<table>
<thead>
<tr>
<th>Code:</th>
<th>ENI109</th>
</tr>
</thead>
<tbody>
<tr>
<td>Format:</td>
<td>Paperback</td>
</tr>
<tr>
<td>Indian Price:</td>
<td>1000</td>
</tr>
<tr>
<td>US Price:</td>
<td>100</td>
</tr>
<tr>
<td>Pages:</td>
<td>640</td>
</tr>
<tr>
<td>ISBN:</td>
<td>8178330482</td>
</tr>
<tr>
<td>Publisher:</td>
<td>Select</td>
</tr>
</tbody>
</table>
The beginning of ink making is something of a mystery. It is certain however, that the development of the art of writing preceded the invention of ink by almost a thousand years. Today inks are divided into two classes: printing inks and writing inks. Printing is a process for reproducing text and images, typically with ink on paper using a printing press. It is often carried out as a large scale industrial process, and is an essential part of publishing and transaction printing. Different techniques and printing equipments are employed for each printing practices. The demand for innovative printing practices has been on a high in recent times. There are various kinds of printing processes; lithographic process, the gravure process, offset printing process etc. Different types of inks derived from different processes are ball pen inks, bleachable inks, fluorescent inks, fast drying ink, automatic press inks, rotary press inks, coated paper inks, planographic inks, lithographic inks, offset tin printing inks etc. The Printing Ink industries have grown significantly during the last decade and this industry is characterized by exceeding high margin profit. As we read newspapers, magazines, and books on a daily basis therefore inks are found in almost every aspect of human activity. The worldwide printing inks market is projected to register a CAGR of about 2.8%. Printing inks market embodies the strength of the global as well as regional economies. With its high correlation to a national GDP, the printing inks market is cyclical in nature, with economic ups and downs amplifying the demand patterns. The world printing inks market is projected to grow moderately over the next couple of years.

The major contents of the book are pigment in the printing inks, manufacturing of printing inks, storage and testing of raw materials, planographic inks, lithographic inks, factors effecting visual appearance of ink film, factors effecting visual appearance of ink film, method of mixing metallic powder and varnish, the principle of reproducing photographs by printing methods, etc.

In this book an attempt has been made to bring together the useful manner as possible the fundamental Principles of ink making. The book contains formulae processes and other relevant information of the manufacturing of different types of printing inks.

Content:
1. Introduction
2. Printing Inks
3. Printing Ink Vehicles
   Vegetable Drying Oils
   Linseed Oil and Linseed Oil Varnishes
   Lithographic Varnish
   China Wood Oil or Tung Oil
   Soya Bean Oil
   Perilla Oil
   Other Vegetable Drying Oils
   The Vegetable Semi-Drying Oils
   Cottonseed Oil
   Rapeseed Oil
   The Vegetable Non-Drying Oils
   Mineral Oils
   Animal Oils
   Terrestrial Animal Oils
   Marine Animal Oils
   Rosin Oils
   Pitch Varnishes

4. Pigment in the Printing Inks
   Pigments
   Nature
   Minerals
   Carbonic sources
   Botanical
   From animals
   Black Pigments
   Lamp black
   Russian black
   Coal or gas
   Wooden coal
   Ivory coal
   Bones
   Parish black
   Lead and graphite
   Composition black
   White Pigment
   White lead
   Antimony
   Chinese white
   Transparent white
   Blainfix white
   Yellow Pigments
Chrome yellow
Cadmium yellow
Ochres yellow
Gummy material
Minerals
Red Pigment
Vermillion
Carmine
Lac
Lake pigment
Kothenial lake
Madar
Blue Pigment
Prusian blue
Ultramarine blue
Reflex blue
Oriental blue
Cobalt blue
Indigo blue
Green Pigment
Emerald green
Chrome green

5. Manufacturing of Printing Inks
Storage and Testing of Raw Materials
Mixing operation
Mixing machines
Milling process
Delivery part of the machine
Quality control
Packing and selling

