

Surface Coating Technology Handbook

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Surface Coating is in use since long back is rapidly increasing with the development of civilization. There has been considerable impact in this field. Surface coating technology specializes in finding out engineering solutions to all the critical production problems related to coating the products on a continuous and consistent basis in your production plant. Surface coating can be defined as a process in which a substance is applied to other materials to change the surface properties, such as colour, gloss, resistance to wear or chemical attack, or permeability, without changing the bulk properties. Production of surface coating by any method depends primarily on two factors: the cohesion between the film forming substances and the adhesion between the film and the substrate. The development of science and technology revolutionized the surface coating industry in the progressive countries of the world. Surface coating technology involves the use of various types of products such as resins, oils, pigments, polymers, varnishes, plasticizers, emulsions, etc. We have completely replaced costly petroleum solvents with water and we get cheaper finished products with no evaporation loss and fire hazards. Paint is any liquid, liquefiable, or mastic composition which after application to a substrate in a thin layer is converted to an opaque solid film. It is most commonly used to protect, colour or provide texture to objects. The paint industry volume in India has been growing at 15% per annum for quite some years now. Varnish is one of the important parts of surface coating industry. They are used to change the surface gloss, making the surface more matte or higher gloss, or to provide the various areas of a painting with a more unified finish. Plasticizer plays an important role in the formation of polyvinylchloride (PVC). It is also used to plasticize the polymers. Polymers are divided into three different types; linear polymers, branched polymers and cross linked polymers. Polymer Energy system is an award winning, innovative, proprietary process to convert waste plastics into renewable energy. On the basis of value added, Indian share of plastic products industry is about 0.5% of national GDP.

This book basically deals with principles of film formation, evaporation of solvent from a solution, chemistry and properties of drying and other oils, glyceride structure and film formation, the size of polymer molecules, processing of oil and resin, inorganic pigments, classification by chemical constitution, azo pigments, organic pigments in architectural (decorative), organic pigments in industrial finishes, solvent requirements of specific resins convertible systems, molecular structure of polymer plasticiser systems, properties of plasticised polymers, surface active agents, optical properties, rheological characteristics, emulsions and other aqueous media, formation of polymer emulsions, modern methods of analysis etc.

The book presents a concise, but through an overview of state of technology for surface coating. This is organized into different chapters like principal of film formation, chemistry and properties of drying and other oils, processing of oil and resin, organic pigment, solvents,

plasticizer, surface active agent, surface preparations etc. This book is an invaluable resource to technocrats; new entrepreneurs, research scholars and others concerned to this field.

1. PRINCIPLES OF FILM FORMATION

Cohesive and Adhesive Forces

1. Mechanical Forces

2. Molecular Forces

Evaporation of Solvent from a Solution

1. Typical Materials

2. Properties of Materials

3. Effects of Evaporation

Evaporation of One of the Phases of an Emulsion

Evaporation of Solvent Plus Polymerisation

1. Oxygen Induced Mechanisms

2. Heat Induced Polymerisations

3. Use of Water as a Curing Agent

4. Systems Using Catalysts

Systems Employing Substantial Amounts of Curing Agents

Systems Employing the Solvent as a Film Former

2. CHEMISTRY AND PROPERTIES OF DRYING AND OTHER OILS

Vegetable Oils

1. Origin

2. Production of Oils

3. Composition of Crude Oils

4. Refining

Fatty Acids

1. Saturated Acids

2. Monoethenoid Acids

3. Polyethenoid Acids

4. Substituted Acids

Glyceride Structure and Film Formation

1. Fatty Acid Composition

2. Fatty Acid Distribution

Chemical Reactions of Glycerides

1. Ester Reactions

Industrial Applications of Ester Reactions

1. Synthetic Oils

2. Fat Splitting

3. Alcoholysis

Reactions Associated with Unsaturation

1. Oxidation

2. Polymerisation

3. Isomerisation

4. Hydrogenation

5. Reaction with Sulphur

6. Reaction with Maleic Anhydride

Specific Reactions

1. Castor Oil Reactions

2. Dehydrated Castor Oil

Film Properties

1. Oily Media
2. Varnish Media
3. Alkyd Media

Synthetic Drying Oils

1. Hydrocarbon Drying Oils
2. Fatty Acid Condensation Products
3. CHEMISTRY OF RESIN FORMATION AND ITS PROPERTIES

Introduction

Fundamentals of Polymer Formation

1. Functions or Reactive Groups
2. Classification of Polymers

Formation of Polymers

1. Condensation Reactions
2. Addition Polymerisation

Types of Polymers

1. Polyesters
2. Polyamides
3. Phenolic Resins
4. Amino Resins
5. Epoxide Resins
6. Vinyl Polymers
7. Acrylic Polymers
8. Silicones

