the "Foil Solids".

Fig4.2.4 (i): Gravity feed spray gun and suction feed spray gun

Fig 4.2.4 (ii): Pressure feed pots

4.2.5 Spray Booth

Fig 4.2.5 (i): Paint booth and down draft dry booth

A spray booth is an enclosure designed for application of paints and coatings onto components. It is generally equipped with an exhaust system to remove paint droplets not deposited on the components. It may consist of suitable filters and / or a water curtain to remove paint droplets.

Spray Booths are categorised as – 'Side Draft Spray Painting Booths' for medium sized components, and 'Down Draft Spray Painting Booths' for heavy and voluminous components. There are 'Bench spray painting booths' for small/tiny components and conveyorised booths for mass production. The conveyorised spray painting booths can be either 'side draft' type or 'down draft' type, depending upon size and weight of the component to be painted.

Spray booth maintenance and checks

- Maintain air velocity in booth at 0.4-0.6 m/sec (50-80 feet / sec) to keep booth under positive pressure
- Keep a check on the booth temperature and relative humidity
- Check whether spraying equipment are functioning correctly
- Check air pressure and cleanliness of the air filters
- Confirm addition of appropriate booth chemicals
- Check the unit in wet condition for appearance, it should be free from any visual defect
- Record any abnormal conveyor stoppages, if any
- Bell / gun flushing should be done as per specified norms
- Confirm whether there is any change in regular practice

To ensure the above points, appropriate check sheet for spray booth controls should be maintained.

4.2.6 Spray Application

Fig 4.2.6 (i): Spray application on plastic components and metal components

Fig 4.2.6 (ii): Spray application in process

POSITION OF THE SPRAY GUN	• Hold the gun in the natural position, placing the index and middle fingers on the trigger • Hold the air and the fluid hoses in the other hand or tie them together for ease of movement • Always keep the spray gun perpendicular to the surface during its entire movement. If the gun is not held perpendicular to the surface during application, it will result in deposition of uneven film • Adjust the gun distance around 6-8 inches for conventional equipment. For electrostatic application, gun distance should be 10-12 inches. Note that closer distance in electrostatic spray can give spark and will cause runs and sags because less solvents will evaporate before paint reaches the substrate. Longer distance will cause dry spray because more solvents will evaporate before paint reaches the substrate

TRIGERRING	• Proper triggering of the gun is the major key for the even application of the coating • Always have the spray gun in motion before triggering • Always trigger the spray gun just after the spray stroke starts and release it just before it ends • Triggering at the end of each stroke would help to prevent the paint accumulation on the air cap • Proper triggering will reduce overspray and tendency of spray nozzle choking, which will cause spitting (un-atomised paint particles that look like dust)
OVERLAP	• Since the paint concentration in the spray is somewhat less at the edges of the pattern, it is important that each of the subsequent strokes overlap about 50% of the previous stroke • It is best to start at one end of the top, then alternate strokes from left to right and right to left, overlapping each previous stroke about 50%
SPEED	• Move the spray gun across the part at the same speed • The speed of movement of gun should be 2-3 feet per second. This would produce correct film thickness without sags/runs
BANDING	• Alternative spraying leaves edges/corner with too thin a coat of paint, this should be banded with a single stroke vertical to the others
APPLICATION OF STROKES	• At very high air pressure solvents evaporate faster giving poor flow and vice-versa • Put on a full wet coat whenever possible • Give proper flash time between two strokes • On similar objects use the same number of strokes • On similar objects end the last stroke in the same place
CLEAN UP	• Clean the spray gun, paint container, paint hose and air filter to avoid future problems • Shut the pressure to the paint pot after it is used to remove the paint from the container and rinse with proper solvent • Fill the container with compatible solvent and apply pressure to paint container and gun. Continue to spray solvent until both spray gun and hose are cleaned • After few minutes remove the air cap. Finally drain and dry all equipment

4.2.7 Paint Application Methods

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 efficiency • It is portable and easy to clean and has a lower risk of blowback to the worker. However, the atomisation 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 6500 psi • Airless spray 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 • Airless spray is limited to painting large areas and requires a different nozzle to change spray pattern. The nozzle tends to clog and it can be dangerous to use or clean because of the high pressure involved. The nozzle size is very important. If a wide nozzle is used, the paint will not atomise
ELECTROSTATIC SPRAYING	• This type of spraying method eliminates overspray and saves considerable paint • It is also capable of coating most of the paints over metallic objects and over many non-metallic materials using a conductive primer. • The difference between electrostatic and air spraying is that the electrostatic gun has an electrode at the nozzle and the object to be painted is grounded. The charged paint is attracted to the grounded object. This requires less pressure, produces little overspray and uses relatively less paint. This also produces a uniform coat because the paint itself acts as an insulator, once the object is covered, it can take no more paint • The disadvantages are: only one coat is possible, only conductive material can be painted, it is more expensive, has higher maintenance costs, is limited to chargeable paints and the surface of the object must be extremely clean • The use of high voltage (around -80 KV) to charge the paint, this method presents a possible shock hazard. The resistivity of the paint, at application viscosity, should be maintained between 500 to 1000 Kilo Ohms for safe operation
ROTARY ATOMISING	• Rotary atomisers use centrifugal force generated due to the high-speed rotation, and air or hydraulic pressure, to atomise the paint and direct it towards the surface to be painted • The atomisation and transfer efficiency by atomisation method is excellent. • Cleanliness is especially important in this method • Rotary atomisers can present a safety hazard due to high speed rotation
DIP COATING	• In this process, parts are dipped into a vat of paint. This allows for high production rate and transfer efficiency, the labour required is relatively lower • The effectiveness of dip coating depends greatly on the viscosity of the paint, thickening with exposure to air should be carefully managed • Dip coating is not suitable for objects with hollows or 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. The paint is collected back in a tank • This system has the advantages of dip coating, along with low installation costs and low maintenance requirement • The quality of the finish is also about as good as with dip coating
CURTAIN COATING	• Instead of many streams of paint, curtain coating uses a waterfall flow of paint to coat parts on a conveyor belt • Curtain coating has 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
COIL COATING	• Paint is applied to auxiliary rollers which then transfer it to the application rollers which runs across the uncoiled sheets • This method has high transfer efficiency and high production rates, but is limited to flat sheets only
ELECTRO COATING (ELECTRO DEPOSITION)	• 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 of 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
HOT SPRAYING	• A few OE – manufacturers in India use this technique • Paint is heated through heat exchanger to 55-60°C and sprayed. Very less solvent addition required (3-5% on paint) to reduce viscosity. Required film build can be achieved in fewer passes • It gives less VOC emission and hence is environmental friendly

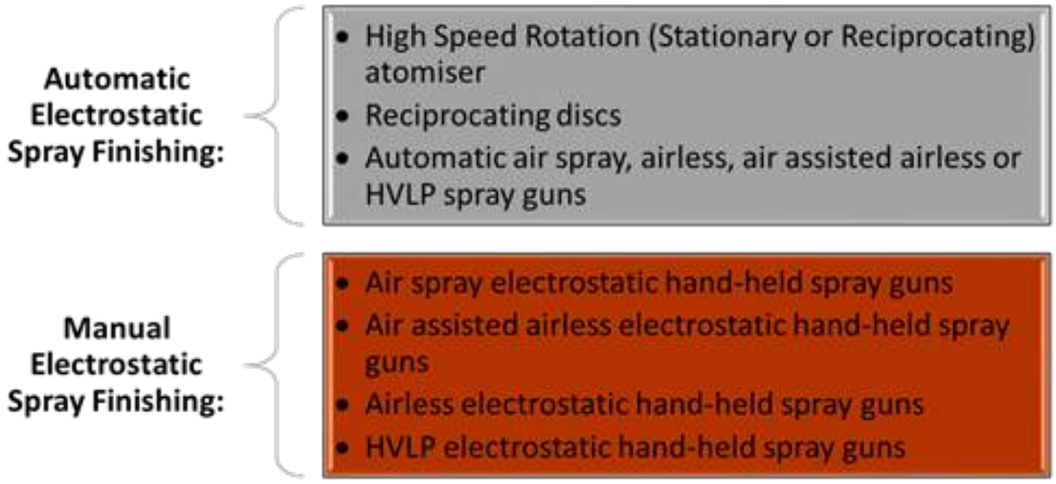
Fig 4.2.7 (i): Conveyorised painting line

4.2.8 Electrostatic Spray

The term electrostatic spray finishing refers to a spray finishing process in which electrical charges and electric fields are used to attract particles of atomised coating material to the target (the object to be coated). In the most common types of electrostatic systems, electrical charges are applied to the coating material and the target is ground, creating an electric field. The charged particles of coating material are drawn by the electric field to the surface of the ground target because of the attraction of opposite electrical charges.

Electrostatic spray improves the transfer efficiency of spray finishing equipment because the electrostatic forces help overcome other forces, such as momentum and air flow that can cause the atomised materials to miss the intended target. It is the most commonly used technique in the OE industry. The type of equipment used may be electrostatic hand guns, electrostatic reciprocating (automatic up and down movement) guns or electrostatic rotary applicators like bell and disc.

The two types of electrostatic spray finishing systems are automatic and manual.



Electrostatic Charging Methods:

There are four types of electrostatic charging methods:

- Corona charging
- Contact charging (also called conduction charging)
- Induction charging (also called non-contact charging)
- Frictional charging (also called tribo charging)

Of these methods, corona, and contact charging are the common methods used in liquid electrostatic spray application.

Corona Charging:

In this method of application, a high voltage generator (power pack) is used to charge an electrode at the tip of the gun. This creates an electrostatic field (or corona) between the gun and the ground component. This charge is transferred to the atomised paint particles as they travel from the gun head

towards the substrate. The charged atomised paint particles are deposited on the ground substrate. Some of the problems associated with corona guns are back ionisation and the Faraday Cage Effect.

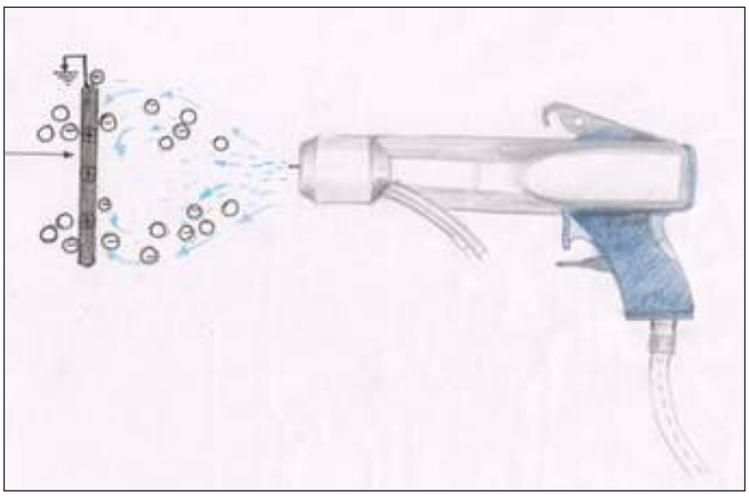


Fig 4.2.8 (i): Corona Gun

The Tribo guns are mainly used for the application of powder coating.

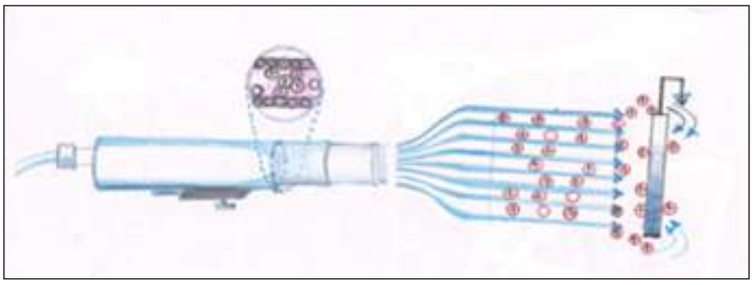


Fig 4.2.8 (ii): Tribo Gun

Contact Charging: The contact charging (or conduction) method utilises a direct charge transfer, rather than ionisation. In this method, an electric charge flows from a source of high potential (voltage) to the coating material that it meets.

A limitation of contact charging is that it is not easily used to apply an electrostatic charge to insulating coating materials. It is limited to relatively conductive coating.

Induction Charging: This method uses an electric field to induce charge onto an earthed (ground) object that is near a charged surface. If the ground is removed from the object, the induced charge cannot be dissipated, and the object retains its charge. Induction charging is also limited to relatively conductive coating.

Frictional Charging: In frictional charging, contact or friction between two unlike materials generates a charge. The amount of charge that is generated depends on the nature of the contact, the electrical properties of the materials and the conditions of humidity and temperature. This is also known as tribo charging.

The wrap around effect is the effect of electrostatic spray application, in which the spray is directed at the face of the object, yet part of the back side of the object is coated. This wrap around effect occurs when spray particles that have moved past the targeted surface are drawn back to the object by the electrostatic force.

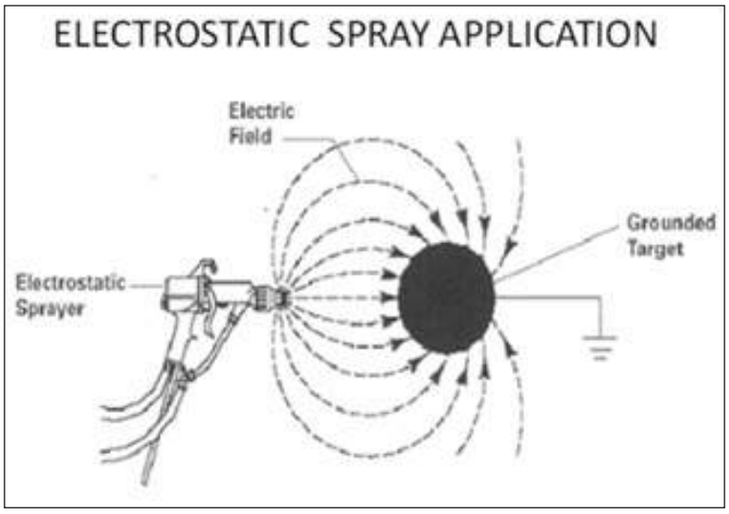


Fig 4.2.8 (iii): Electrostatic spray application

Objects with deep cavities are not ideal for electrostatic spray finishing process. This is because the paint is drawn to the outermost points of the object, which can lead to uneven coating. This type of uneven coating is the result of the **Faraday Cage Effect** as illustrated here.

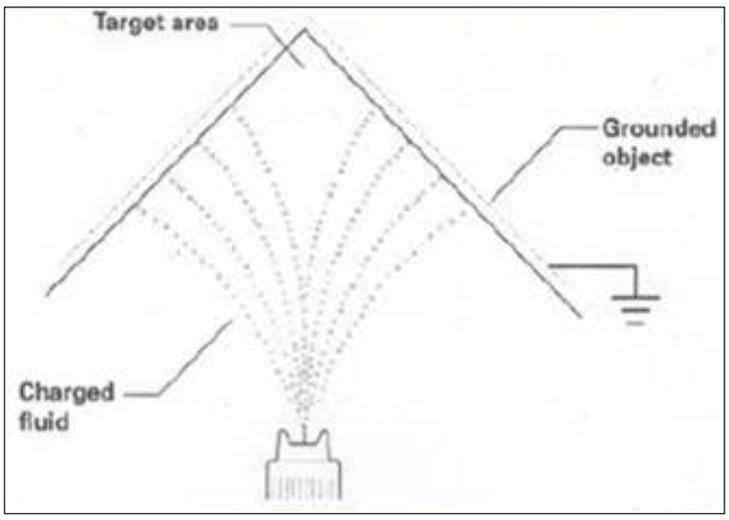


Fig 4.2.8 (iv): Faraday Cage Effect

4.2.9 Electrodeposition

Although dip coatings penetrate the recessed areas, they are usually washed off by solvent vapours during baking. This led to development of electrocoat.

Advantages of electrocoat:

1. Formation of protective films in highly recessed areas such as flanges and box sections provide critical corrosion protection.
2. Transfer efficiency of more than 95%, results in reduced paint wastage.
3. Use of water as practically the only carrier, virtually eliminates fire hazard, materially reduces water and air pollution.

4. The low paint bath viscosity (approximately equal to that of water) results in ease of pumping and allows drainage of trapped materials in coated vehicle.
5. Freshly deposited paint is insoluble in water, permitting complete rinsing and recovery of dragged out material.
6. Being a closed loop automated systems, productivity and consistency is excellent at low operating cost.

Electrocoat is used on automobiles, motor accessories, farm equipment, domestic appliances, steel furniture, electrical equipment and many other articles of metal. An Electrocoat bath generally has 82% water + 10% Resin + 5% pigment + 3% solvent.

Cathodic Electro Deposition (CED) plant requires many facilities like: paint circulation, heat exchanger, rectifiers, ultra-filtration system (UF), anolyte system, oven etc. The electro deposition process is self-limiting because the paint insulates the surface such that, a point is reached where no more paint can be deposited. Although input rectifier capacity is higher, average voltage utilisation is 200-300 volts, during CED deposition the anolyte is needed to remove excess acid from the paint bath. Continuous circulation of bath keeps the paint solids suspended in solution, provides method of cooling the paint and provides mechanical filtration.

Ultra-filtration is a process for separating a portion of low molecular weight component of the paint bath from the main system.

Conductivity, pigment to binder ratio, solvent content, ionic ppm analysis, bacteria analysis are the major parameters to be checked. CED is a complex process and specialised training is required to understand the concept and run the line.

4.2.10 Transfer Efficiency

Transfer efficiency is a measure of the percentage of coating material that coats the product versus what is wasted in the form of overspray.

Transfer efficiency is usually expressed as the percentage of the weight of solids gained by the part versus the weight of solids sprayed. For example,60 percent transfer efficiency means that 60 percent of the weight of the solids in the material that was sprayed reached the target. The balance of 40 percent was lost to the spray booth or other areas during the spray application process.