6. Typographic Printing Inks
Job Press Inks
Job Black
Job Press Bright Red
Job Press Green
Automatic Press Inks
Automatic Press Black
Automatic Press Red
Flatbed Cylinder Press Inks
Cylinder Press Black
Cylinder Press Peacock Blue
Rotary Press Inks
Rotary Press Red
Rotary Press Black
7. Planographic Inks
Lithographic Inks
High Grade Lithographic Black
Lithographic Peacock Blue Ink
Lithographic True Blue
Offset Printing Inks
Offset Red for Lake C
Offset Milori Blue
Offset Tin Printing Inks
Tin Printing Reddish Blue
Tin Printing Medium Yellow
Dry Offset Printing Inks
Dry Offset Red for Lake C
Dry Offset Bronze Blue
Photogelatin Inks
Photogelatin Blue
Photogelatin Black

8. Intaglio Printing Inks
Copper Plate Engraving Inks
Copper Plate Black
Copper Plate Blue
Steel Plate Engraving Inks
Steel Plate Black
Toner Blue Ink for Plate Black
Steel Plate Orange
Stamping Inks
Gloss Stamping Red
Dull Stamping Black
Photogravure Inks
Photogravure Picture Black
Photogravure Brown
Rotary Photogravure Inks
Plateless Engraving or Thermographic Inks
Dense Black for Plateless Engraving
True Blue for Plateless Engraving

9. Printing Inks and Colour
Subtractive Theory of Colours
Additive Theory of Colours
Reproduction of Colour By Printing Ink
Classification of Colours
Primary colours
Secondary colours
Tertiary colours
Examples of tertiary colours
Factors effecting visual appearance of ink film
Influence of colours
Cold colours
Warm colours
Terminology Related to Colour
Contrast
Harmony
Hue
Tint
Shade
Tone
Analogous colours
Complementary colours
Density in colour
Transparent and opaque colours

10. Qualities of Offset Inks
Working Qualities
Optical Qualities
Effects After Printing

11. Gravure Printing Inks
Characteristics of Gravure Inks
Vehicles in the Gravure Inks
Considerations for Purchasing Inks

12. Printing Inks for Letterpress
News ink
Inks for platen and cylinder machines
Moisture-set inks
Important Points
Quick-set inks
Cheque inks
Heat-set inks
Important Points
Metallic inks
Method of mixing metallic powder and varnish
Precautions
Aniline inks
Neo-set Inks

13. The Nature of Printing Ink
The Three Main Printing Systems
Typographic Method
Lithographic Method
Intaglio Method
General Properties of Letterpress Inks
The Silk Screen Method
The Principle of Offset Printing
Methods of Ink Drying
Relation between the Printing Process, Ink, And Paper
The Principle of Reproducing Photographs by Printing Methods
14. The Colloidal Nature and Rheology of Printing Inks
Ink Compared to Colloidal Dispersions
Flocculation
Types of Flow
Fluidity
Newtonian Flow
Plasticity
Plastic Flow
Consistency
Thixotropy
Measurement of Thixotropy
Pseudo-plastic Flow
Dilatant Flow
The Empirical Flow Test
Rheological Specifications of An Ink
Flow Requirements of Letterpress Inks
Supply of Ink from the Duct
Behaviour of Ink in the Duct
Distribution of Ink on the Press
Impression
Special Flow Requirements of News Inks
Flow Requirements of Offset Inks
Flow Requirements of Copper-plate Inks
Ink Tack
Nature of Tack
Measurement of Ink Tack
Elasticity and Plastic Flow
Elasticity
Relaxation Time
Fundamental Rheological Properties

15. Inorganic Pigments and Extenders
Nature of Pigments
The Oil Adsorption of Pigments
Opaque White Pigments
16. Ink in Relation to Paper
The Nature of Paper
The Fundamentals of Paper Making
Conversion of Raw Materials to 'Half Stuff'
Rag Half Stuff
Esparto Half Stuff
The Treatment of Wood
Sulphite Method For Chemical Wood
Caustic Soda Method For Chemical Wood
Soda Sulphate Method For Chemical Wood
Mechanical Wood Treatment
Beating
Hand-made Paper
Machine-made Paper
Methods or Glazing Paper
Special Finishes
Opacity Improvements
Watermarking
Wove, Laid, and Twin-wire Paper
17. The Typographic Process

Stereotypes
Half-tone Engravings in zinc and Copper
Line Blocks

Printing Machines
The Hand Press
Platen Machines
Vertical Platen Machines
Automatic Platens
Cylinder Machines
The Vertical Miehle
Miehle Two-revolution Cylinder Machine