The Size of Polymer Molecules

1. Estimation of Molecular Weight
2. Measurement of M_n
3. Measurement of M_w
4. Viscosity Relationship

Physical Properties of Polymers

1. Factors Affecting Tensile Strength
2. Cohesive Energy
3. Influence of Molecular Order
4. Intermolecular Attraction
5. Crystallinity
6. Achievement of Flexibility

Chemical Properties of Polymers

1. Effect of Molecular Weight on Solubility
2. Effect of Polymer Structure

Selection and Design of Polymers

1. Addition-Condensation Polymers
2. Designing for Water Solubility
3. Use of Inorganic Ingredients
4. Advent of Truly Synthetic Polymers

4. PROCESSING OF OIL AND RESIN

General Requirements for Processing Equipment

Materials of Construction

Design of Reaction Kettles

1. The Kettle Body
2. Branches and Connections
3. Stirring Equipment

Fume Disposal and Scrubbing

1. Disposal Systems for General Use

2. Water Scrubbing of Anhydride Vapours

3. Packed Scrubbers

Condensing and Refluxing

1. Condensers for P.F., V.F. and M.F. Resins

2. Condensers for Alkyd and Polyester Type Resins

Ancillary Equipment

1. Thinning and Blending Tanks

2. Instruments

3. Vacuum Equipment

4. Valves and Fittings

5. Inert Gas Pipes

6. Pressure and Flow Indication

7. Fume Extraction

8. Lagging

9. Miscellaneous

Heating and Cooling

1. Criteria for Selection of Heating and Cooling Systems

2. Heating of Low Temperature Products

3. Heating at Higher Temperatures

4. Fluid Heat Transmission

5. Heating by Electricity

6. Heating of Pipework and Ancillaries

5. INORGANIC PIGMENTS

Introduction

Origins of Pigments

1. Comparison of Natural and Synthetic Pigments

2. Problems in Producing Natural Pigments

3. Pigment Classification

Pigmentary Properties

1. Particle Size and Particle Size Distribution

2. Particle Shape

3. Colour

4. Refractive Index

Chemical Engineering Processes of Manufacture

1. Precipitation

2. Vapour Phase Oxidation

3. Heterogeneous Surface Reaction (Corrodibility and Corrosion)

4. Solid Phase at Elevated Temperature

Important Groups of Pigments

1. Titanium Dioxide Group

2. Lead Group

3. Zinc Group

4. Antimony Group

5. Lead Chrome Group

6. Chrome Green Group

7. Iron Oxide Group

8. Iron Blue Group

9. Ultramarine Group

10. Cadmium Yellow and Red Group

6. ORGANIC PIGMENTS

Important Properties of Organic Pigments

1. Light Fastness

2. Fastness to Solvents

3. Heat Fastness

4. Chemical Fastness

Types of Organic Pigments

1. General Classification

2. Classification by Chemical Constitution

Azo Pigments

1. Monoazo Pigments

2. Disazo Pigments

Non-azo Pigments

1. Miscellaneous Products

2. Phthalocyanine Pigments

3. Vat Pigments

4. Miscellaneous Heterocyclic Compounds

Factors Governing Choice of Organic Pigments

1. Hiding Power

2. Dispersion

3. Stability of Pigmented Systems

Organic Pigments in Architectural (Decorative)

Finishes

1. Solvent-Based Paints

2. Water-Based Paints

Organic Pigments in Industrial Finishes

1. Air-Drying Industrial Finishes

2. Finishes Drying by Solvent Evaporation

3. Heat-Cured Industrial Finishes

4. Chemically Cured Finishes

7. EXTENDERS

Introduction

1. Production and Manufacture

2. Opacity

3. Chemical Constitution and Composition

Oxides

Silicas

Hydroxides

Alumina

Carbonates

1. Calcium Carbonate

2. Magnesium Carbonate

3. Calcium-Magnesium Carbonate

4. Barium Carbonate

Silicates

1. Aluminium Silicates

2. Calcium Silicates

3. Magnesium Silicates

4. Asbestos

Sulphates

1. Barium Sulphate

2. Calcium Sulphate

8. SOLVENTS

Introduction

Characteristics of Solvent Groups

1. The Terpenes

2. Hydrocarbon Solvents
3. Ketones
4. Esters
5. Glycol Monoethers
6. Ethers
7. Alcohols
8. Halogenated Compounds
9. Nitroparaffins