High transfer efficiency not only helps meet environmental regulations and cuts costs, it also provides a safer work place. Suppose, you take 1 liter paint for application, after the painting you will find that 70% paint was deposited on parts and 30% lost by way of overspray. This means transfer efficiency of the application method is 70%.

Calculating Transfer Efficiency:

A simple formula for calculating transfer efficiency is given below. The necessary inputs for using this formula can be obtained by measuring the amount of material sprayed and the amount of material on the part.

- Ws = Weight of material sprayed
- Wp = Weight of material on the part
- T.E.= Wp/Ws x 100%

Transfer efficiency depends on:

- Paint non-volatile content (% solids),
- Reciprocating speed, paint flow rate (emission volume),
- Pattern width, conveyor speed, spray distance,
- RPM of electrostatic Bells and disc applicators,
- Jig design and component loading (jig density) etc.

Transfer Efficiency vs Application Method

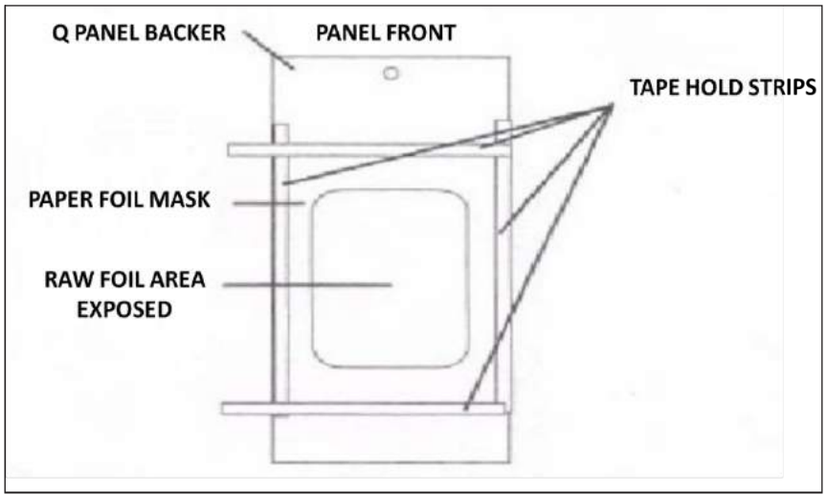
Transfer efficiency of various application methods is summarised below.

NO	APPLICATION METHOD	% GENERAL TRANSFER EFFICIENCY
1	Conventional air spray	30 – 50
2	Airless spray	55 – 75
3	Air assisted airless spray	55 – 75
4	HVLP	55 – 75
5	Electrostatic spray	55 – 75
6	Electrostatic Rotary spray	75 – 95
7	Powder coating	75 – 95
8	Dip coating	90 +
9	Electro deposition	95 +

Foil Solid

- Transfer Efficiency can be established using a method called **"Foil Solid"**using pre-cut and pre-weighted aluminium foil.
- After painting, the foil is folded and weighed again.
- Then it is unfolded and baked to full cure using the normal baking schedule (time and temperature).
- From this data, one can calculate the actual solids transferred on the foil. Supply solids of the paint are known or can be measured using standard lab test method.

Using foil solid method, transfer efficiency at various stages (immediately after spray, during flash off, before entry in oven etc.) can be calculated and this data is used for achieving consistent performance. The foil can be fixed as shown in the figure below.

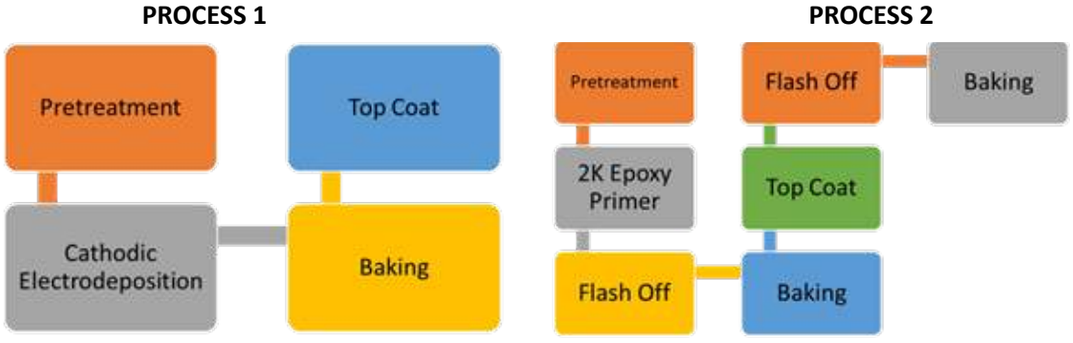


4.2.11 Different Paint Systems Used in General Industrial Painting

Paint Systems for Tractor Industry

Application methods:

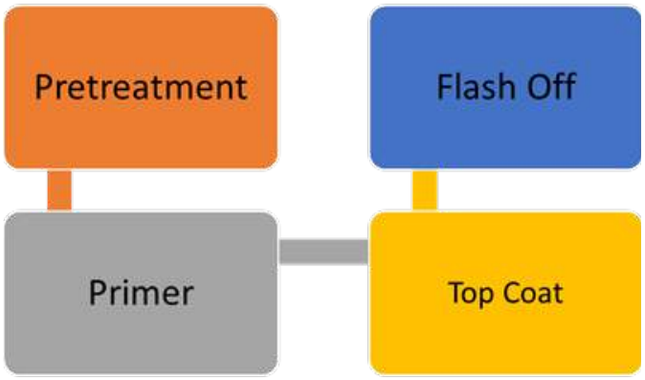
- Conventional spray
- Electrostatic handgun
- Electrostatic rotary atomiser



Paint Systems for Cycle Industry

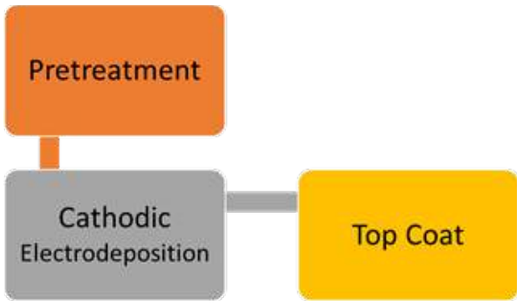
Application methods:

- Conventional spray
- Electrostatic handgun
- Electrostatic rotary atomiser



Paint Systems for Wheel Industry

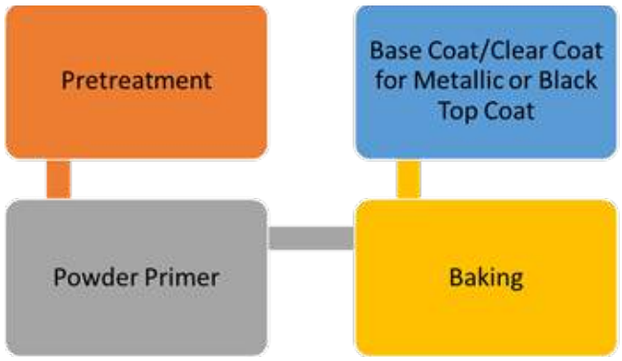
For Mild Steel Wheels



For Aluminium Alloy Wheels

Application methods:

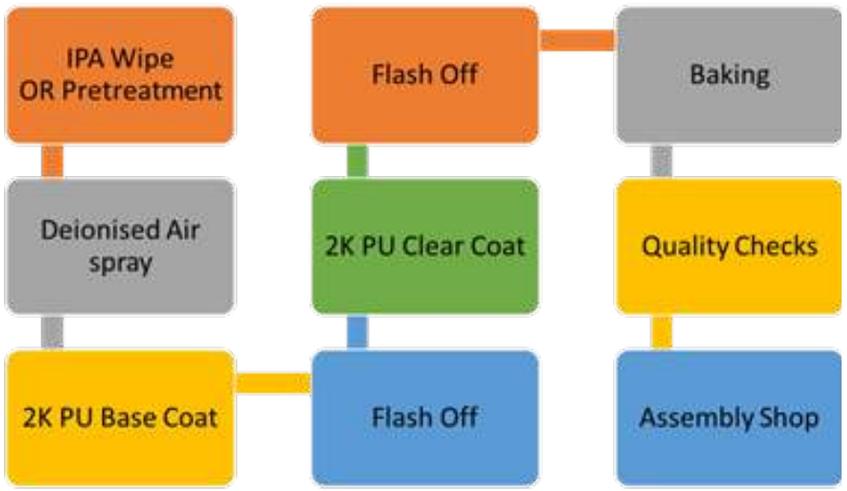
- Conventional spray
- Electrostatic handgun
- Electrostatic rotary atomiser



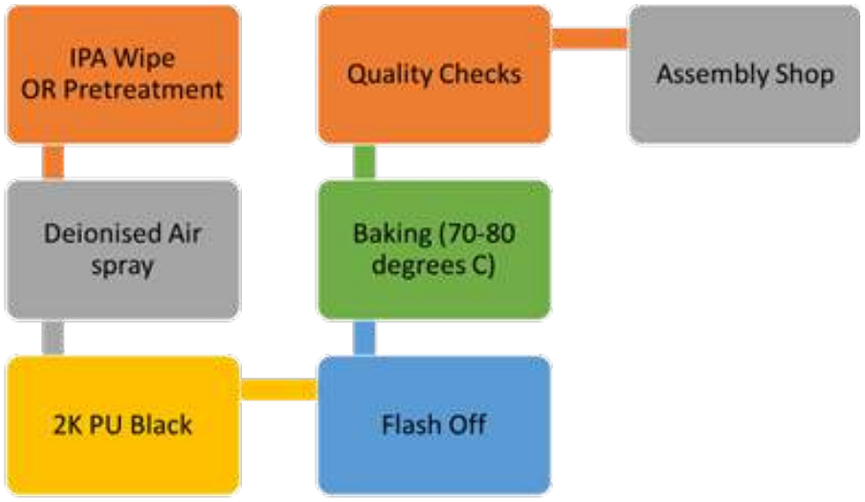
Paint Systems for Plastic Industry

ABS (Acrylonitrile Butadiene Styrene)

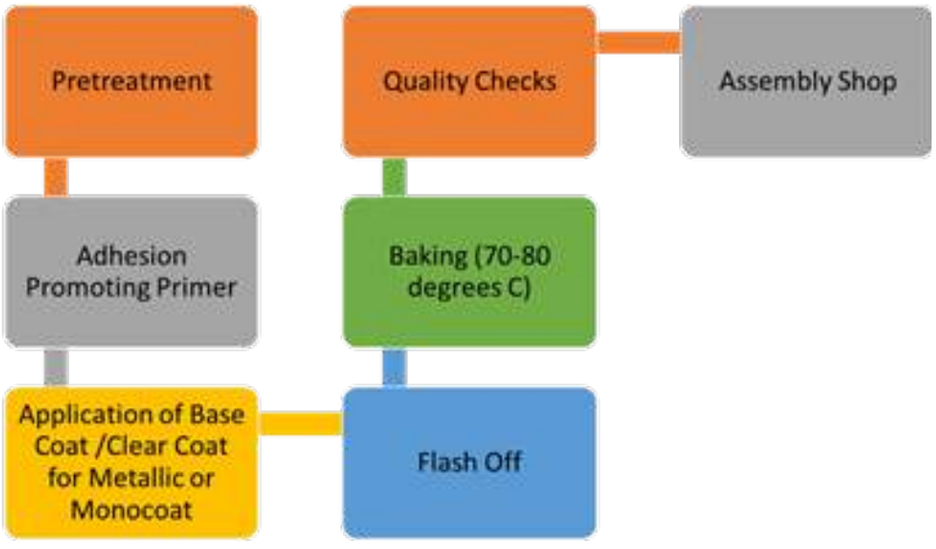
This system is for metallic shades. For black, 2k PU Black is used.



Second system for black top coat



PP EPDM (Polypropylene- Ethylene Propylene Diene Monomer)

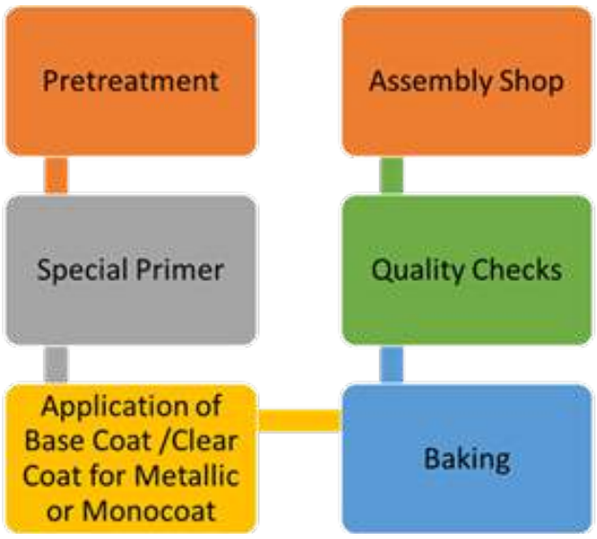


**Pretreatment can be Corona Arc / Flame Burning / Chemical Pretreatment / IPA Wipe / Plasma Pretreatment*

Mineral Filled Nylon and other plastics

Application methods:

- Conventional spray
- Electrostatic handgun
- Electrostatic rotary atomiser



**For plastics, special conductive primer is necessary before electrostatic application to have conductivity*

4.2.12 Heat Resistant Paints

In OE industry, heat resistant paints are used on various parts which are subject to high temperature during service, such as engine covers, silencers, etc. The temperature during service may range from 250 ^{o}C to 650 ^{o}C. Heat Resistant paints are based on modified/ pure silicone resins. The method of application of heat resistant paints is generally conventional spray for exterior surfaces and pouring or pumping in for interior surfaces. The coatings are generally cured by baking at elevated temperatures of about 140° C.

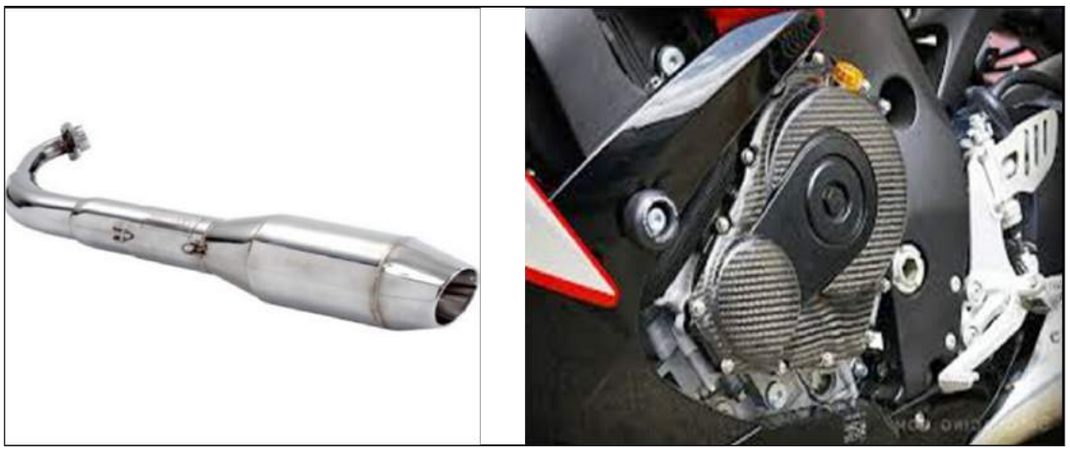


Fig 4.2.12 (i): Motorcycle silencer and engine cover

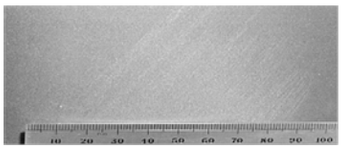
4.2.13 Common Problems in Spray Application

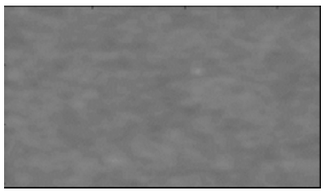
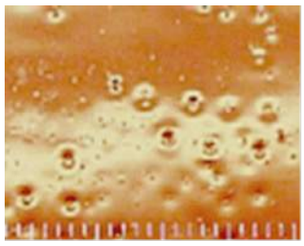
PROBLEM	CAUSE	CORRECTION
FLUID LEAKAGE FROM FLUID PACKING UNIT	• A loose packing nut • Worn packing • Dry fluid-needle packing	• Lubricate packing with a few drops of light oil • Tighten packing nut to prevent leakage, but not so tight as to grip the fluid needle • Replace the packing when it is worn out • Tighten the packing nut until it grabs and holds the needle, then back off the packing nut until the needle is free to travel into the fluid tip
AIR LEAKAGE	• Foreign matter on valve or seat • Worn or damaged valve or seat • Broken air-valve spring • Sticking valve stem due to lack of lubrication • Bent valve stem • Packing nut too tight • Gasket damaged or omitted	Inspect and correct
FLUID LEAKAGE FROM THE FRONT OF THE GUN (PRESSURE FEED)	• Worn or damaged fluid tip or needle • Lumps of dirt lodged in fluid tip • Packing nut too tight • Broken fluid-needle spring • Wrong size needle or tip	Inspect and correct
JERKY OR FLUTTERING SPRAY	Applying to both suction and pressure feed: • Lack of sufficient material in container • Tipping container at excessive angle • Obstructed fluid passageway • High-viscosity coatings requiring addition of thinner • Loose or cracked fluid pick-up tube in cup or tank • Loose fluid tip or damaged tip seat	Inspect and correct
TOP-HEAVY PATTERN	• Horn holes partially plugged • Obstruction at the bottom of fluid tip • Dirt on air cap seat or fluid tip seat	Determine if obstruction is on air cap or fluid tip. This is done by making a solid test spray pattern, then rotating the cap one-half turn and spraying another pattern