Letterpress Rotaries
Machine Design And Make-ready in Relation to Ink
Letterpress, Typographic, or Relief Printing Inks
Factors Involved In Formulating the Ink

Making Platen and Cylinder Inks
Rotary News Inks
Type of News Ink Formulation
Ink Spray or Fly.
Berk’s Heat-set Black News Ink

Flated News Inks
Type of Flatbed News Ink Formulation
Cheap Magazine Inks
Type of Cheap Rotary Magazine Ink

Slow-speed Rotary Magazine Inks
Formulation
Uses
Drying Oil Black Ink
Letterpress Inks Based on Special Varnishes:
Non-reactive Resin in Drying Oil
Non-reactive Resin in Drying-oil Ink
Letterpress Inks Based on Synthetic Resins
Letterpress Ink Formulations
Thinning and Reducing Platen and Cylinder Inks
Double-tone Letterpress Inks
I.C.I. Double-tone Letterpress Inks
Yellow-black Double-tone Ink
Nitrocellulose Inks
Special Letterpress Inks
Letterpress Ink Worries and Cures
Caking
Collecting Dirt
Colour Drift or Colour Variation
Colour Fade
Crystallization
Fast Drying Ink
Ink Flying or Spraying
Ink Retreat From Fountain Roller
Insufficient Gloss
Mottle
Picking or Plucking
Powdering or Chalking
Repeats or Ghost Duplicates
Set-off or Offset
Show-through
Slur
Trapping
Wipe

18. Special Inks
Ball Pen Inks
Bleachable Inks
Fluorescent Inks
Phosphorescent Pigments
Fluorescent Pigments
Pigment Manufacture
Printing
Silk-screen Fluorescent Printing
Power Press Printing
Invisible or Sympathetic Inks
Heat-sensitive Type
Water-sensitive Type
Chemically-sensitive Type
Metallic Inks
Pigments
Stock
Media
Letterpress Metallic Inks
Gravure Metallic Inks
Silk-screen Ceramic Metallic Inks
Printing Metallic Inks
Pigmentation
Summary
Washable Fabric Inks and Textile Marking Inks
Water-colour Inks
Inks for Special Requirements
Low Odour Inks
Rub-resistant Inks

19. Natural Resins, Modified Natural Resins, and Bituminous Materials
Nature of Resins
Classification of Resins
Congo Copal
Manila Copal
Sierra Leone Copal
Zanzibar Copal
Amber
Damar
Rosin or Colophony
Rosin Oil
Polymerized Rosin
Hydrogenated and Oxidized Rosins
Tall Oil
Shellac
Sandarac
Mastic
Zein
Modified Natural Resins
Ester Gum
Lime-hardened Rosin
Bituminous Materials Nature
Asphalts
Bitumens
Pitches
Firnigrals and Iranols
Uses in Printing Inks

20. Aniline, Dye-spirit, or Flexographic Inks
   Transparent Aniline Inks
   Uses And Advantages
   Basic Dyes Suitable for Transparent Aniline Inks
   Media
   Pigmented Flexographic Inks
   Synthetic Resins For Spirit Inks
   Maleics
   Pure Phenolics
   Unesterified Rosin Modified Cresol-formaldehyde
   Resins
   Unesterified Rosin Modified Phenol-formaldehyde Resins
   Miscellaneous Phenolics
   Ketone-aldehyde Base Synthetic Resins
   Spirit Type, Flexographic Ink Formulations
   Flexographic Inks Not Based On Alcohol
   Aniline Machines

21. Drying Oils
   The Nature of Drying Oils
   The Acids Present In Drying Oils
   Properties of Semi-drying Oils
   Linseed Oil
   Production of Raw Linseed Oil
   The Refining of Linseed Oil
   Bleaching of Refined Linseed Oils
   Comparison of the Properties of Acid
   Boiled Linseed Oil
   Blown Linseed Oil
   Heat-bodied Linseed Oil Or Stand Oil
   Plant For Making Stand Oils
   Catalysts For Bodying Linseed Oil
   Improved Stand Oils
   The Chemical Changes in the Heat Bodying
   of Linseed Oil
   Tung Oil
   Properties of Tung Oil
   Dehydrated Castor Oil (D.C.O.)
   Castor Oil
   Following The Dehydration
   D.C.O. Stand Oils
   Blown Dehydrated Castor Oil
Perilla Oil
Oiticica Oil
Stillingia Oil
Soya Bean Oil
Sunflower Oil
Tobaccoseed Oil
The Drying Oil Fatty Acids
Linseed Oil Fatty Acids (L.O.F.A.)
Dehydrated Castor Oil Fatty Acids (D.C.O.F.A.)
Semi-drying Oil Fatty Acids
Further Drying Oils
Improved Drying Oils By Processing
Fundamentally Modified Drying Oils
Vulcanized or Sulphurized Oils
Styrenated Oils
Maleinized Oils
Epoxidation And Hydroxylation Of Drying Oils
The Use Of Drying Oils In Printing Inks