Evaluation and Selection of Solvents

1. Solvency
2. Tolerance for Non-solvents
3. Viscosity of Resin Solutions
4. Drying Time
5. Final Properties of the Film
6. General Conclusions

Solvent Requirements of Specific Resins—Convertible Systems

1. Oil Varnishes
2. Alkyd and Alkyd/Amino Resin Composition
3. Silicones
4. Acrylic Resins
5. Urethanes
6. Phenolic Resins
7. Epoxy Resins
8. Polyester Resins

Solvent Requirements of Specific Resins-Non-Convertible Systems

1. Cellulose Compositions
2. Vinyl Resins
3. Acrylic Resins
4. Shellac and Other Spirit-Soluble Resins
5. Rubber Resins and Derivatives

9. PROPERTIES OF SOLVENTS

10. PLASTICIZERS

Introduction

Molecular Structure of Polymer-Plasticiser Systems

1. Effect of Molecular Size
2. Types of Polymers
3. Identification of Polymer Types

Criteria of Plasticiser Efficiency and Compatibility of Polymers

1. The Second-Order Transition Temperature
2. Tests to Show Whether A Given Polymer System Can Be Plasticised
3. Properties of Concentrated Polymer Solutions
4. Compatibility of Resin and Plasticiser
5. Vapour Pressure of Plasticisers

Properties of Plasticised Polymers

1. Exudation Phenomena and Exudate Composition
2. Migration of Plasticisers
3. Tensile Strength
4. Viscosity of Plasticisers and Its Effects
5. Inflammability

The Chemical Types of Plasticisers

1. Hydrocarbons
2. Esters
3. Epoxidised Vegetable Oils
4. Polyesters

Toxicity of Plasticisers

1. Hydrocarbons
2. Halogenated Hydrocarbons
3. Alcohols
4. Glycols
5. Ketones
6. Esters-organic
7. Esters-Inorganic

11. SURFACE ACTIVE AGENTS

Introduction

Types of Surfactants

1. Anion Active
2. Cation Active
3. Ampholytic
4. Non-ionic
5. Miscellaneous

Properties

1. Compatibilities
2. Chemical Stability
3. Physico-Chemical Characteristics
4. Surface and Interfacial Tension

Suspension, Sedimentation and Flocculation

1. Factors Governing Sedimentation Rate
2. Emulsions

Choice of Surfactant

1. Effect of Chain Length
2. Hydrophile/Lipophile Balance
3. Foaming and Anti Foaming

Pigment Treatment

1. Surfactants as Additives in Grinding and Dispersion
2. Pigment Pretreatment
3. Pigment Flushing

Specific Uses in Paints

1. Oil-Bound Water Paints
2. Emulsion (Polymerised) Paints
3. Adhesion of Paints
4. Rheological Properties
5. Speciality Paints
6. Miscellaneous Allied Applications

12. OPTICAL PROPERTIES

Introduction

1. Factors Affecting the Appearance of Coatings
2. Application of Optical Data

Light Transmission, Absorption and Reflection

Correlation of Light Beam Phenomena

Scattering

Opacity

Types of Transparent Coatings

Methods of Measuring Clarity
Scattering Materials
Effects of Pigment Properties
Reflectance Measurement
Gloss
Gloss Measurement Techniques
Colour
Spectrophotometry
Colorimetry
Alternative Methods of Colour Measurement
Appearance of Coatings
Fluorescence
Fading
Lightfastness Tests
External Influences on Lightfastness
Standards of Lightfastness

13. RHEOLOGICAL CHARACTERISTICS

Introduction
Rheological Behaviour In Liquids
1. Newtonian Flow
2. Non-Newtonian Flow
Theories of Viscosity
Eyring's Theory
Einstein's Equation
Molecular Complications
Relaxation Mechanisms
Rheological Measurements
1. Coaxial Cylinder Viscometer
2. Cone-and-Plate Viscometer
3. Capillary Flow Viscometers
4. Falling Sphere Viscometers
5. Efflux Viscometers
Practical Applications
1. Brushing Properties
2. Sagging and Flow