BOTTOM HEAVY PATTERN	• Horn holes partially plugged • Obstruction at bottom of fluid tip. • Dirt on air cap seat or fluid tip seat	• If the defect is inverted, obstruction is on the air cap. Clean the air cap. • If not inverted, it is on the fluid tip. Check for fine burr on the edge of the fluid tip (remove with 600 wet or dry sand paper) or for dried paint just inside the opening (remove by washing)
HEAVY RIGHT-SIDE PATTERN	• A loose packing nut • Right side horn holes partially clogged • Dirt on right side of fluid tip	Inspect and correct
HEAVY LEFT-SIDE PATTERN	• Left side horn holes partially clogged • Dirt on left side of fluid tip	Inspect and correct
HEAVY CENTRE PATTERN	• Too low a setting of the spreader adjustment valve • Too low an atomising pressure or material too thick • With pressure feed, too high a fluid pressure for the atomisation air being used or material flow in excess of the cap's normal capacity • Too large or too small a tip for the material used	Readjust atomising pressure, fluid pressure and spray width until the desired spray is obtained.
SPLIT SPRAY PATTERN	Air and fluid not properly balanced	Reduce width of spray pattern by means of the spreader adjustment valve or increase fluid pressure. This latter adjustment increases speed and the gun must be handled much faster.
DRY SPRAY	Sprayed coat is short of liquid material because • Air pressure is too high • Material is not reduced or thinned correctly (suction feed only) • Gun is too far from work or out of adjustment	Decrease air pressure Reduce or thin according to directions, use proper thinner or reducer Adjust distance to work; clean and adjust gun fluid and spray pattern controls.
STARVED PATTERN	Spotty, uneven pattern, slow to build due to • Inadequate material flow • Low atomisation air pressure (suction feed only) • Gun motion too fast	• Back fluid adjusting screw out to first thread • Increase air pressure, rebalance gun • Move at moderate pace, parallel to work surface
UNABLE TO GET ROUND SPRAY	Fan adjustment stem not sealing properly	Clean or replace

WILL NOT SPRAY	• No air pressure at gun • Internal-mix air cap used with suction feed • Fluid pressure too low with internal-mix cap and pressure tank • Fluid tip not open enough • Fluid too heavy for suction feed or viscosity too high	• Check air lines • Change external air cap • Increase fluid pressure at task • Open fluid adjusting screw • Change to pressure feed or reduce fluid (i.e. add thinner)
DRIPPING FROM FLUID TIP	• Dry packing • Sluggish needle • Tight packing nut • Spray head misaligned on type – MBC guns, causing needle to bind	• Lubricate packing • Lubricate • Adjust • Tap all around spray head with wood and rawhide mallet and retighten locking bolt
EXCESSIVE OVERSPRAY	• Too much atomisation air pressure • Gun too far from surface • Improper stroking i.e. arcing, moving too fast	• Reduce air pressure • Check distance • Move at moderate pace, parallel to surface work
EXCESSIVE FOG	• Too much or quick drying thinner • Too much atomisation air pressure	• Remix • Reduce air pressure
FLUID LEAKAGE FROM PACKING NUT	• Packing nut loose • Packing work or dry	• Tighten, but not so tight as to grip needle • Replace packing or lubricate
THIN, SANDY, COARSE FINISH DRYING BEFORE IT FLOWS OUT	• Gun too far from surface • Too much air pressure • Quick drying thinner	• Check distance • Reduce air pressure • Remix
TAILS IN SPRAY FANS	• Inadequate fluid delivery • Fluid not atomising	• Increase fluid pressure • Change to larger tip orifice size • Reduce fluid viscosity • Clean gun and filter(s) • Reduce number of guns using pump • Install sapphire insert
PATTERN EXPANDING AND CONTACT (SURGE)	• Pulsating fluid delivery • Suction leak	• Change to a smaller tip orifice size • Install pulsation chamber in system or drain existing one • Reduce number of guns using pump • Increase air supply to air motor • Remove restrictions in system, clean tip screen or filter if used.

4.2.14 Troubleshooting

DEFECTS	PROBABLE CAUSE	CORRECTIVE ACTION
Sag/Runs: Downward excess flow of paint on vertical areas or at edges 	• High wet film thickness • High paint output • Use of slow evaporating solvents/thinner • Less flash time between the coats • Less gun distance • Low booth temperature • Low atomising air pressure • Low application viscosity • Narrow fan width	• Ensure proper wet film thickness • Reduce paint output • Use suitable solvents/thinner • Ensure proper flash time between the coats • Increase gun distance • Maintain booth temperature • Adjust atomising air pressure • Thin the paint to suitable application viscosity
Dry Spray: Rough finish of film during and after application 	• Low wet film thickness • Low paint output • Use of fast evaporating solvents/thinner • High flash time between two strokes • High gun distance • High booth temperature • High atomising air pressure • High/low application viscosity • High fan width	• Ensure proper wet film thickness • Increase paint output • Use suitable solvents/thinner • Ensure proper flash time between the coats • Avoid excessive gun distance • Maintain booth temperature • Adjust atomising air pressure • Thin the paint to suitable application viscosity • Adjust fan width properly
Shade Mismatch: Shade variation when compared with the standard shade 	• Poorpaintapplicationtechnique (mottling, wet/dry spray) Poor mixing of paint in drum • Uneven film thickness • Poor hiding power of paint • Excessive baking	• Apply paint properly to avoid mottling, wet/dry spray • Ensure proper mixing of paint in drum • Ensure even film thickness • Check hiding power of paint • Avoid Excessive baking
Sand Marks: Sand marks through top coat 	• Use of very coarse sand paper • Low film build of top coat • Under baked primer	• Use appropriate sand paper • Ensure proper film build up of top coat • Ensure proper baking of primer

Mottling: Uneven, patchy appearance of metallic paints 	• High wet film thickness • High paint output • Use of slow evaporating solvents/thinner • Less flash time between the coats • Less gun distance • Low booth temperature • Low atomising air pressure • Very low/high application viscosity • Narrow fan width	• Ensure proper wet film thickness • Reduce paint output • Use suitable solvents/thinner • Ensure proper flash time between the coats • Avoid less gun distance • Maintain booth temperature • Adjust atomising air pressure • Thin the paint to suitable application viscosity • Adjust fan width properly
Pin Holing: Formation of minute holes in paint film during application and drying. (Looks as if pierced with a pin) 	• Surface contamination by oil, water, dirt etc. • Poor spray conditions (e.g. Viscous coating through small nozzle) • Insufficient mixing of thinner	• Avoid surface contamination • Ensure proper spray conditions • Ensure sufficient mixing of thinner
Cissing/Cratering: Small rounded indentations evenly or unevenly spread over affected area 	• Contamination-grease/oil/silicon etc. • Booth under negative pressure • Contaminated air supply system • Surface contamination • Over baked primer	• Avoid paint contamination by grease/oil/silicon etc. • Ensure that booth is under positive pressure • Check air supply system to avoid contaminants through it • Avoid surface contamination • Ensure proper baking of primer
Dirt: Irregular particles distributed on affected area. 	• Booth under negative pressure • Poor air filter • Spray booth and flash off zone doors not closed • Poor surface preparation • Poor housekeeping • Unfiltered paint • Improper/dirty/ruptured paint filter • Incompatible flushing solvent • Poor booth and oven maintenance	• Ensure that booth is under positive pressure • Use proper air filter • Keep spray booth and flash off zone doors closed • Ensure proper surface preparation • Ensure good housekeeping • Use only filtered paint • Use proper, clean, unruptured paint filter • Use only compatible flushing solvent • Ensure proper and regular, booth and oven maintenance

Poor Gloss: dull surface appearance, poor light reflectance and poor image clarity 	• Low film build of top coat • Excessive baking • Surface contamination Use of fast evaporating solvents/thinner	• Ensure proper film buildup of top coat • Ensure proper baking of film • Avoid surface contamination • Use suitable solvents/thinner
Blisters/Solvent Popping: Small bumps in the paint film with hole at the top 	• High film build up • High paint output during application • Use of slow evaporating solvents/thinner • Less flash time between the coats • Less gun distance • Low booth temperature • Low atomising air pressure • Low application viscosity • Narrow fan width	• Apply proper wet film thickness • Reduce paint output • Use suitable solvents/thinner • Ensure proper flash time between the coats • Avoid less gun distance • Maintain booth temperature • Adjust atomising air pressure • Thin the paint to suitable application viscosity • Adjust fan width properly
Orange peel: Orange skin like appearance of paint film 	• Use of fast evaporating solvents/thinner • High gun distance • High booth temperature • High atomising air pressure • High application viscosity • Wide fan width	• Use suitable solvents/thinner • Avoid more gun distance • Maintain booth temperature • Adjust atomising air pressure • Thin the paint to suitable application viscosity • Adjust fan width properly

Some more probable causes for dirt

- Dust is the biggest cause of rejection.
- Dirt can circulate in the paint shop atmosphere and not be seen.
- Some dirt particles can be polished out, but dirt in undercoats cannot be polished out.
- Cartridge filters are more efficient than bag filters, but cost is high. The mesh size of the bag can be distorted. Frequency of filter change is important.
- The pressure difference between supply line and return line should be monitored. High pressure difference means filter is choked.
- Regular cleaning of application equipment is very important.
- High pressure in circulation line can agglomerate metallic and pearl mica pigments.
- Dirt can be through pipe lines.
- The object to be painted should be free from dirt.
- In pretreatment line if few raw materials are being received in paper bags, fibres can fly all over the shop atmosphere.
- Welding spatter is very small in size and cannot be seen by naked eye.

- During CED baking condensates are generated and when oven is cooled they can form hard particles.
  - Overspray/overspray on walls can give dust problem.
  - Fibres from tag rack/overalls.
- Oven cleaning
- Do not add solvent too quickly to thin down the paint. This can give a shock to paint agglomerates can form.
- Entry to booths should be disciplined.
  - Booth balancing (air velocity) should be monitored.
  - Regular particle count will help to know the dust level.
- Inspect the inside of the booth filter housing. Housing should not be opened while in operation, as this can be dangerous.
- Regular training should be conducted to emphasisea positive anti-dirt culture.

Tips

- Before application of paint check that the pretreatment quality is good and there is no flash rust.
- Ensure that proper masking as per requirement has been carried out.
- Clean all the paint thinning containers.
- Adjust viscosity as per temperature viscosity chart.
- Keep watch on air pressure. High or low air pressure will affect the coating appearance.

Practical Activity

Mixing of paint and application using a brush,roller,or a spray gun.

Note

UNIT 4.3 Finish the Surface

Unit Objectives

At the end of this unit, you will be able to:

1. Describe and explain the process of curing
2. Describe the correct process before, during and post painting
3. Understand importance of constantly checking surface before painting

4.3.1 Curing

Industrial paints or OE (Original Equipment) paints are mainly baking or stoving type. The painted components require to be put in the oven for specific time at specific temperature to get a cured cross-linked film.

1K (One Pack) products like Alkyd-Amino, Polyester-Amino, Acrylic-Amino, and Epoxy-Ester-Amino are generally baked at 120°C to 140°C for 25-30 minutes.

2K (Two Pack) products like Alkyd-Isocyanate, Polyester-Isocyanate, Acrylic-Isocyanate, which are most suitable paints for plastic substrates are dried at 65-75°C for 20-30 minutes. Such drying process is called **'Force – Drying'**. This low temperature is required as popular engineering plastic like ABS (Acrylonitrile-Butadiene-Styrene) melts at 80°C and above. 2 K products can be air dried but it takes about 2 hours to get tack free film and for a continuous production line, such drying time is not suitable.

The baking schedule or stoving schedule (Time and Temperature) mentioned above is actually the temperature of the substrate. It is called Effective Metal Temperature (EMT).

Travelling Thermometer: EMT can be recorded by an instrument called 'Travelling Thermometer'. It is a small electronic device with different probes (metal probes and plastic probes) kept in an insulated box. The probes are fixed on different areas of the component and the instrument is switched on before the component enters the oven. The instrument travels with the component on the conveyor through the oven and records the temperature of the substrate. One probe reads the air temperature in the oven. When the component come out of the oven, the captured data can be seen on the computer screen, which gives all details. This graph is called TTR (Travelling Thermometer Record).

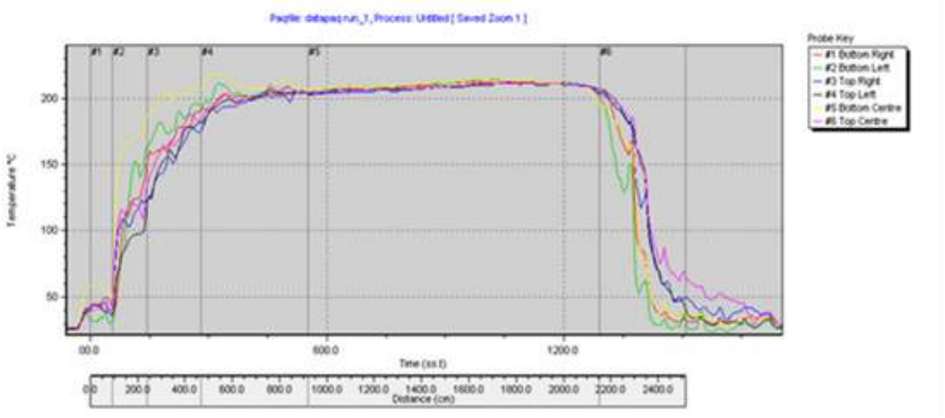


Fig 4.3.1 (i): Travelling Thermometer Graph

From the graph above, one can get exact temperature (EMT) and time it remained for. Note that air temperature has to be higher than EMT, because of losses due to induction. It is important to note that the dial temperature of oven is hot air temperature and not the substrate temperature. Substrate temperature details can be obtained by taking a Travelling Thermometer run.

Baking Window: A paint film may be baked at a higher temperature for a shorter time or at a lower temperature for longer time, so long as the performance properties are not affected. The entire set of temperature-time combinations in which the film can be baked without jeopardising performance properties is known as the baking window of the product.

Normal baking temperature can show variation on line. To ensure proper baking, use of **'Baking Window'** is recommended. Baking window is derived in laboratory by baking the paint system panels at various temperatures and checking important performance properties. The limits which pass all these important parameters are considered workable. The actual on-line temperature has to be within this baking window. It is better to keep baking temperature close to recommended baking schedule.

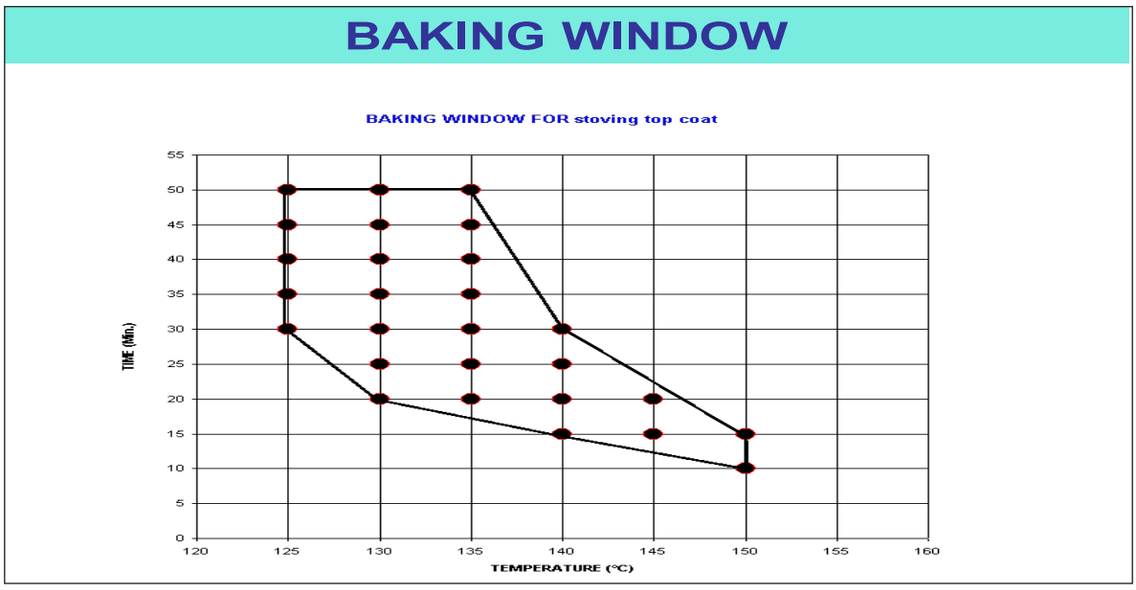


Fig 4.3.1 (ii): Baking window

4.3.2 Check Surface after Painting

All industrial paint users have their own paint specifications derived from the overall performance expectations of coating. The final film performance after the painting is inspected and checked through various tests.

The test methods are derived from either international standard (ASTM, DIN, JIS, ISO, DIN EN ISO) or BIS-Bureau of Indian Standards (earlier IS specifications).

Dry film properties:

1. Appearance
2. Dry film thickness (DFT)
3. Gloss
4. Shade

5. Pencil Hardness/ Scratch Hardness/ Persoz / Pendulum hardness/ Tukon hardness
6. Intercoat Adhesion
7. Impact Resistance
8. Flexibility
9. Distinctness of image (DOI)
10. Re-coatability test
11. Abrasion resistance
12. Cupping value
13. Crockmeter test
14. AmtecKistler Car Wash

Durability testing:

1. Resistance to engine oil
2. Resistance to gear oil
3. Petrol / Gasoline resistance test
4. Acid resistance
5. Alkali resistance
6. Normal water resistance
7. Hot water resistance
8. Resistance to solvents
9. Salt spray resistance
10. Humidity resistance
11. Thermal cycle resistance
12. Corrosion cycle test
13. Scab corrosion test
14. Filiform corrosion test.
15. Prohesion chamber test
16. Chipping resistance
17. Edge corrosion test
18. Accelerated weathering test (Weatherometer/QUV)
19. Condensation test (QCT)
20. Natural exposure test

Fig 4.3.2: Paint testing lab

4.3.3 Instructions at a Glance

BEFORE PAINTING	DURING APPLICATION	POST APPLICATION
• Check sheet metal quality • Check pretreatmentquality • Ensure all equipment is in proper working order [application equipment, pressure feed vessels, on line filters, air-compressor, pumps, conveyer, ovens, burners, blowers etc.] • Use appropriate thinner / solvent • Correct conveyer speed • Adequately clean jig • Proper masking as per instructions/requirement • Correct oven temperature	• Paint pot agitation / circulation • Application viscosity at specified temperature • Application pressures • Paint flow rate • Application resistivity • Application voltage • Quality of compressed air • Dust-free environment • Temperature and humidity in spray – booth • Rotations per minute, of bell / disc • Distance between spray-equipment and article to be painted	• Flash – off period • Dust free environment in flash – off zone • Proper air circulation in oven • Careful unloading • Removal of masking tapes

- Do not thin paint excessively
- Do not apply very thick coats
- Do not apply any coat without curing of previous coat
- Do not add any material other than recommended
- Do not work with faulty equipment
- Do not paint in dusty environment
- Clean the area on component to be sanded thoroughly, before and after sanding. Use soft hand or sponge pad for very fine sanding. Adjust two grades finer when going from dry to wet sanding. Use clean water for wet sanding.
- Do not use high pressure and speed to save time as it can cause damage.
- Do not use dirty water as it will contaminate the surface
- Remove masking without touching the coating. It is always better to remove masking after component has cooled post baking.
- Check the coating in wet condition and after it comes out of oven.
- Take appropriate measures to correct the defects observed on the painted components
- To get best paint performance, manufacturer's recommendations and instructions should be strictly adhered to.