22. Printing Ink Driers or Siccatives
Nature of Ink Driers
General Use of Driers
Paste And Liquid Driers
Theory of the Promotion of Drying
Methods of Preparation of Liquid Driers
Properties of Liquid Driers
Appearance of The Driers
Standard Specifications
The Use of Driers In Printing Inks

23. Ink on Surfaces other than Paper
General Principles
Cellophane Printing
Moisture-proof Viscous Film Printing
Polyethylene or Polythene Film Printing
Printing on Lacquers and Varnished Surfaces
Printing on Rubber
Printing on P.V.C.
Printing on Metal and Metal Foil
Printers Use For Roller Coating
Roller Coatings
Cold-set Inks
24. Solvents, Diluents, and Plasticizers

General Properties of Solvents
Boiling Range
Flash Point
Evaporation Rate
Solvent Retention
Solvent Balance
Viscosity Changes During Drying
Solvent Power
Undesirable Solvent Properties
   Instability
   Bad Odour
   Bad Colour
   Impurities
   Toxicity
Petroleum Alkanes
Natural Petroleum
Petroleum Ether
S.B.P. Spirit
Petroleum Spirit, Ligroin Or Gasoline
White Spirit (W/S)
Mineral Oils
Coal-tar Hydrocarbons
Benzene C6h6
Toluene, C6H5CH3, Methyl Benzene
Solvent Naphthas
   Light Naphtha
   Heavy Naphtha or Aromatic White Spirit (A.W.S.)
Terpene Solvents
   Turpentine
   Oxidized Turpentine
   Dipentene, C10H16
Pine Oils
Hydrogenated Naphthalene Solvents
   Decalin, C10H18
   Tetralin C10H12
Alcohol Solvents
   Ethanol, Ethyl Alcohol, CH3CH2OH
   Isopropanol
   Butanol CH3CH2CH2CH2OH
   Methyl Isobutyl Carbinol (M.I.B.C.)
   Diacetone Alcohol Or Dical
   Benzyl Alcohol C6H5CH2OH
Glycol Solvents
   Ethylene Glycol HO.CH2CH2OH (E.g.)
   Diethylene Glycol HO.CH2CH2O.CH2CH2OH. (D.E.G.)
   Propylene Glycol Ch3.CHOH. CH2OH (P.G.)
Dipropylene Glycol HO. (CH2)3.O. (CH2)3OH (D.P.G.)
Hexylene Glycol, 2 Methyl, (2, 4) Pentanediol (H.G.)

Ethers
Di-ethyl Ether, C2H5.O. C2H5
The Ether Alcohols or Cellosolves
Methyl Cellosolve / CH3.O.(CH2)2.OH
Cellosolve, Ethylene Glycol Monoethyl Ether
Butyl Cellosolve CH3.(CR2)3.O.(CHZ)2OH

The Carbitols
Carbitol
Methyl Carbitol

Ketones
Acetone
Methyl Ethyl Ketone (M.E.K.) CH3.CO. C2H5
Methyl Isobutyl Ketone (M.i.b.k.)
Isophorone, C9H14O
Sextone B, Methyl Cyclohexanone
Acetonyl Acetone, 2.5 Hexanediol

Furfural
Ester Solvents
Butyl Acetate. C4h9.coo.ch3
Butyl Lactate C4H9COO.CHOH.CH3

Plasticizers
Di-butyl Phthalate (D.B.P.)
Tri-phenyl Phosphate (T.P.P.)
Tri-cresyl Phosphate (T.C.P.)
Triacetin
Ethyl Abietate