14. EMULSIONS AND OTHER AQUEOUS MEDIA

Introduction
Emulsion Media
Emulsion Polymerisation
Polymerisation
Copolymerisation
Formation of Polymer Emulsions
Particle Charge in Polymer Emulsions
Surface Coating Emulsions
Polyvinyl Acetate and Its Copolymers
Polystyrene
Butadiene/Methyl Methacrylate Copolymers
Emulsified Resins and Oils
Coacervate Emulsions
Emulsion Paints
Film Formation
Composition and Rheology
Solution Media

Proteins

Synthetic Water-Soluble Polymers

Maleinised Oils

Silicates and Siliconates

Solid Cementitious Binders

15. CORROSION

Corrosion of Metals

Electrochemical Basis of Corrosion

Electronic Permeability of the Oxide Film

Permeability of the Oxide Film to Metal Cations

Electrolytic Resistance of the Solution

Effect of an Applied E.M.F.

Protective Action of Organic Coatings

Permeability of Organic Coatings to Oxygen and Water

Permeability of the Oxide Film to Metal Cations

Resistance Inhibition

Metallic Pigments

16. FILM PROPERTIES AND DEFECTS

Properties

1. Adhesion

2. Hardness

3. Flexibility

4. Film Strength or Cohesion

5. Abrasion Resistance

6. Water Absorption

7. Water Permeability

8. Chemical Resistance

9. Solvent Resistance

10. Heat Resistance

11. Colour Retention

12. Fungus Resistance

13. Durability

Defects

1. Black Spotting

2. Blistering

3. Bloom

4. Blushing

5. Bronzing

6. Chalking

7. Cracking

8. Cratering

9. Flaking

10. Floating and Flooding

11. Gas-Checking and Frosting

12. Orange Peel

13. Ropiness or Ropy Finish

14. Seediness

15. Sheariness

16. Silking

17. Sleepiness

18. Sulphide Staining

19. Sweating

20. Wrinkling or Rivelling

17. SURFACE PREPARATIONS

Metal Surfaces

1. Iron and Steel
2. Aluminium
3. Cadmium
4. Copper and Brass
5. Lead
6. Magnesium
7. Stainless Steels, Nickel and Chromium
8. Tin
9. Zinc
10. Pretreatment Primer for Metallic Surfaces

Wood

1. Characteristic Properties
2. Preparation for Painting
3. Preparation for Varnishing and Lacquering

Plaster and Cement Surfaces

1. Drying and Priming
2. Treatment of Efflorescence
3. Control of Drying Out Process
4. General Principles
5. Asbestos Cement

Masonry and Building Boards

1. Brickwork
2. Stone Masonry
3. Miscellaneous Building Boards

Preparation for Repainting

1. Removing Old Paint
2. Dealing with Contaminated Surfaces
3. Schedules of Painting

18. APPLICATION TECHNIQUES

Introduction

Brush and Roller Application

Use and Maintenance of Brushes

Roller Application—Hand

Roller Application—Machine

Spray Application

Compressed Air

Spray Guns and Accessories

Metering Spray Equipment

Spray Booths

Hot Spraying

Steam Spraying

Petroleum Solvent Spraying

Cold Hydraulic Spraying

Hot Hydraulic Spraying

Electrostatic Spraying

Dip Application

Slipper Dip

Trichloroethylene Dip

Controlled Extraction

Flood Coating

Flow Coating

Curtain Coating
Barrelling and Centrifugal Application
Stoving
Operation of Stoving Ovens
Convection Ovens
Radiant Heat Ovens
19. MODERN METHODS OF ANALYSIS
 "Absorption spectroscopy
 Introduction
 General Features
 Wavelength
 Intensity
 Quantitative Analysis
 Ultra-Violet Spectroscopy
 Principle
 Instruments and Technique
 Analytical Applications
 Infra-Red Spectroscopy
 Principle
 Instruments and Technique
 Analytical Application
 "Gas chromatography
 Introduction
 Basis of System
 Injection System
 Detector
 Applications
 Solvent Analysis
 Plasticiser Analysis
 Hydrocarbon Analysis
 Fatty Acid Analysis
 Phenol Analysis
 Resin and Polymer Analysis
 Recent Developments

About NIIR

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