Tips

Electrostatic spray application is an efficient process. The electrically charged paint droplets are attracted to the oppositely charged surface thus improving the coating efficiency.

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5. Maintain Jigs, Tools and Machines

Unit 5.1 - Maintain Pretreatment Baths, Coating Booth

Unit 5.2 - Maintain Coating Application Tools and Equipment.

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Applicable NOS – PCS/N5108

Key Learning Outcomes

At the end of this module, you will be able to:

1. Describe how to maintain pretreatment batch
2. Describe how to clean and maintain the coating booth and oven
3. Explain the upkeep and maintenance of the coating application equipment, facility and jigs

UNIT 5.1 Maintain Pretreatment Baths, Coating Booth

Unit Objectives

At the end of this unit, you will be able to:

1. Describe maintenance of pretreatment bath
2. List the daily and monthly steps to clean the booth
3. Describe the cleaning process during colour change
4. Describe the maintenance schedule for bake oven

5.1.1 Overall System Maintenance

Good coating system maintenance will help avoid problems of:

- Low productivity
- High rejections and low product quality
- Increased operating cost
- Low customer satisfaction and comfort level

A plan for preventive maintenance with clearly defined Standard Operating Procedure (SOP) should be available. This document should clearly define all aspects of a specific job to be performed, such as:

- Objectives
- Task
- Frequency
- Supplies
- Tools
- Safety precautions
- Steps of the process
- The SOP must be monitored for effectiveness and reviewed for continuous improvement.

Maintenance Plan

WHAT	WHEN	WHO	HOW
•What needs to be done? •What component of the system needs periodic cleaning? •What component of the system needs periodic replacement? •What needs to be inspected? •What items needs to be tested? •What resources are needed?	•Determine how often these tasks need to be performed •Daily / weekly / monthly/ quarterly / annually	•Who will do it? The best suited employee(s) for each task •Are they trained enough?	•What tools will be required to do the work?

5.1.2 Pretreatment Bath Maintenance

Check pretreatment baths for:

- Concentration / pointage
- pH
- Conductivity
- Bath temperatures
- Oil content in degreasing tanks
- Bath tank cleanliness at set intervals
- Discard of baths at recommended intervals
- Regular removal of oil from degreasing tank

Chemical supplier should do a systematic sample audit on a regular basis in their laboratory by receiving samples from chemical user.This data is recorded and statistically analysed to produce sustainable quality.

Fig 5.1.2 (i): Correct and incorrect maintenance of pretreatment baths

Fig 5.1.2 (ii): Chemical pretreatment bath

Fig 5.1.2 (iii): Pretreatment bath with SOP and other technical information

5.1.3 Maintenance and Upkeep of the Coating Machine, Tools and Spray Gun

Hose and Gun

- Inspect periodically for weak and worn spots
- Check if hose connections are correct and tightened
- Ensure that gun is grounded through hose connections

Spray Application

- Keep spray booth clear of exhaust fumes from previous spraying

Paint Booth Maintenance

The quality of a finish depends greatly on the condition and performance of the equipment used. Spray booths are classified into two basic categories: Dry booths and wet booths.

Dry Booth: Ideal for small operations this type of booth removes overspray through forced ventilation, dry wall coatings and a filter system. In some applications, dry booths are more economical to operate than wet booths because the expense of sustaining a constant water wash curtain and pump maintenance is avoided.

One problem with dry booths is the removal of coating accumulation from walls, floor, vent pipes and fan blades. The coating can be removed through manual chipping and scraping though it is tedious and time consuming.

A solution to the problem of coating build-up is the use of specially formulated chemical strippers and protective booth wall coatings.

Wet Booth: Water wash spray booths are used in production line spray coating. This type of booth uses a curtain of water as a screen to trap and remove overspray before it can stick to the booth walls or escape into the ventilation system.

Protecting booth surfaces-

- Problem of overspray, drips, and spills cause accumulation of coating material on floors, walls, ceiling, lights and jigs. These must be protected to minimise maintenance,labour costs and down time.
- One method is to apply a strippable, protective booth coating. This helpsavoid the time-consuming and tedious removal of coating material accumulation from spray booths.
- Plastic based peel-able booth coatings can be an economical way to protect booth wall, floor and ceiling from overspray build-up.

Stripping booth floor:The ideal stripper should be able to strip any coating material and be safe for use. Strippers are generally applied to large areas and allowed to react with the accumulated coating material. After sometime, the softened coating material is scraped off or rinsed off with water.

Booth Maintenance Schedule

DAILY	WEEKLY	MONTHLY
Skimming of tanks	Tank cleaning and purging	Spray equipment
Chemical concentration	Strainers, baffle plates and sidewalls	
	Nozzles	
	Main header	

- **Skimming:** Water wash reservoirs should be skimmed daily or hourly, if possible, to assure continued operation without down time. Water wash compounds neutralise the overspray, causing it to congeal and float to the surface. This sludge should be skimmed from the surface. Do not allow paint sludge to stand overnight, or it will become waterlogged and sink, creating more maintenance problems.
- **Tanks:** In case of heavy production schedule, clean the water reservoir once a week or more. Drain the water from the tank and remove the residue from the walls and bottom of the tank. A systematic check of the water level should be done.

- **Purging:** Weekly cleaning and purging of the water wash system should be done for proper operation even under the best maintenance schedule.
- **Strainers, baffle plates and sidewalls:** Each time the water wash booth is purged, baffles and side walls should be inspected for coating material accumulation. If heavy build-up is seen, these areas should be cleaned. A proper purging schedule should be followed. Side walls in dry booths should also be checked for excess overspray build-up to minimise fire hazards.
- **Nozzles:** Nozzles should remain unclogged. If a nozzle is clogged, remove it and clean it manually to avoid further complications. If nozzles continually clog, the entire system should be checked to determine the source of the problem.
- **Main header:** Always remove the end cap and check for sludge build-up. A weekly purging should keep the header free of sludge. Maintaining proper concentrations and periodic purging should keep the booth running smoothly.
- **Chemical concentration:** The solution in the reservoir tank should be maintained at the proper concentration. A reservoir tank that is not kept at the proper concentration allows sludge to circulate throughout the system.
- Maintain spray equipment (guns, hoses, filters, dryers) and replace routinely.

5.1.4 Coating Booth Maintenance

Daily / Weekly Checks:

- Cyclone cleaning (for powder coating)
- Booth suction
- Cartridge type, after filter, manometer pressures, should be cleaned when manometer goes out of prescribed range
- Guns, pumps and hoses should be inspected daily for wear/ leaks
- Booth should be cleaned properly while changing colour
- Always stay alert for signs of moisture or oil in compressed air
- Conveyor cleaning / lubrication and arresting the dripping of oil from overhead conveyor

Fig 5.1.4 (i): Dust on conveyor that must be cleaned

Fig 5.1.4 (ii): Dust deposited surrounding the conveyor

Fig 5.1.4 (iii): Flammable condensed deposits that must becleaned

Monthly Checks:

- Voltage and current of guns must be checked monthly to ensure maximum charge
- Nozzle wear to be checked against the template provided by the gun supplier
- Keep records of all the checks done and maintenance performed on the coating line
- Guns to be disassembled and cleaned as per manufacturer's recommendations

5.1.5 Cleaning for Colour Change

Fig 5.1.5 (i): Cleaning a coating booth

Cleaning a liquid coating booth

- Drain the paint from the hose back into the paint supply tank. The paint suction valve should be closed
- After draining off the paint, feed in cleaning solvent through the suction into the paint hose
- Circulate the cleaning solvent in the system (solvent suction tank + hose + gun) to ensure proper cleaning
- Feed in the new colour paint through the suction, into the hose and gun. This pushes out the cleaning solvent from the hose and gun. Collect / drain this solvent, till fresh paint flows out through the gun
- Circulate the paint in the system
- For a normal colour change, booth floor, walls and ceilings need not be cleaned
- Clean the sieve/ filter during cleaning solvent circulation. Replace, if required
- In case of a colour change from a dark colour to a pastel colour (e.g. from black to white), it is better to use a different hose and gun

5.1.6 Bake Oven Inspection and Cleaning

Fig 5.1.6 (i): Coating ovens found in such conditions must be cleaned

Fig 5.1.6 (ii): Inside oven dust deposits to be cleaned

Fig 5.1.6 (iii): Dust deposits on blower to be cleaned

Suggested inspection and cleaning schedule for a bake oven

Weekly	Monthly	Annually
Flame failure detection system	Check fuel safety shutoff valves for leakage	Ignition and burner components
Ignition and burner operation	Check fan and airflow interlocks	Combustion air supply system
Combustible gas analysis and automatic interlock	Clean conveyor inside the oven	Flame failure system components
Inside area cleaning	Check / clean high temperature sensors	Piping, wiring and connections of all interlocks and shutoff valves
	Check explosion venting latches	Combustion control system
		Calibration of indication and recording instruments
		Automatic fire checks
		Operating sequence tests for all components

Fig 5.1.6 (iv): Oven duct conditions (damaged ducts) that must be repaired

The dust in the oven can contaminate coatings and hence it is important to keep the oven dust free and clean it weekly as per set specifications of your company.

Fig 5.1.6 (v): Dust in oven burner chamber that must be cleaned

Notes

UNIT 5.2 Maintain Coating Application Tools and Equipment

Unit Objectives

At the end of this unit, you will be able to:

1. Describe how to maintain the cleaning devices
2. Describe the cleaning process for powder hoses and guns
3. Describe the cleaning process for jigs, hooks and racks
4. Describe the process for cleaning the facility

5.2.1 Maintain the Cleaning Devices

- **Compressed air / cleaning solvent:** Used for gun and feed system, booth.
- **Emery Paper:** It is not reusable, so a new paper must be used every time.
- **Wire Brush:** It is not reusable, so a new brushmust be used every time.
- **Vacuum Cleaner:** Should be in working condition and replacement dust bags should be in stock.

5.2.2 Cleaning of Hoses and Guns

- Powder container and powder gun must be cleaned daily and before and after every colour change.
- Powder booth and recovery system must be cleaned daily cleaning and before and after every colour change.
- Liquid Painting container, feed hose and gun must be cleaned daily and before and after every colour change. Feed hose and gun must also be cleaned at the end of every shift / day.
- Booths must be cleaned every week.

5.2.3 Cleaning Process for Jigs and Racks

Jigs and hooks must be checked weekly to remove the thick coating layer and make them conductive (in case of electrostatic application).

- While cleaning the coating spray gun manually ensure the cleaning brush does not damage the spray gun and nozzle set.
- Ensure that the inside of the air cap and the zone around the air distribution insert is thoroughly dry blown/ cleaned with cleaning solvent before each work break.

- Coating container and gun to be cleaned daily and before and after every colour change.
- Coating booth and powder recovery system needs to be cleaned daily and before and after every colour change.

Fig 5.2.3 (i): Powder deposits on jigs will prevent proper earthing

Common methods of cleaning hanging devices or jigs

- Chemical stripping (Hazardous)
- Controlled pyrolysis (Creates Pollution)
- Heating and degradation – hot sand fluidised bed cleaning
- Blasting

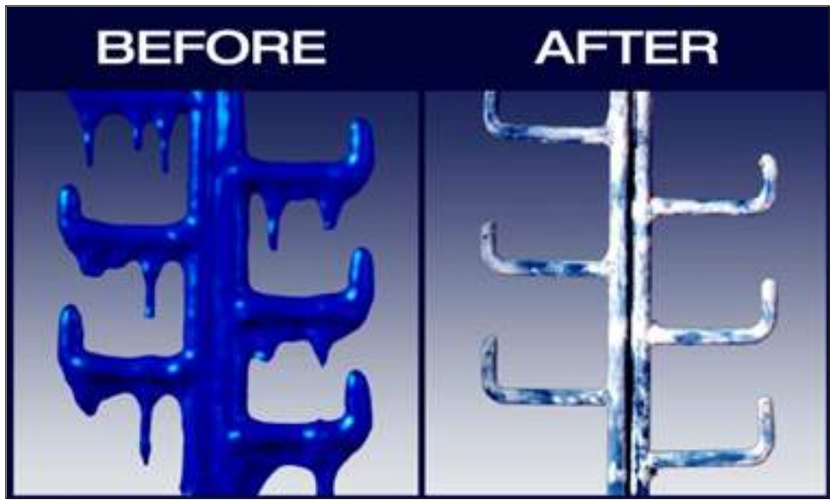

Fig 5.2.3 (ii): Jigs before and after cleaning

5.2.4 Cleaning the Facility

DAILY CHECKS	
FOR POWDER COATING	**FOR LIQUID PAINTS**
Vacuum clean the floor, walls and ceiling	Check air pipelines and valves for any choking and / or cracks, leakages
Check air pipelines and valves for any choking	Component cleaning before application
Component cleaning before application	

Fig 5.2.4 (iii): Vacuum cleaning the facility

Checklist of operation / maintenance from operator point of view

Sr. No.		Check	Observations	Image / Description
1	**Mechanical Pretreatment**			
	a	Date and time		
	b	Degreasing - Clean Wipe cloth		
	c	Degreasing - Water Break Test		
	d	Metal Surface Temperature		
	e	Compressed Air Cleanliness (blotter) Test		
	f	Air pressure as per Specs		
	g	Abrasive Selection - Test Certificate		
	h	Hand tool cleaning of non-accessible/small areas		
	i	Prepared Surface Inspection -Cleanliness Sa 2 ½		
	j	Prepared Surface Inspection -Surface Depth		
	k	Dust/Debris Removal		
	l	Dust Level - Tape test		
2	**Chemical Pretreatment**			
	a	Phosphating		
	b	Loading of the jobs		

	c	Actual Conditions w.r.t Reference Chart		
	d	Water Quality		
	e	Water break test after water rinsing		
	f	Sludge in the phosphate bath		
	g	Uniform grey phosphating		
	h	No traces of white sludge powder		
3	**Liquid / Powder Coating**			
	a	Date and time		
	b	Compressed Air Cleanliness (blotter) Test		
	c	Illumination 600 lux		
	d	Surface pre-treatment acceptable		
	e	Coating gun nozzle check		
	f	Resistance between the job and true earth		
	g	Voltage – KV		
	h	Air pressure for spray gun – bar		
	i	Masking done		
4	**Oven Drying**			
	a	Oven temperature is reached		
	b	Calibration of the oven done		
5	**Test for Final Coat**			
	a	DFT Check		
	b	Adhesion Tape Test		
	c	Gloss Test		
	d	MEK Rub test		
6	**Final Checks for Cured Film**			
a		Visual Inspection for defects if any		

Tips

- Paint booth and paint application equipment to be cleaned daily (at the end of every shift) and before and after every colour change.
- Jigs must be cleaned regularly as paint deposits on jigs will prevent proper earthing, for electrostatic application.

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6. Coordinate with Colleagues and Customers

Unit 6.1 - Interacting with Superior
Unit 6.2 - Communicating with Colleagues
Unit 6.3 - Communicating Effectively with Customers

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Applicable NOS – PCS/N 9901

Key Learning Outcomes 

At the end of this module, you will be able to:

1. Learn behavioural skills to interact with your colleagues and co-workers effectively
2. Describe steps to achieve customer satisfaction
3. List quality and service orientation markers

UNIT 6.1 Interacting with Superior

Unit Objectives

At the end of this unit, you will be able to:

1. Describe best ways of interaction with your superiors at work

An organisation is a group of people working collectively towards a common goal linked to an external audience/environment. Simply put, all the employees in an organisation act as tiny parts of a large machinery which helpseamless and efficient functioning.

Every organisation must have a structure. The organisation structure enables clarity of purpose and role of every individual ensuring there are no overlap in functions. It also clearly defines a hierarchy which determine who takes what decision and thus how those decisions shape the organisation. These decisions provide the direction needed in the organisation.

Interpersonal relations / communication between employees across hierarchies are thus very important. A code of conduct / protocol ensures expectation management and reducing the gap between superior and subordinates by increasing the levels of trust and support ultimately achieving organisational and personal goals.

Openness and comfort in communication plays a very important role in achieving job satisfaction. Reporting problems and asking for possible solutions after your own unsuccessful attempts, taking feedback etc. all come under interactions with your superior.

Notes

UNIT 6.2 Communicating with Colleagues

Unit Objectives

At the end of this unit, you will be able to:

1. Describe best ways of communication with colleagues

Building trust with colleagues and co-workers is as important as doing your work efficiently and effectively. Here are a few actions you can take to build a relationship of trust and respect with your colleagues and co-workers:

- Greet everyone in the workplace with a smile and positive body language.
- Offer help to a new colleague to settle down in the job.
- Show courtesy and respect to colleagues.
- Do not disturb others when they are working.
- Keep your workstation clean.
- Leave washroom and other common facilities clean after use, for others.
- Do not waste your time and others' time by holding long conversations which are not related to work.
- Do not use cell phones at work.
- Do not mope. Keep a smiling face.