Solvents From Petroleum

25. Printing Ink Carbon Blacks
Carbon Black
Manufacture of Impingement Channel Blacks
Furnace Combustion Blacks
Furnace Thermal Decomposition Blacks
Lamp Black
Charcoal Black
Bone Black
Mineral Black
Graphite
Cabot Nigrometer Scale

26. Waxes
Nature of Waxes
Mineral Waxes
Paraffin Wax
Microcrystalline Wax
Petroleum Jelly
Ozokerite
Montan Wax
Vegetable Waxes
Carnauba Wax
Candelilla Wax
Animal Waxes
Beeswax
Wool Wax or Lanolin
Tallow
Synthetic Waxes
Carbowaxes
Condensation Waxes or Glycol Ester Waxes
Acrawax
Chlorinated Naphthalenes
Polyethylene Waxes
Polyamide Waxes
Other Waxes
Uses of Waxes in Printing Inks

27. Selection of Media and Pigments for Printing
Suitability of a Resin for Letterpress and Planographic Inks
Suitability of a Resin for Gravure Inks
Common Film Defects
Blooming or Blushing
Bubbling
Chalking
Checking
Cissing
Cracking or Flaking
Orange Peel
Pin-holding or Pitting
Wrinkling or Shrivelling
Webbing
Selection of Pigments
Comparison of Bronze, Ultramarine, and Monastral Blues
Nature of the Pigments
Masstone
Reduced Tones
Density and Oil Adsorption
Ease of Grinding
Resistance to Soap, Fats, Solvents, Water and Oils
Stability to Chemicals
Stability to Heat
Stability to Light
Pigmentation Limit
Length and Rheological Properties
Expense
Special Faults
Recommendations
Comparison of Chrome, Hansa, and Benzidine Yellows
Nature of Pigments
Specific Gravity, Opacity, Oil Adsorption and Brilliancy
Grinding and Rheological Properties
Stability to Heat and Light
Stability to Acids and Alkalis
Resistance to Fat, Soap, Wax, Oil, Alcohol, and Water
Special Advantages and Defects
Four-colour Process Pigments
Madder Lake Scale Test

28. Surface-Active Agents, Anti-oxidants, And Adhesives
Surface-active Agents
Properties
Mode of Action
Evidence of Action
Types of Surface-active Agents
Lecithin
Uses in Printing Inks
Anti-oxidants
Guaiacol
Methyl Ethyl Ketoxime
Adhesives
Gum Arabic
Starch
Dextrin

29. Analysis and Calculation
Detection of Driers in Varnishes
Identification of White Pigments
Examination of Ash for Inorganic Pigments
Ink Analysis
Method
Ink Technology Calculations
30. Principles of Ink Formulation
- Colour Matching
- Grinding
- Consistency
- Drying Times
- Length of Ink
- Printed Appearance
- Machine Performance
- Fading
- Special Requirements

31. The Intaglio Process
- Copper Plate Engraving
- Mezzotinting
- Principles of Photogravure
- Preparing the Photogravure Copper Sleeve
- Rotogravure Machines
- Offset Gravure
- Die Stamping
- Hand Die-stamping Machines
- Counter-sunk Dies
- Power Press Die Stamping
- Intaglio Inks
- Types of Media for Copper-plate Inks
- Principles and Characteristics of Steel-plate Photogravure Inks
- Rotary Photogravure (Rotogravure)
- Rotogravure Ink Characteristics
- Simple Examples of Gravuxe Inks
- Synthetic Resins for Gravure
- Gravure Printing on Foil and Plastic Sheeting
- Special Gravure Inks
- Howard’s Gravure Formulations
- Die-stamping Inks
- Characteristics of Die-stamping Inks
- Die-stamping Media
- Letterpress Imitation Die-stamping
- Gravure Ink Worries and Cures
- Hard and Porous Prints
- Pearling
- Poor Highlights
- Poor Neutral Greys
- Static Electricity in the Paper
- Sticking When Re-reeling the Wed
32. The Lithographic Process
Branches of Lithographic Reproduction
Senefelder’s Lithographic Stone
Modern Lithographic Plates
Photolithography
Bimetallic Plates
Trimetallic Plates
Offset Lithography
Pantone Dry Lithography
Collotype Direct Lithography
Direct Lithographic and Offset Machines
Principle of Offset Rotary Machines
Xerographic Printing
The Lithographic Process
Principle of Lithography
Essential Properties of Lithographic Inks
The Importance of Correct Ink-water Balance
Offset Ink Formulation
Conventional Direct Litho and Offset Inks
Defective Offset Media
Anomalous Lithographic Drying
Dry-offset Inks
Bronze Preparations
Tin Printing Offset Inks
Lithographic Ink Worries and Cures
Drying Too Fast
Embossing the Blanket
Fluffing
Greasing
Image Detail Disappears
Image Thickens
Ink Retreating from Fountain Roller
Piling
Rollers Stripping
Scumming
Spotty Ink Drying
Tinting
Worries Due to Using Etch