Following right communication rules is very important to keep a healthy relationship with colleagues and co-workers. In modern day workplace, people generally work in teams. It is important to build healthy relationship with the team members. Following are some important communication rules to follow:

- Speak in a polite and respectful tone. A voice tone suggesting impatience, sarcasm or taunt is not acceptable in the workplace.
- Use positive words and body language. Avoid words and topics which may offend anyone at workplace.
- If there is any conflict with a co-worker, resolve the issue amicably without raising your voice or getting angry.
- Greet your colleagues and co-workers in the morning or at the beginning of the shift.
- Use positive words and body language.

The quality of relationship you build with your colleagues and co-workers will depend on the behaviour you demonstrate while interacting with them. A relationship built on trust, good and clear communication, polite language and appropriate behaviour at all times helps you to be successful at work.

UNIT 6.3 Communicating Effectively with Customers

Unit Objectives

At the end of this unit, you will be able to:

1. Describe best way of communicating with customers
2. List quality and service satisfaction markers

A customer in your context is anyone – internal or external who might legitimately have a work-related expectation from you. Both their opinions are critical to the success of your company and sale of your products.

Internal customers are persons within the organisation who use products or services delivered by you as inputs in their work. For example, production staff in a factory are internal customers of maintenance technicians. The feedback provided internal customers is valuable. It must be implemented and taken seriously.

External customers are the end consumers and/or companies who buy your products. They do not belong to your organisation. These individuals are essential to the success of your company, as they purchase your product. Satisfied external customers make repeat purchases.They also refer the experience to others.

- Understanding customer expectations and implementing the same helps achieve customer satisfaction. Delivering more than expected adds to the overall experience of a good sale. It brings repeat customers.
- Managing customer relations requires dedicated and committed effort. It involves understanding the customer's need correctly and fulfilling it every time. With a business customer, it involves understanding their business and in what ways our product / service can help grow and improve their business.

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General tips for interactions with customer are as follows:

- Greet and welcome the customer in a friendly manner
- Make an earnest effort to understand customer needs. Ask specific pertinent questions.
- Be attentive, listen carefully and make notes. Suggest upgradation and add-ons if they give value to the customer.
- Find out customer's likes and dislikes by soliciting their opinion and comments on the demonstrated samples
- Never promise more than you can deliver. Always deliver more than you promise, never fall short
- Agree on all terms and conditions

When the customer is another organisation (such as an OE company, a cooperative society or a club), many persons from the customer organisation get involved. Each may have different needs and expectations. In such situations,

- Identify all the stakeholders (internal and external) and opinion makers right at the outset and understand their needs
- Understand the organisation's strategy and its priorities. This is critical to understanding which needs rank high.
- Be aware that there will be internal dynamics at work in any organisation, and one needs to steer clear of getting caught up in any interpersonal conflicts.
- Document what will be delivered (quantities, specifications and timelines) with a formal sign-off from the customer's side. This can avoid misunderstanding and disappointment later. Such document should also list key expectations from the customer that are critical for timely and quality delivery.
- With a long-term customer, explore ways of bringing about continuous improvements that can help the customer's business. This is critical to keep getting continuing business.
- Be available to deal with the customer's queries and concerns promptly and at all times.

Notes

6.3.1 Quality and Service Orientation

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Quality is the sum total of all the elements connected with the product and service that impact the customer's perception positively. Examples are the product's functional performance, aesthetic appeal, reliability, durability, quality of the material used, meeting the design specifications of the end user, customer service during and after the delivery etc. The test of quality is when the customer is totally satisfied with the product in every respect.

Service orientation is the ability and desire to anticipate, recognise and meet customers' needs. It is a personality characteristic which makes people focus on providing satisfaction and making themselves available to others. Excellent customer service is unthinkable without customer service orientation.

6.3.2 Customer Satisfaction

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Customer satisfaction means the customer is satisfied and happy with the work we have done. A satisfied customer is ready to give us repeat business or recommend us to friends and acquaintances.

Customer satisfaction is important because in today's competitive market place every business competes for customers. Your business is constantly under threat from competition trying to take it away; consistently maintaining high customer satisfaction is crucial to retain customers for the long term. Customer satisfaction is the best indicator that the customer is likely to be a repeat customer. It is always cheaper to retain an existing customer than to acquire a new one.

Tips

Always remember customer is King! Think of the many ways in which you can contribute to increased customer satisfaction.

Notes

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7. Maintain Standards of Product / Service Quality

PAINTS AND COATINGS SKILL COUNCIL

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Applicable NOS – PCS/N 9902

Key Learning Outcomes

At the end of this module, you will be able to:

1. Explain product / service quality requirements for general industrial painting
2. Follow company's policy and work instructions on quality standards to achieve customer satisfaction.
3. List out various defects and tests to check the quality of the painting job done

UNIT 7.1 Meeting and Exceeding Customer Expectations

Unit Objectives

At the end of this unit, you will be able to:

1. Describe the target customer and the quality standards defined by the company.
2. Implement the improvement suggested by supervisor and the customer.

A thorough understanding of the total coating system is necessary to begin the discussion with the customer.

1. Understand customer requirements:

You should be able to obtain clear instructions and specifications from the customer about the desired finish, look, durability expectation and corrosion protection specifications. Some customers may not have a clear idea about their requirements. In such cases they will need to be guided. Prepare a few samples and get the customer to choose finish, gloss, and shade, which are some basic visual requirements for a coated film.

Established industries generally have well defined specifications stating their requirement. However, even here it is necessary to engage with the customer to ensure common understanding on tolerances, subjective parameters, working limitations and skill levels at customer factory as well as other unstated terms. For example

- When the customer asks for exact match to a standard colour panel, what is the level of tolerance permitted? Will the customer go by visual judgement or by an instrument match?
- What are the testing methods and standards that the customer would use?
- What is the process for maintaining and updating standard panels?
- What are the application equipment, parameters and conditions at the customer end?
- Are there any work restrictions at the customer's premises, for example on working hours, holidays, use of elevators, etc.? It is important to be clear on these while committing to aggressive completion targets.
- Can we describe what performance would be seen as exceeding the customer's expectations?
- Does the customer have internal targets for continuous improvements over time? What are the expectations from the coating supplier/ contractor in this regard?

2. Understand the total coating application system/process, nature of the facility and limitations:

Delivering good and consistent quality in the design, production or application of paints and coatings requires understanding application conditions in detail. This includes obtaining insights and information on all relevant factors such as:

- Type and quality of the substrate and variations that may be encountered
- Surface preparation needed
- The type of coatings to be applied
- The application equipment available/ needed

- Applicable/expected quality standards
- Ambient conditions and site conditions
- Maximum size of components which can be fitted
- Overall magnitude of the job
- Maximum weight the conveyor can take (known as point load)
- Bake conditions, oven design, baking window
- Support facility limitations (e.g. conveyor speed, maximum loading etc.)

3. Fool-proof the process and have the right equipment

Analyse and find areas which need to be corrected to gain control of the overall process. This will reduce variations/ surprises and facilitate meeting quality expectations in a consistent and timely manner.

- Inspect the material(s) to be coated before starting the process to ensure good quality and good finish
- Check materials and consumables to be used. Make sure that they conform to specifications
- If the input jobs do not meet the requirements, discuss with the customer and quality in-charge and take appropriate actions
- Follow the right processes and use correct equipment for the job
- Ensure that applicable SOPs are adhered to

4. Get feedback from the customer and incorporate suggestions for improvement:

- After delivering the product/ output, proactively find out specific customer feedback
- Make a note of the feedback and improvements the customer is looking for
- Tell the customer what improvements you will incorporate in the next job

7.1.1 Quality Standards of the Company

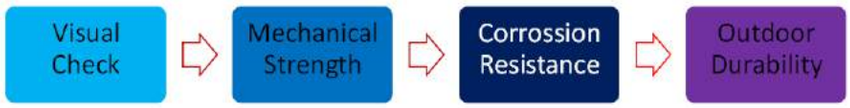
When coating is carried out under proprietary or customer specifications usually the following criteria are considered to check the quality of the finished job.

(a) On visual inspection, the coating should show the desired finish and correct curing without defects or blemishes.

(b) Mechanical strength checks are performed to ascertain that the DFT (Dry Film Thickness), hardness and flexibility criteria are met

(c) The film is tested for corrosion resistance. This may include salt spray resistance test, humidity resistance test etc.

(d) Outdoor durability tests include ultraviolet resistance test and actual outdoor resistance test



UNIT 7.2 Coating Defects, Tests and Standards

Unit Objectives

At the end of this unit, you will be able to:

1. Explain the process of maintaining and enhancing quality standards.
2. Describe various tests and their pass/fail criteria and acceptable tolerance level.
3. List the equipment used for quality tests.
4. Describe the ways to improve company's customer satisfaction rating.

A company's policy defines and helps ensure adherence to quality standards.

- What kind of durability must the finished product meet?
- What are the criteria laid out for the quality assurance program?
- What are the customer specifications?

Based on these a 'Standard Operating Procedure' or 'SOP' is generated with specific work instructions. An **SOP** is a procedure specific to the operation that describes the activities necessary to complete tasks in accordance with industry regulations, legal requirements and quality standards

Why is it important to follow an SOP?

- Saves time and eliminates mistakes
- Ensures that consistent standards are followed throughout the process
- Reduces training costs
- Supports quality goals

7.2.1 Tests and Standards to Check Quality

- Dry Film Thickness (DFT) measurement
- Gloss
- Colour
- Flexibility / bend test
- Pencil hardness test
- Adhesion test

7.2.1.1 Dry Film Thickness (DFT) Measurement

This test is devised to check the correct coating thickness on the components as per the specifications.

- Dry film thickness (DFT) is the thickness of the coating
- DFT is measured for cured coatings. Proper thickness range is recommended in specifications

- There are various types of DFT Gauges available in the market, from simple magnetic gauges to digital gauges
- The gauge should be calibrated periodically by using a bare metal plate (zero setting) & standard thickness plastic foils (shims) which are supplied with the gauge
- Different gauges are available for Ferrous and Non-Ferrous substrates (F and NF)

Fig 7.2.1.1 (i): Magnetic Gauge

Fig 7.2.1.1 (ii): Digital Gauge

7.2.1.2 Gloss Check

Fig 7.2.1.2: Gloss meter

- Gloss is measured with Gloss Meter of different designs. The reflection is measured, and the angle of reflection is specified at 20°, 45°, 60° and 85°
- An angle of 60° is most common in the coating industry
- An angle of 20° is used for a more differentiated result of high gloss surfaces; usually recommended for **Automotive class "A" finish**
- An angle of 85° is used for a more differentiated result of matt surfaces, not so common

7.2.1.3 Colour Check

Colour may be checked visually or using a computer aided spectrophotometer. If measured by a spectrophotometer, the colour difference is reported as ΔE (Delta E). The ΔE should fall within the demarked tolerance zone.

- Visual inspection, compared to a master. It is very important to use a relevant light source when judging colour
- Computer aided spectrophotometer
- Stationary equipment orportable equipment

Fig 7.2.1.3: Spectrophotometer

7.2.1.4 Flexibility - Bend Test

This test is to determine the elasticity, adhesion and elongation ability of a dry coated film applied on a flat metal support.

- It is checked using either a conical or cylindrical mandrel with a graduated scale
- The apparatus contains a holder for a mandrel, a bending lever fitted with height adjustable rollers, and sliding tongs for fastening the sample
- It is a laboratory apparatus to bend coated test panels over a conical/cylindrical shaped mandrel in order to assess the elasticity of the coating, in accordance with ISO 6860 and ASTM D522
- The conical shape of the bending area allows the deformation of the test panel and examination of the elasticity range of a coating over any diameter between 3.1 and 38 mm in one single test

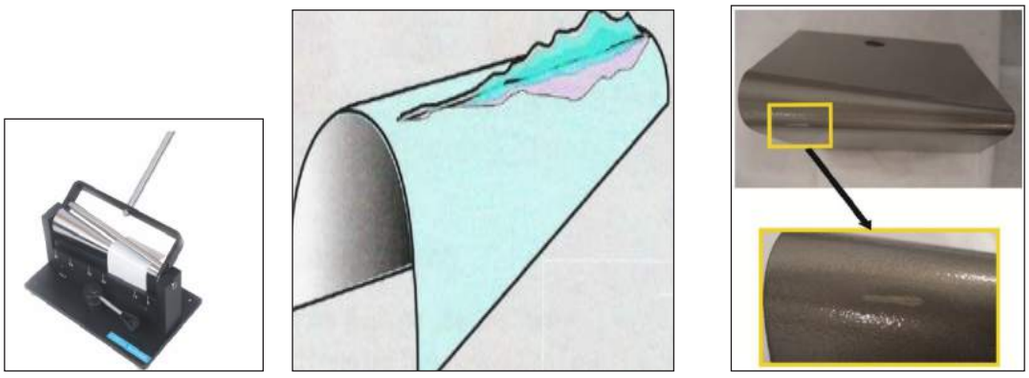


Fig 7.2.1.4: Bend test on a conical mandrel

7.2.1.5 Pencil Hardness Test

Fig 7.2.1.5: Pencil Hardness Test

Pencil hardness test is one of the many tests used to evaluate coatings. It is a simple and dependable test that uses pencils that are graded. The grade of the pencil is determined by the amount of baked graphite and clay in its composition. The test is performed by scratching the coated surface with pencils of known hardness. Mitsubishi UNI pencils are international industry standard.

Softer Pencils							Harder Pencils						
6B	5B	4B	3B	2B	B	HB	F	H	2H	3H	4H	5H	6H

7.2.1.6 Adhesion Test

Adhesion test is used to determine if the paint or coating will adhere properly to the substrate to which it is applied. There are three different tests to measure the adhesion of the coating to the substrate.

- Cross-cut test
- Scrape adhesion
- Pull-off test

Cross-cut test

This test determines the resistance of the coating to separation from the substrate by utilising a tool to cut a right-angle lattice pattern into the coating, penetrating all the way to the substrate. It is a quick test to establish pass/fail test. When testing a multi-coat system, the resistance to separation of different layers from one another can be determined by this test.

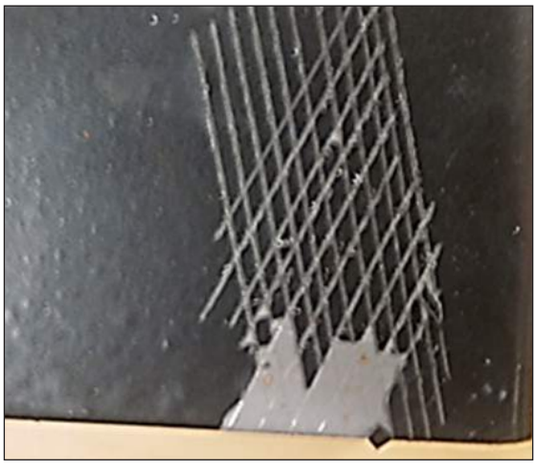


Fig 7.2.1.6 (i): Adhesion test fail

Fig 7.2.1.6 (ii): Adhesion test pass

Pull off dolly test: Unlike the other methods, this method maximises the tensile stress, therefore results may not be comparable to the others.

- 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 is then aligned to apply tension perpendicular to the test surface.
- The force that is applied gradually increases and is monitored until a plug of coating is detached

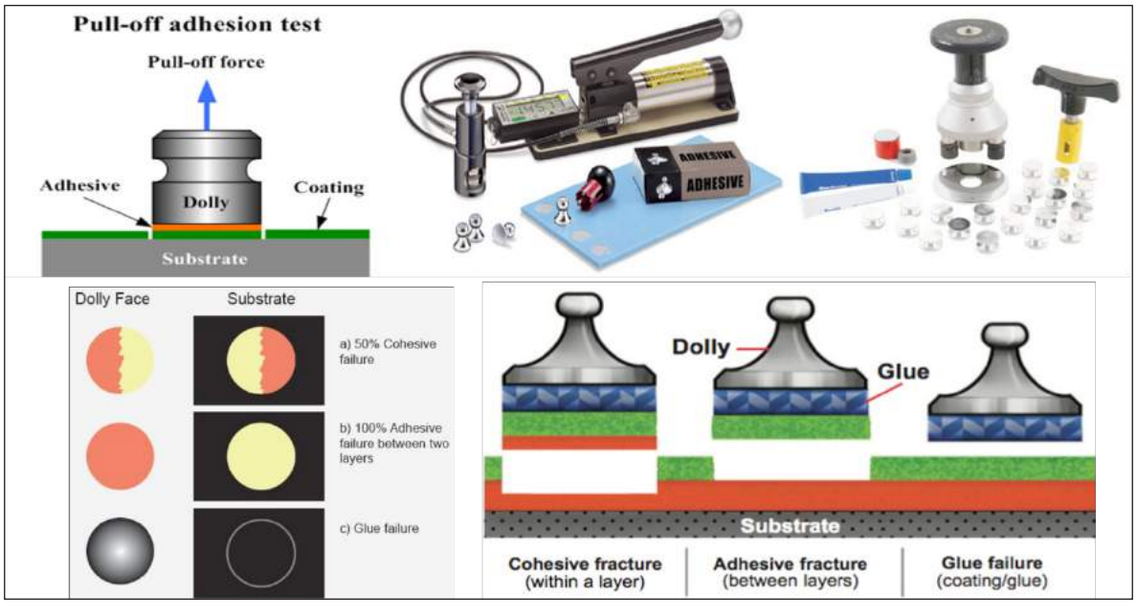


Fig 7.2.1.6 (iii): Pull-off Adhesion Test

7.2.1.7 Impact Test

Impact test is also known as drop weight test. The coated panel is subjected to mechanical impact by dropping a standard weight which can deform the coating and /or the substrate. With this test coating is tested for elasticity, brittleness, and adhesion to the substrate. As per ISO 6272-1:2011 - it is a method for evaluating the resistance of a dry coating film to cracking or peeling from a substrate when it is subjected to a deformation caused by a falling weight, with a 20-mm-diameter spherical indenter, dropped under standard conditions.

- Measures the deformation of a coating film
- Test performed on the front and reverse sides of a panel
- Result expressed as Pass or Fail

Fig 7.2.1.7 (i): Impact Tester

Fig 7.2.1.7 (ii): Impact Test

7.2.2 Defects in a Coated Film

Quality checks and maintenance are a mandate every coating applicator must follow. Quality maintenance reflects excellence in your own skills and makes you an expert at your job. The quality parameters to be met and the checks to be performed will depend on the coating and where it is applied. For example, the requirements of a performance or industrial coating are very different from that of a house paint.

No.	DEFECT	CAUSES
1	**RUNS AND SAGS**	• Over thinned paint • Use of very slow evaporating thinner • Applying paint without proper flash time between coats • Very low air pressure during spray application • Improper spray gun set-up or an unbalanced spray pattern • Very cold substrate

2	**CHALKING**	• Chalking is a surface phenomenon, generally caused by exposure to UV radiation produced by the sun and its action on the organic binder • In the presence of UV light, airborne reactants such as oxygen, humidity, and pollution react with the resins in the binder, causing it to disintegrate and leaving the pigments free on the surface • Typically, amine-cured epoxies and epoxy esters chalk rapidly and acrylics and acrylic-modified resins have good chalk-resistant properties since they are less affected by the sun's radiation • Chalking may not be a serious problem, and typically the coating will continue to provide protection in most cases, even though it may look faded
3	**EROSION**	• It is a surface defect often associated with chalking and often seen in brush applied coatings where the brush marks are exposed as the coating wears away • It is caused largely by heavy rainfall, high winds, hail or a combination of wind and rain; by sand erosion along beach areas; or by sandstorms in desert areas • Erosion of internal linings can be a significant problem in pipes carrying slurry or cooling water • Resins with some elastomeric quality may be effective, providing resilience to combat the impact of the eroding particles
4	**CHECKING**	• Checking is a form of cracking and is identified by small breaks in the coating that form as the coating ages and becomes harder and more brittle • It is a surface phenomenon that does not go all the way to the substrate • It can be caused by the mixture of resins, solvents and pigments that are not compatible. • Excessive film thickness, low flash off between coats, inadequately dry or thick undercoat are also some of the causes for checking • To minimise checking, the coating should be formulated with weather resistant resins, non-reactive pigments that do not contribute to checking, long lasting and stable plasticisers, and reinforcing pigments that reduce stress in the coating surface • Apply thinner coats of paint with adequate flash off or drying between coats
5	**ALLIGATORING**	• It is mostly a formulation-related failure and prevention is a matter of selection • The coating system selected should not specify a soft primer under a harder topcoat. The coating should be applied in thin coats, which should be allowed to cure before application of successive coats • Never apply a hard coating that oxidises or requires polymerisation over a permanently softer or more rubbery primer

6	**CRACKING**	• This formulation related failure is due to premature aging or weathering and, unlike checking or alligatoring, the cracks break through the coating, extending to the substrate • Cracking is a much more serious type of failure than checking • Checking results from the stress on the coating surface, while cracking results from stress throughout the film and between the film and the substrate • The use of proper resins, plasticizers, and pigments in coating formulation minimises the tendency of the coating to cracking • Fibrous or acicular (needle shaped) reinforcing pigments can help in reinforcing the coating against cracking
7	**MUDCRACKING**	• Unlike alligatoring, mudcracking goes directly to the substrate. It presents an immediate corrosion problem with possible chipping and flaking of coating from the surface • It occurs when highly filled or pigmented coatings, particularly zinc rich coatings are applied too thick • Highly filled water-based coatings sometimes mud crack, with the reaction occurring as soon as the solvent or water carrier begins to dry out of the coating • Mudcracking can be prevented by a combination of coating selection and proper application. If fast drying conditions exist or are expected, the user should avoid highly filled water-based coatings. • The coating should be applied during more moderate drying conditions, in thin coats without runs and sags
8	**WRINKLING**	• Wrinkling generally occurs when coatings are applied too thick. • It results from the swelling of a coating where the surface of the coating expands more rapidly during the drying period than the body of the coating • Occurs most with oil-based coatings • If a coating contains an excess of surface driers, wrinkling may occur wherever the coating is thicker than normal • Wrinkling is likely to occur in cold weather when the thickened coating is applied so that a heavy film develops or in hot weather when the topcoat dries quickly but the coating underneath remains soft
9	**BLISTERING**	• Blister develops first in localised spots where the adhesion is weakest • Blisters can be large or small and may exist in isolation or in groups • Blisters may be initiated by several causes. Mostly, they are formed due to the presence of moisture or other vapours, such as air or solvent, within the coating • A blister generally first appears when the vapour within the coating expands at elevated temperatures. It can also arise from soluble pigments in the primer and soluble chemical salts. • Yet another cause could be inadequate solvent release by the coating

10	**INTER-COAT DELAMINATION**	• Delamination is the loss of adhesion between coats in a multi coat system and is most common where repair or maintenance coatings are applied over cured coatings • New coatings applied over existing coatings may not be compatible with the previous coating, and delamination can occur • Precautions should be taken to minimise the problem by cleaning adequately and by applying coatings as quickly as possible after the cleaning operation • Another cause of delamination is the application of a coating over another coating that has over cured • Some modern coating formulations have been specifically developed with a low cross-link density to reduce this problem
11	**EXCESSIVE ORANGE PEEL**	• Film thickness out of proper range • In case of powder coating, too slow heat-up rate and slow oven ramp-up time is the main cause • The oven temperature should cross 120°C -140°C very quickly • Grounding should be checked • The kV setting of the spray gun to be lowered • In case of liquid paints, a balance of slow and fast evaporating thinner should be maintained to achieve a smooth, orange peel free film without causing runs and sags. • In air assisted spray, the recommended air pressure should be maintained
12	**GLOSS TOO LOW FOR HIGH GLOSS TYPE COATING**	• Incompatibility between different coats • Micro-pinholing from outgassing • Excessive orange peel due to inadequate DFT • Over-curing of parts
13	**INCONSISTENT FILM THICKNESS**	• Incorrect positioning of spray guns • Defective spray equipment / nozzle • Reciprocators not matched to line speed • Air flow in booth disturbing spray pattern • Improper manual technique
14	**POOR IMPACT RESISTANCE AND/ OR FLEXIBILITY**	• Over baked film • Poor cleaning • Excessive film thickness
15	**POOR ADHESION**	• Poor cleaning / pretreatment • The PT line is not properly maintained • Oil removal from the degreasing stages not proper • Under-cured film

16	**PINHOLES**	• Moisture in coating • Moisture in compressed air • Mixing of two different coating types • Porous component like casting • Heating too fast creating outgassing while curing
17	**CISSING OR CRATERS**	• Moisture in coating • Oil in compressed air
18	**CHIPPING**	• Loss of adhesion of the film to the substrate due to impact from stones or other hard objects • Sand and featheredge damaged areas to remove chips, then refinish. • Use premium two component undercoat and topcoat system. • Use a flex agent in undercoat and/or topcoat system in areas that are prone to chipping.
19	**DUST CONTAMINATION**	• Inadequate cleaning of the surface • Dirty spray environment • Inadequate air filtration in the booth • Use of poor grade masking paper • Dirty spray gun • Dirty work clothes • Fine dust contamination can be removed by sanding and polishing
20	**FISHEYES**	• Spraying over surfaces contaminated with oil, wax, silicone, grease etc. • Use of thinner/ reducer in place of a solvent cleaner Spraying over previously repaired areas containing fisheye eliminator additive • Remove wet paint film with solvent cleaner and refinish. Add recommended fisheye eliminator and respray the affected areas. • Do not use fisheye eliminator in undercoat or basecoat colour. • If the paint has dried, sand to a smooth finish below the fisheye cratering and refinish
21	**LOSS OF GLOSS**	• Top coat applied in heavy, wet coats • Inadequate flash time between coats • Insufficient film thickness of topcoat colour or clearcoat • Using a poor grade and/or too fast evaporating thinner • Improper cleaning of the substrate • Insufficient air movement during and after application • Spraying over a deteriorated or solvent sensitive substrate finish without proper priming or sealing procedures • Natural weathering of the finish • Allow finish to cure thoroughly, compound or polish to restore gloss. • Sand and refinish

22	**MOTTLING**	• An uneven distribution of metallic flake • Too much thinner/reducer • Colour overthinned/ reduced • Applying clear coat to a basecoat that has not thoroughly flashed/ dried • Improper application of basecoat To get a uniform single stage metallic finishes, apply a higher-pressure mist coat, panel by panel, while previous coat is still wet or allow basecoat colour to flash, then apply a low-pressure mist coat. Finishes that have dried must be sanded and refinished. Use recommended spray gun, including fluid tip and air cap for the material being sprayed
23	**SANDING MARKS**	• Scratching or distorting metallic/mica flakes close to the surface of the paint film Allow finish to dry, sand and refinish. Avoid sanding basecoat finishes before clear coating. If sanding is necessary, apply additional colour following label direction. When sanding single stage, finishes confine the sanding to minor imperfections – nib sanding rather than entire panel
24	**SOFT FILM**	• Applying undercoat and/or topcoat excessively wet • Insufficient dry time between coats • Improper shop ventilation or heating • Adding too much or too little hardener to the paint material. • Using the incorrect thinner/reducer for spray conditions • Omission of drier in enamel/ urethane topcoat Allow additional dry time, maintaining a shop temperature of 30 degrees centigrade or above or force dry following temperature and time recommendations or remove coating film and refinish. Use recommended spray gun, fluid tip and air cap for the material being sprayed.
25	**BLEEDING**	• Solvent in the new topcoat dissolves soluble dyes/pigments in the original finish, allowing them to seep into and discolour the new topcoat. • Remedial measures can be to remove original paint film and refinish. • Preventive measure can be to isolate the suspected bleeding finish by applying a two-component surface/sealer. • Allow to cure and then apply desired topcoat.
26	**TRANSPARENCY**	• Paint not thoroughly stirred • Colour over thinned/reduced • Substrate not uniform in colour • Wrong colour undercoat used • Insufficient number of colour coats applied Apply additional coats of colour until hiding is achieved or sand and apply similar coloured undercoat/ground coat and refinish.

Fig 7.2.2 (i): Sagging of paint coating

Fig7.2.2 (ii): Chalking

Fig 7.2.2 (iii): Erosion

Fig 7.2.2 (iv): Checking

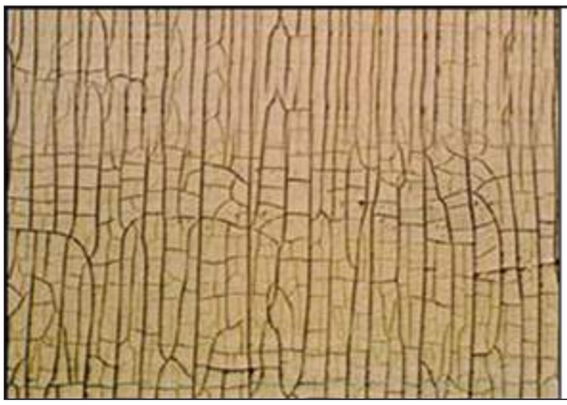


Fig 7.2.2 (v): Alligatoring

Fig 7.2.2 (vi): Cracking

Fig 7.2.2 (vii): Mud cracking

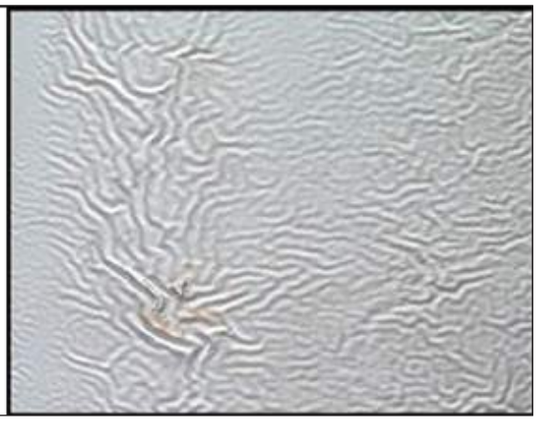


Fig 7.2.2 (viii): Wrinkling

Fig 7.2.2 (ix): Blistering

Fig 7.2.2 (x): Inter-coat delamination

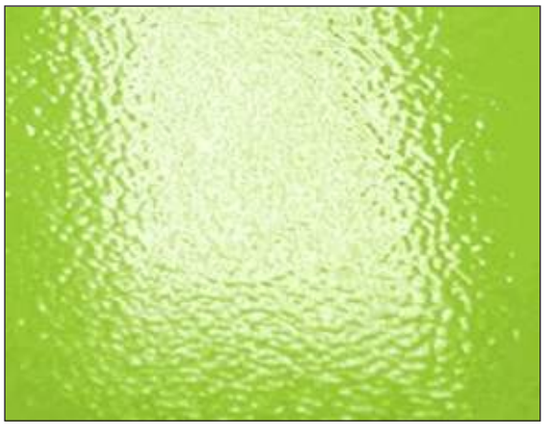


Fig 7.2.2 (xi): Orange peel

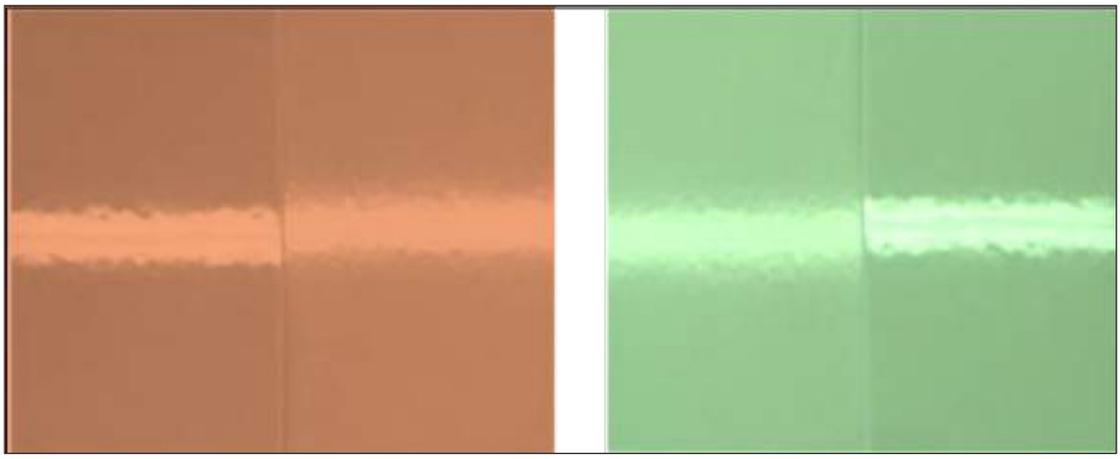


Fig 7.2.2 (xii):
Standard Gloss Lower Gloss

Fig 7.2.2 (xiii):
Standard Gloss Higher Gloss

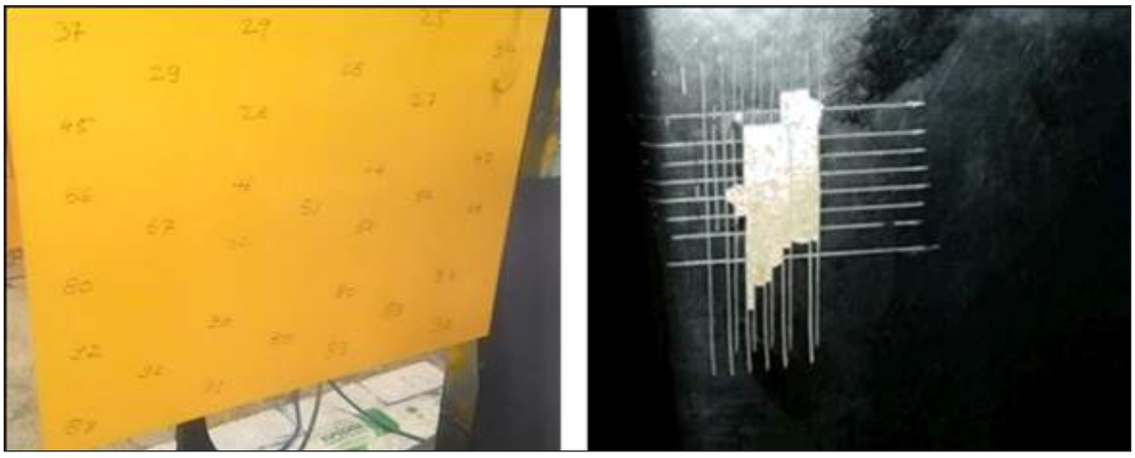


Fig 7.2.2 (xiv): Varied DFTs mentioned on panel

Fig 7.2.2 (xv): Poor pencil adhesion

Fig 7.2.2 (xvi): Impact Reverse Impact

Fig 7.2.2 (xvii):Failed impact test

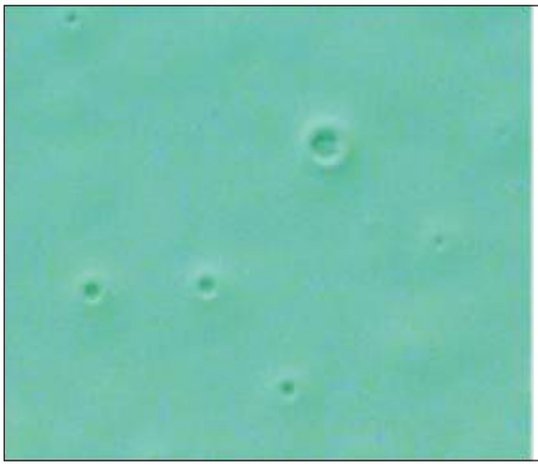


Fig 7.2.2 (xviii): Pinholes

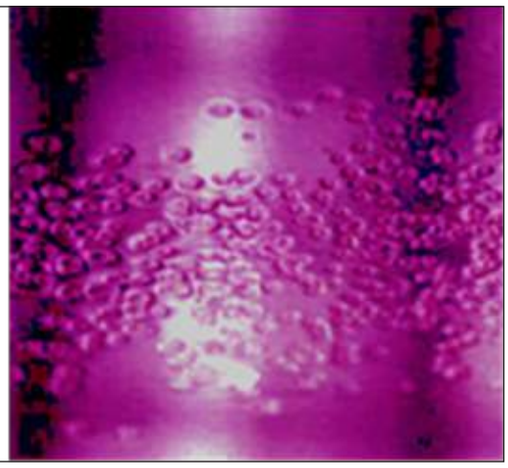


Fig 7.2.2 (xix): Cissing or craters

Fig 7.2.2 (xx): Chipping

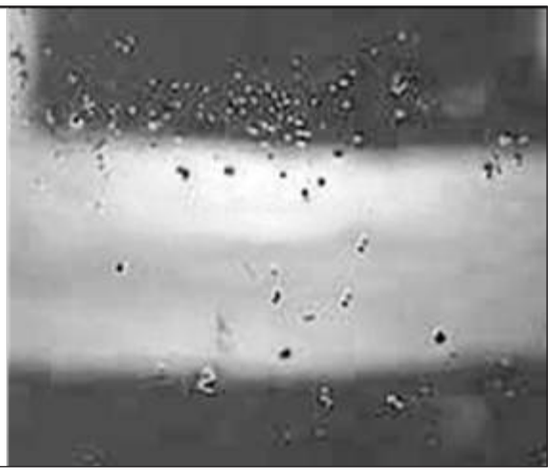


Fig 7.2.2 (xxi): Dust contamination

Fig 7.2.2 (xxii): Fisheyes

Fig 7.2.2 (xxiii): Loss of gloss

Fig 7.2.2 (xxiv): Mottling

Fig 7.2.2 (xxv): Sanding marks

Fig 7.2.2 (xxvi): Soft film

Fig 7.2.2 (xxvii): Bleeding

Fig 7.2.2 (xxviii): Transparency

UNIT 7.3 Your Responsibility as a General Industrial (Liquid) Painter

Unit Objectives

At the end of this unit, you will be able to:

1. Organise paint material and tools for painting as per customer's requirement
2. List down the quantity of paint consumed and consumables used to work out the cost incurred

Your job responsibilities may vary from job to job, but general duties always include:

- Obtain, read, and fully understand the coating specification. Bring up any questions with the appropriate person, and get them resolved
- Fully comply with specification requirements and that work performed matches the required standard of quality
- Determine that all essential raw materials, especially coatings, are stored correctly and used in batches within the manufacturer's recommended shelf life
- Maintain records of all work done, the conditions under which it was done, and any other appropriate report items required by the supervisor
- Ensure that the necessary test instruments and standards required are available at all times and that each instrument is fully functional and properly calibrated

Notes

UNIT 7.4 Prevention of Injuries

Unit Objectives

At the end of this unit, you will be able to:

1. Apply safe working practices to avoid injuries due to use of high-pressure equipment, moving parts and electric shocks
2. Identify toxic ingredients by reading a MSDS and use recommended PPE

Avoiding skin injections:

- Stay clear of high-pressure fluid streams and sprays
- Never remove protective devices,such as spray gun tipguards, during application
- Use proper pressure-relief procedures
- Use proper flushing practices described in instruction manual
- Never try to stop leaks with your hands or body.
- Always use the spraygun trigger safety lock when not spraying.
- Don’t feel for leaks with your hands or a rag.

Avoiding pressure-related injuries:

- Do not exceed the working pressure ratings (WPR) of components, paying special attention to high-pressure equipment
- Operate the motor within the recommended air or hydraulic pressure
- Do not repair permanently coupled hoses
- Use only genuine service parts as specified by the manufacturer
- Properly align spray tips to prevent back-spray
- Do not use low-pressure fittings on high-pressure equipment
- Do not use damaged or worn out equipment
- Check for proper connections and make sure they are tight before pressurising the system
- Follow procedures for relieving fluid pressure whenever you stop equipment for service or repair

Avoiding injury from moving parts:

- Never operate equipment with guards or other protective devices removed
- Check regularly to ensure that safety devices are operating properly
- Properly use bleed type shut-off valves

Avoiding toxicity:

- Use recommended personal protection equipment (PPE) to avoid contact with hazardous materials
- Read and follow directions on all coating material labels and material safety data sheets (MSDS)
- Never operate gas engines indoors

Avoiding electric shocks:

- Properly ground all objects in the system, including operators
- Follow the procedures in instruction manuals to avoid shocks from electrostatically charged components
- Never operate electric equipment when it is wet or when the surrounding area is wet
- Use only grounded outlets, extension cords and fluid hoses designed for high-pressure spraying that are in good condition
- Do not modify or remove electrical cords

Tips

Defects on the painted / coated surface reflects poor skills and workmanship. This may lead to early failure of the coating. Hence a greater emphasis on excelling at your job is important.

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8. Maintain OH&S Standards and Follow Environmental Norms

Unit 8.1 - Responsibility Regarding Safety
Unit 8.2 - Waste Disposal
Unit 8.3 - Use Safety Tools and Personal Protective Equipment (PPE)
Unit 8.4 - Handling of Coating Materials and Equipment as per Safety and Environmental Standards
Unit 8.5 - Precautionary Measure

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Applicable NOS – PCS/N 9903

Key Learning Outcomes

At the end of this module, you will be able to:

1. List the personal protective equipment and its uses to be used at the workplace
2. Explain the precautionary measures for emergencies

UNIT 8.1 Responsibility Regarding Safety

Unit Objectives

At the end of this unit, you will be able to:

1. Explain safety
2. Identify various types of hazards in your workplace
3. Describe what an MSDS is and why it is important

Safety is the responsibility of all employees whether at the job site or in a factory. The employer has the prime liability for safety, but every employee should be knowledgeable on safety. They should be able to work in a safe manner without any safety violation.

As a member of the plant team or the site team you are responsible for:

- Your own safety
- Reporting any unsafe conditions or practices to the safety engineer or supervisor
- Following all specific safety requirements as set forth in the specification and by the safety engineer or supervisor
- Adopting safe practices while working with solvents, coatings, spray equipment, scaffolding, abrasive blasting, etc.
- Knowing the location of first aid stations
- Knowing the location of the nearest telephone and emergency telephone numbers like ambulance, fire department, safety engineer etc.

8.1.1 Primary Hazards

Fire	Explosion	Reactivity	Health Hazards
• All solvent based coatings, whether in a container or as a wet film on a surface, are flammable. In most cases, the coating's binder resin is also flammable. Precaution should be taken to prevent a spark or a flame from coming in contact with wet film or liquid paint.	• When sufficient solvent vapour is present in the air, a spark or a flame, can cause the entire air volume to react at one time, creating an explosion. Explosion can occur without fire, although they are often combined. Every effort should be made to prevent the solvent-air mixture from reaching 50% of the lower explosive limit.	• Reactivity is not ordinarily a major problem from safety standpoint. However, in two pack systems, the mixing of the base and the hardener makes the system reactive and can generate substantial amount of heat. Epoxies, polyurethanes, and similar reactive materials such as polyesters catalysed with acid, develop a substantial amount of heat, whenever they are mixed. Hence the base and the hardener or catalyst should be stored separately.	• Most coatings are not so toxic and protective clothing and proper equipment can provide full protection. Any worker sensitive to heights should not work on ladders, scaffolds, or rigs.

8.1.2 Hazards Associated with Coating Materials and Equipment

Most paint materials are hazardous to some degree. All paints, except water-based paints are flammable; many are toxic, and others can irritate the skin. However, most paints are quite safe to use if simple precautions are followed every time.

Among paint raw materials, solvents, resins and solvent based drier solutions are flammable. Some solid materials such as metallic powders carry explosion risk. Products such as fungicides used in certain water-based paints are toxic. Powder raw materials such as pigments and extenders pose risk of inhalation. All these materials need to be handled with appropriate personal protective equipment and, following all safety instructions correctly.

Surface preparation materials like solvents, acid or alkali cleaners can cause skin irritation if not used with care.

Due precautions need to be observed during the use of high pressure abrasive or water blasting methods for surface preparation. Safety gear should be used when using ladders, scaffolds and rigs for working at heights.

Slippery floors and obstacles located on the floor may cause falls.

Electrical /mechanical equipment may produce shocks or other serious injuries if not handled with care. An obvious hazardous location is the interior of a tank at a paint factory or at a customer site. Deviations or taking short cuts and not following proper procedures may produce unsafe working conditions which may result in accidents, loss of life, time and materials.

8.1.3 Chemical Hazards

Chemical manufacturers are required to evaluate chemicals produced to determine if they are hazardous. The manufacturer reviews the chemical substance to determine if it is carcinogenic, toxic, irritant or dangerous to human organs, flammable, explosive, or reactive. This information is available in the material safety data sheets (MSDS) that are supplied with materials.

What is a Material Safety Data Sheet (MSDS)?

A Material Safety Data Sheet (MSDS) is an information sheet that lists the hazards, safety and emergency measures related to specific products. An MSDS is required for industrial products used in the workplace like chemicals, paint, thinners, pretreatment chemicals and cleaners.

Why do I need to use an MSDS?

You may want to know if there are chemicals in the products that can cause adverse health effects such as allergies or asthma during its handling and use. This information may be helpful to prevent exposure to chemicals from new products or in finding out if existing products may be causing symptoms.

Where can I get an MSDS?

Suppliers provide a MSDS for each product supplied to the customer. This may be available with the safety department of your company. You may also obtain an MSDS from data bank available on internet.

Why is an MSDS sheet required for a medical emergency?

In an emergency, the doctor can request an MSDS, to understand the nature of the hazard and the anti-dote recommended for treatment.

Where can I get more Information?

Some product labels include a full list of ingredients. Some suppliers will provide a full list if you request it. You can also ask the supplier's chemist for more information, including a list of additional ingredients.

Are all ingredients Included in MSDS?

No. Only specific hazardous chemicals are mentioned on a MSDS. Thus, perfume or a chemical odorant that may not be considered hazardous may not show up in the MSDS. Manufacturers do not disclose information they consider proprietary. Such information may relate to the chemical composition.

The MSDS lists each required substance that makes up more than 1 per cent of the product. However, if the chemical causes cancer, respiratory sensitisation, or reproductive effects, then it must be listed even if it makes up more than 0.1 per cent.

How much of a chemical is a problem?

It is important to consider several factors to determine if you should be concerned. For example, the quantity, toxicity and other effects, and the potential exposures of each chemical are important to think about. It is also important to know that most of the information on an MSDS relates to exposure to one chemical at a time.

Technical Terms: Listed below are some definitions of terms you may find on an MSDS.

- Carcinogen: causes cancer
- Hormonal: some chemicals act like hormones
- Reproductive toxin: damages the male or female sex organs, sperm, or eggs
- Sensitisation: a body response which makes you react to a smaller amount than before
- Teratogen: causes developmental abnormalities to the foetus (unborn child)
- Toxin/toxic: poison/poisonous

LG Chem Yeosu Complex	Material Safety Data Sheet	Identity No.	GHS – IPA - 001
	ISOPROPYL ALCOHOL CAS No. : 67-63-0	Page	1/10

1. Product and company identification

1) Product name : ISOPROPYL ALCOHOL
2) Advisable use and Restriction
- Advisable use
  - Solvent (oils, gums, waxes, resins, alkaloids, cements, primers, varnishes, paints, printing inks)
  - Medical (anitseptic disinfectant for home, hospital, and industry ; rubbing alcohol)
- Restriction of product using : Not available

3) Manufacturer/Supplier/Distributor information
- Company : LG Chem, LTD. Acrylates plant
- Address : 70-1, Hwachi-dong, Yeosu-si, Jeollanam-do
- Emergency response number : 061-680-1331
- Respondent: 2AA Team

2. Hazard identification

1) GHS classification of the substance:

- Flammable liquid: Category 2
- Eye Damage/Irritation : Category 2A
- Specific target organ toxicity (single exposure) : Category 3(respiratory tract irritation, narcotic effect)

2) GHS label elements, including precautionary statements

- Pictogram and symbol: :

- Signal word: Danger

- Hazard statements
  - H225: Highly flammable liquid and vapour
  - H319: Causes serious eye damage
  - H335: May cause respiratory irritation
  - H336: May cause drowsiness or dizziness

- Precautionary statements:
  - Precaution:
    - P210: Keep away from heat/sparks/open flames/ hot surfaces – No smoking.
    - P233: Keep container tightly closed.
    - P240: Ground/bond container and receiving equipment.
    - P241: Use explosion-proof electrical/ventilating/lighting equipment.

Fig 8.1.3: Material Safety Data Sheet (freeenergystore.com)

UNIT 8.2 Waste Disposal

Unit Objectives

At the end of this unit, you will be able to:

1. Describe how and why improper waste disposal is hazardous

Impact of dumping waste in the open:

- Water pollution – toxic liquid seeps into surface and groundwater
- Soil pollution – toxins seeps into the soil and surrounding vegetation
- Dump fires – waste decomposition releases inflammable methane which can result into explosion
- Disease – flies, rodents and pets can spread diseases from open dumpsites
- Other impacts – visual ugliness, foul smell, bird menace which can be a hazard to airplane

Waste is treated in an effluent treatment plant, as recommended by the supplier and then disposed of safely, in a specially designed landfill with protective measures to save the environment. Landfills also serve as a backup in case of malfunction in the plant treatment facility.

Notes

UNIT 8.3 Use Safety Tools and Personal Protective Equipment (PPE)

Unit Objectives

At the end of this unit, you will be able to:

1. List the different types of personal protective equipment mandatory while working

Personal Protective Equipment (PPE) and their usage is not an option; it must be practiced always without any deviations. In case of emergency, ensure you safeguard yourself first before helping others.

Personal Safety	Ladders	Scaffolding	Power Tools
• Use Personal Protective Equipment (PPE) to limit exposure to the eyes while handling powders or while spraying paint • Use regulated air respirator while spraying • Position yourself upwind of object being sprayed	• Use ladders that are stable • Wear shoes with heels • Inspect for loose, worn, or damaged rungs • Do not carry any tools in hand while climbing • While climbing face ladder, never jump from a ladder • Guard against metal ladder coming in contact with electric power lines	• Inspect for damage or deterioration • Ensure scaffolding is plumb and level • Ensure handrailing is provided on all scaffolding	• Verify safety guards are fitted and operational • Dust collection systems are operational when working with hazardous materials

Recommended PPEs

1. Gloves

(a) Nitrile gloves - used against solvent handling / painting

(b) Leather gloves - used against handling hot objects / blasting

(c) Surgical gloves - made up of latex, general purpose

(d) Polyethylene and cotton gloves - in powder coatings / painting

A powder coating operator should not use gloves as his hand should connect to the spray gun for grounding of his body.

Fig 8.3 (i): Latex gloves for pretreatment

Fig 8.3 (ii): Gloves for component handling

2. Masks

- Solvent mask - Dry charcoal network is used as filter in mask used with cartridge or pre-filtered
- Powder mask - It is used while feeding and it is not efficient than solvent mask

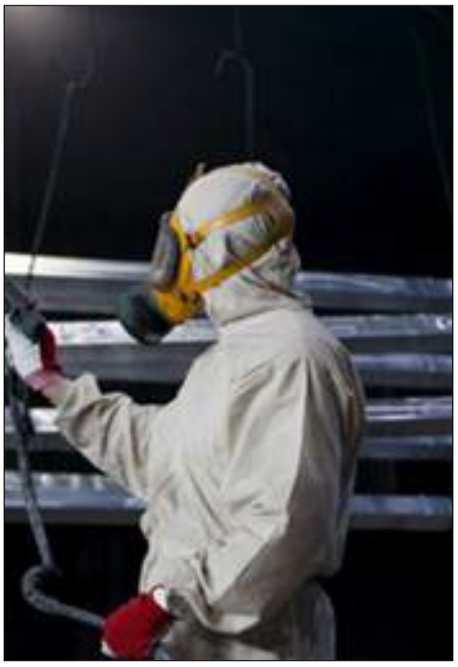


Fig 8.3 (iii): Worker with a mask

3. Ear plug/Muff

- Ear plugs are used to protect ears when large sounds are produced
- Ear plus- it can be used for 2 hours
- Non-disposable ear muffs - these can be reused after washing with water

Fig 8.3 (iv): Ear plugs

4. Eye shield

- Eye shield must be used while spraying and working with dust and powder.
- Eyewash bottle is also used.
- An eye shield can be used for 8 hours

Fig 8.3 (v): Eye shield

5. Industrial barrier cream

It should be used before work on hand so that any paint can be removed easily.

6. Renal hands rub cream

It is used after work to remove paint on hands.

7. Head guards and steel toe shoes (safety shoes)

They are used while working on the shop floor.

Fig 8.3 (vi): Safety precaution chart

Notes

UNIT 8.4 Handling of Coating Materials and Equipment as per Safety and Environmental Standards

Unit Objectives

At the end of this unit, you will be able to:

1. State how one can practice safe handling of materials and equipment used in painting and coating

Coatings Materials	Pretreatment Chemicals	Safety actions for fire risk	High temperature environments
• Read the MSDS. • Avoid excessive skin exposure. • Wear proper respiratory equipment. • Wear proper clothing and eyewear. • Always follow the manufacturers written procedures.	• Read the MSDS • Avoid skin contact • Wear recommended safety clothing • Maintain good ventilation • Always stay alert while handling chemicals	• Eliminate sources of ignition • Maintain a safe concentration of powder/ solvent vapour in air- below 50% of the lower explosion (flammability) limits • Maintain a good ground throughout the racks • Maintain a good ground on everything in the electrostatic coating application system	• Allow the temperature to attain the room temperature before carrying out any work • Disconnect power before entering • Use good lighting when entering • Wear a hard hat in areas where it is necessary to stoop • Never open washer or oven during operation • Know the hazards inside the equipment

Other than the above mentioned, basic elements of combustion such as electrical equipment, matches and cigarettes should be eliminated from site.

Notes

UNIT 8.5 Precautionary Measures

Unit Objectives

At the end of this unit, you will be able to:

1. Learn about ergonomic lifting, bending and moving equipment
2. List what goes into a first aid kit
3. Learn the actions to take during emergency procedures
4. Identify different kinds of safety signs

8.5.1 Ergonomic Lifting, Bending or Moving Equipment and Supplies

Fig 8.5.1 (i): Correct lifting techniques (worldartsme.com)

8.5.2 First Aid

A well-stocked first aid kit is a must at the workplace. It is essential to check the kit regularly and have items such as medications, emergency phone numbers, allergy details of employees and medical assistance numbers in the first aid kit. All expired and out dated medication should be discarded.

As per Red Cross recommendation, following articles must feature in a first aid box.

- 2 absorbent compress dressings
- 25 adhesive bandages (assorted sizes)
- 1 adhesive cloth tape
- 5 antibiotic ointment packets
- 5 antiseptic wipe packets
- 2 packets of aspirin
- 1 blanket
- 1 breathing barrier (with one-way valve)
- 1 instant cold compress
- 2 pair of no latex gloves (size: large)
- 2 hydrocortisone ointment packets
- Scissors
- 1 roller bandage (3 inches wide)
- 1 roller bandage (4 inches wide)
- 5 sterile gauze pads
- 5 sterile gauze pads (4 x 4 inches)
- Oral thermometer (non-mercury)
- 2 triangular bandages
- Tweezers

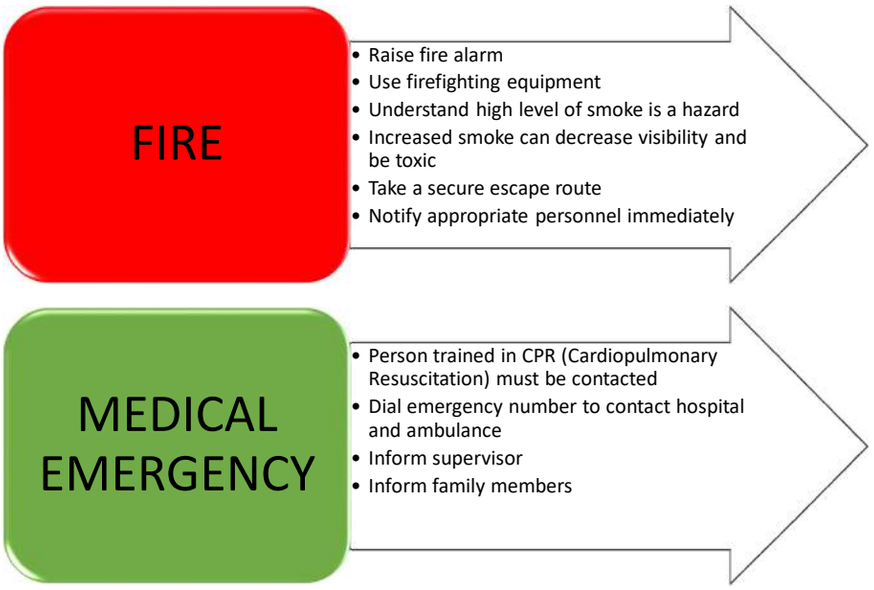
8.5.3 Emergency Procedures

On rare occasions, you may experience an emergency while working in a coating plant such as:

- Fire
- Medical emergency
- Armed hold up/robbery
- Bomb threat
- Natural disaster

Find out the emergency procedures and evacuation plans for emergency and obtain information on the evacuation plan of the company. Emergency procedures are reviewed from time to time based on the actual incidents. Remember your safety is of utmost importance in case of any emergency. Please refer to your supervisor/manager for specific information regarding your workplace.

- Evacuation routes and exits are prominently displayed in the building and premises.
- Emergency exits, and evacuation routes must comply with local building codes.



8.5.4 Display Safety Signs

- Learn to respect safety signs
- Learn to display them at appropriate places
- It is crucial for your safety and safety of other people
- Never take safety sign instructions lightly

8.5.5 Safety Checklist

As a paint/powder applicator, for all emergency situations, you must

- Know how to report a safety incident
- Understand the evacuation policy and procedures
- Have access to the list of emergency contact numbers inside and outside the facility
- Understand the procedure for employees during shutdown of critical operations
- Never disconnect hose under pressure
- Not leave pressurised unit unattended
- Never point the spray gun at human body
- Ensure the gun has required trigger guard
- Use electrically conductive hose in airless applications
- Ensure that no ignition source is present when flammable materials are used
- Minimise use of low flash point materials
- Check for adequate ventilation

GENERAL SAFETY	• Locate nearest telephone • Identify restricted areas • Locate fire alarm • Locate fire extinguisher and fire blankets • Locate moving objects, cranes, and traffic • Identify and observe safety warning tags and signs • Learn facility alarms, evacuation procedures, and general emergency protocols
LADDERS	• Periodically inspect for loose, worn, or damaged rungs • Never carry any tools in hand while climbing • Always face ladder while climbing • Never jump from a ladder • Guard against danger of metal ladder coming in contact with electric power lines • Secure the ladder
SCAFFOLDING	• Periodically inspect for damage or deterioration • Ensure scaffolding is plumb and level • Ensure handrailing is provided on all scaffolding • Never ride scaffolding on rollers when it is being moved • Verify inspection tags are valid and in place at all times
POWER TOOLS	• Ensure safety guards are fitted and operational • Ensure dust collection systems are operational when working with hazardous materials
ABRASIVE BLAST	• Ensure that the following are installed and in working order: o Deadman valve o Pressure control valves o Adequate moisture and oil separators o Protective clothing (hoods and gloves) o Filtered and regulated air-supplied respirator • Make certain that: o Entire system is grounded, including hoses, operator, and work piece o Hose couplings are wired shut o Abrasive hose is stored in a dry place o Abrasive hose is curved around, not bent at 90° angle o Nozzle is never pointed at human body or breakable object o Abrasive hose is inspected for damage and wear
SPRAY APPLICATION	• Ensure no ignition sources are present • Minimise use of low flash point materials • Adequate ventilation must always be provided • Ensure spray booth is clear of exhaust fumes from previous spraying • Ensure no rags become soaked with flammable liquid in spray area

PERSONAL PROTECTION	• Goggles and safety glasses must be worn at all times • Regulated air respirator must be used always • Operator must always be positioned upwind of object being sprayed
HOSE AND GUN	• Hoses must be inspected periodically for weak and worn spots • Hose connections must be correct and tightened • Hose must never be disconnected or recoupled while under pressure • Pressurised unit must never be left unattended • Gun must be grounded through hose connections • Operator uses electrically conductive hose in airless applications.
TEST EQUPMENT	• Holiday detectors must always be grounded • No volatile substances must be present when high voltage detectors are in use • Equipment must be suitable for the environment in which it is being used, e.g., intrinsically safe in hazardous confined spaces

Tips

- Working in a safe, environmentally clean manner without adversely impacting your health and that of your co-workers is not an option, but a mandatory requirement in any job.
- Be conscious of the health hazards posed by various chemicals and substances you use and learn and practice ways of mitigating them.
- Always learn to respect safety signs.
- Make safe working a habit.
- Never take safety sign instructions lightly.

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9. Maintain IPR of Organisation and Customer

Unit 9.1 - Secure Company's Intellectual Property Rights (IPR)
Unit 9.2 - Copyright
Unit 9.3 - Confidential Information and Trade Secrets
Unit 9.4 - Organisation Information to be Kept Confidential
Unit 9.5 - Customer Information to be Kept Confidential

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Applicable NOS – PCS/N9904

Key Learning Outcomes

At the end of this module, you will be able to:

1. Understand what Intellectual Property Rights are and their significance in your job
2. Describe what aspects of your job come under Intellectual Property Rights

UNIT 9.1 Secure Company's Intellectual Property Rights (IPR)

Unit Objectives

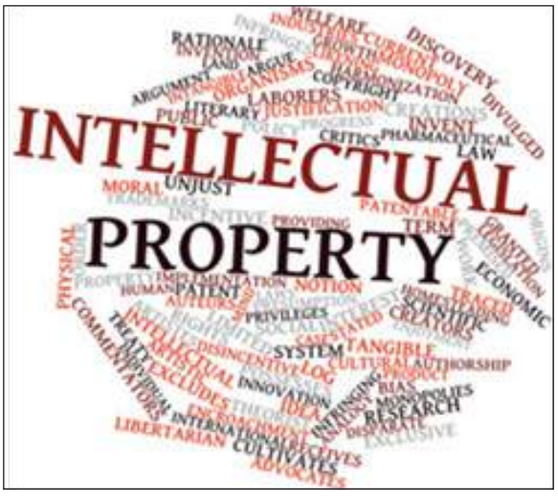
At the end of this unit, you will be able to:

1. Describe and discuss about various kinds of IPRs in the country

With the advent of the knowledge and information technology era, intellectual capital has gained substantial importance. Companies are carrying on business in several countries and selling their goods and services to entities in multiple locations across the world. Since intellectual property rights ("IPRs") are country-specific, it is imperative, in a global economy, to ascertain and analyse the nature of protection afforded to IPRs in each jurisdiction. We will discuss here the IP law regime in India and the protections provided thereunder.

Intellectual Property Right (IPR) a term referring to creations of the intellect for which a monopoly is assigned to designated owners by law.

- Some common types of intellectual property rights (IPR) are copyright, patents and industrial design rights; and the rights that protect trademarks, trade dress and in some jurisdictions trade secrets.
- All these cover music, literature, and other artistic works; discoveries and inventions; and words, phrases, symbols and designs.



IPR in India

The importance of intellectual property in India is well established at all levels - statutory, administrative and judicial. The agreement provides for norms and standards in respect of trademarks, copyrights, industrial designs and patents. The Indian government has taken several initiatives to create a conducive environment for the protection of intellectual property rights of innovators and creators by bringing about changes at legislative and policy level.

Aim

- Establish a vibrant IP regime in the country
- Adopt best practices in IP processing
- Strengthen public delivery of IP services
- Ensure a high level of transparency and user-friendliness

TYPE OF IPR	DEFINITION & SIGNIFICANCE	IPR ADMINISTERED THROUGH
PATENT	A patent is granted for an invention which is "a new product or process, that meets conditions of novelty, non-obviousness and industrial use".	• Department of Industrial Policy and Promotion, Ministry of Commerce & Industry • The Patents Act, 1970 (as amended in 2005)
DESIGN	A design refers only to the features of shape, configuration, pattern, ornamentation, composition of colour or line or a combination thereof, applied to any article, whether two or three dimensional or in both forms by any industrial process or means which, in the finished article, appeal to and are judged solely by the eye.	• Department of Industrial Policy and Promotion, Ministry of Commerce & Industry • Designs Act 2000
	A Trade Mark can be a device, brand, heading, label ticket name, packaging, sign, word, letter, number, drawing, picture, emblem, colour or combination of colours, shape of goods, signature or a combination thereof.	• Department of Industrial Policy and Promotion, Ministry of Commerce & Industry • Trade Marks Act 1999 (as amended in 2010) For example, paint and powder coating company logos which are Trade Marks of the companies and which the companies have the copyright to.
SEMICONDUCTOR INTEGRATED CIRCUITS LAYOUT-DESIGN	The aim of the Semiconductor Integrated Circuits Layout-Design Act 2000 is to provide protection of Intellectual Property Right (IPR) in the area of Semiconductor.	• Department of Electronics and Information Technology, Ministry of Communications, and Information Technology • Semiconductor Integrated Circuits Layout-Design Act, 2000

Fig 9.1: Logos of various paint companies (for representation purpose only)

Notes

UNIT 9.2 Copyright

Unit Objectives

At the end of this unit, you will be able to:

1. Explain in detail what is Copyright and what aspects get covered under Copyright

A Copyright is a right given by the law to creators of literary, dramatic, musical and artistic works and producers of cinematograph films and sound recordings. In fact, it is a bundle of rights including, inter alia, rights of reproduction, communication to the public, adaptation and translation of the work.

It is administered by The Ministry of Human Resource Development and The Copyright Act, 1957 (as amended)

A copyright gives the creator of an original work exclusive rights to it, usually for a limited time. Copyright may apply to a wide range of creative, intellectual, or artistic forms, or "works". Copyright does not cover ideas and information themselves, only the form or manner in which they are expressed.

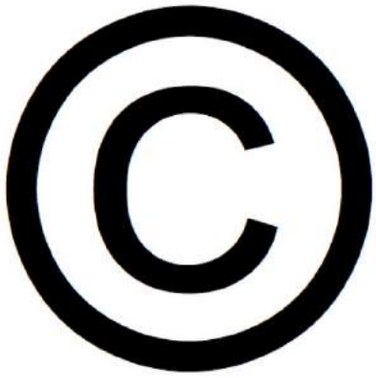


Fig 9.2: Copyright symbol

What rights does Copyright provide?

A copyright grants protection to the creator and his representatives for the works and prevents such works from being copied or reproduced without his/their consent. The creator of a work can prohibit or authorise anyone to:

- Reproduce the work in any form, such as print, sound, video, etc.
- Use the work for a public performance, such as a play or a musical work
- Make copies/recordings of the work, such as via compact discs, cassettes, etc.
- Broadcast it in various forms
- Translate the same to other languages

What is the term of Copyright?

The term of copyright is, in most cases, the lifetime of the author plus 60 years thereafter.

Copyright Infringement

- Copyright infringement is reproducing, distributing, displaying or performing a work, or to make derivative works, without permission from the copyright holder. It is often called "piracy".
- Enforcement of copyright is generally the responsibility of the copyright holder

A Copyright is infringed if a person without an appropriate license does anything that the owner of the Copyright has an exclusive right to do. However, there are certain exceptionsto the above rule (e.g., fair dealing). The Copyright Act provides for both civil and criminal remedies for Copyright infringement. When an infringement is proved, the copyright owner is entitled to remedies by way of injunction, damages, and order for seizure and destruction of infringing articles.

Importation of infringing Copies

The amendment in the Copyright law has introduced a revised Section 53. This provides a detailed procedure whereby the owner of the Copyright can make an application to the Commissioner of Customs (or any other authorised officer) for seizing of infringing copies of works that are imported into India.

Rules and Acts related to Copyrights:

- Copyright Act, 1958
- Copyright Act, 1987
- International Copyright Order, 1999
- The Copyright (Amendment) act, 2012

Notes

UNIT 9.3 Confidential Information and Trade Secrets

Unit Objectives

At the end of this unit, you will be able to:

1. Describe what comes under confidential information and understand why trade secrets must be protected

Confidential information and trade secrets are protected under the common law and there are no statutes that specifically govern the protection of the same. In order to protect trade secrets and confidential information, watertight agreements are signed between the employee and the owner/ management supported by sound policies and procedures.

Non-Disclosure Agreements

- Sound and concise company policies and non-disclosure agreements with the employees protect confidential information and trade secrets of the company. Such agreements should define "confidential information" and the exceptions to confidentiality.
- Non-compete clauses, afford an organisation added protection with respect to its confidential information. Such provisions must have a clear purpose, which is to restrict the use of confidential information and trade secrets obtained during employment.
- To ensure that the rights of third parties are not violated, the non-disclosure/employment agreement imposes an obligation on the employee not to integrate into the organisation's data or intellectual property, any confidential information of a third party. Organisations execute such agreements at the time of employment, subsequently executed agreements should expressly cover the confidential information obtained by the employee from the date of his employment.

Internal Processes

- You should be able to identify information that is confidential and a trade secret of your company. Data that is confidential should clearly be not shared with any one.
- Third-party interaction and disclosures should be channelled only through specified personnel. Confidential information should only be shared with those employees who have a legitimate need to know such information, thus enabling the employees to perform the assigned tasks.

UNIT 9.4 Organisation Information to be Kept Confidential

Unit Objectives

At the end of this unit, you will be able to:

1. Understand why organisational information is crucial to the success of an organisation

Organisation's information regarding the following should be kept confidential at all times. It should not be disclosed to anyone other than the immediate supervisor and employees who need to know the information legitimately.

- Process adopted including equipment/s used
- Production volume
- Cost of the product
- SOP of the company

The new product design and application process gives the company a competitive advantage in the market. Any leakage of the new design and its launch plans will reduce the competitive advantage as competitors' can also launch new designs simultaneously. Any information on this should be passed on to the immediate supervisor only. Report any infringement of the brand and/ or logo observed in the market, to the immediate supervisor. It takes only one employee to commit the mistake and the entire company suffers.

Notes

UNIT 9.5 Customer Information to be Kept Confidential

Unit Objectives

At the end of this unit, you will be able to:

1. Understand why customer information is important and is crucial to the success of a company

Customer's information regarding the following should be kept confidential. It should not be disclosed to any other customer or outside agency but only with the immediate supervisor or persons who have the legitimate right to have the information within and outside the company.

- Process adopted
- Equipment/s and products used
- Line design, component/ parts design, its loading pattern
- Production volume/ day/ month/ annual

Why is confidentiality important?

- Failure to protect confidential customer and business information can lead to the loss of business/clients.
- Confidential information in wrong hands can be misused to commit illegal activity e.g., fraud which can result into costly lawsuits for the employer.

What type of information of your company should be protected?

- Employee information – personal information of your colleagues and superiors like personal phone number, email id, etc.
- Confidential management information includes disciplinary actions, employee relations issues, impending layoffs/reductions-in-force, terminations, workplace investigations of employee misconduct, etc. While disclosure of this information is not "illegal," it can seriously damage the image of the company.
- Trade secrets like business plans, manufacturing processes and methods, computer program and data compilation, financial data, budgets and forecasts, client/customer lists, ingredient formulas and recipes, employee lists, supplier lists, etc.

Tips

- Do not share confidential information of the company with people outside your organisation.
- Do not take photographs of components, parts, SOP or any other company documents.
- If anyone other than the employee of the company is taking photographs of components or parts or any document, you must not allow them and immediately inform your supervisor.
- Do not upload confidential information on social media.
- Remember, sharing secret and confidential information and documents can result in customer withdrawing the project from your company and can also be punishable by law.

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