33. Directory Section

Sample Chapter:
Printing Ink Driers or Siccatives

NATURE OF INK DRIERS

A DRIER is a chemical additive which has the power of accelerating the drying time of a drying oil, and of many synthetic resin varnishes which dry by air curing, e.g. alkyds. A drier aids the drying of those oils which form a solid film of linoxyn when exposed to air by an oxidative polymerization process. No amount of drier will cause a mineral, lubricating, or spindle oil to dry. The driers have the properties of catalysts in that they accelerate the rate of a chemical reaction, which in drying oils is reacting with oxygen in the air. Apart from salicylic acid which has a mild siccative or drying action, the driers used are metallic compounds. The metallic concentration is the fundamental activator, and driers have been bought by assessing their merit as the number of units of metal per unit of cost. Some metals exert a more powerful drying influence than others. As metals are insoluble in drying oils, it is an oil soluble compound of the metal that must be used, and it is these soluble metal compounds which are termed driers.

GENERAL USE OF DRIERS

Driers are used in oil-based and synthetic-resin inks. They are employed to assist the drying of all letterpress, planographic, copperplate engraving, steel-plate engraving, and quickset inks. They are used in all gloss varnishes, overprinting varnishes, and tin-printing inks. They are fundamental constituents of many die-stamping inks, some oil-based silk-screen inks, most roller coatings, and roller-coating inks.

PASTE AND LIQUID DRIERS

Both paste and liquid driers are used in making printing inks. Paste driers consist of certain metal salts such as acetates, borates, or oxalates, finely ground in a drying oil, usually together with some inert filler such as barium sulphate. The dispersion of paste driers is generally improved by the addition of an aromatic or fatty acid which has a stabilizing and peptising action. Liquid driers are metallic soaps, e.g. linoleates, naphthenates, which are soluble in turpentine, white spirit and drying oils. The approximate order of the effectiveness of the metals is Cobalt, Manganese, Cerium, Lead, Chromium, Iron, Nickel, Uranium, Zinc, Platinum, Palladium, Calcium. Cobalt driers are the linoleate, linolenate, naphthenate, xanthate, resinate and, for paste driers, the acetate and borate.

Lead driers are lead naphthenate, lead resinate, litharge, and red lead.

Lead paste driers may contain the acetate.

Manganese driers include manganese sesquioxide, manganese dioxide, the borate, resinate, linolenate, oxalate, linoleate, and naphthenate.

The borate is obtained as a precipitate by adding manganese sulphate solution to a hot solution of borax. The oxalate is made by adding a solution of sodium oxalate to a solution of soluble manganese salt. Manganese driers are usually highly coloured and are often claret shades.

The metallic 'octoates' are becoming popular as driers: these are the metal salts of 2-ethyl hexoic acid; this is a pure substance of low odour.

THEORY OF THE PROMOTION OF DRYING

Much more than the percentage metal content must be known to calculate the activity of a drier. Drier efficiency or activity depends upon the percentage metal in active form which is not accurately known, the degree of dispersion of the drier which is uncertain, and surface energy properties of the drier which cannot be computed. Drying also depends on the rates of diffusion of several different organic oxygen containing radicles in the exposed film. These diffusion rates must constantly change as the polymerization proceeds, as the film viscosity increases, and as the dispersion of these oxygen products in the film alter.
A metal that can form more than one oxide acts as a drier or oxygen carrier when dissolved in oil, providing that the lower valency state is stable. Exceptions to this are the mild driers calcium and aluminium, but their lack of drying power may be connected with lack of variable valency. An important aid to the effectiveness of a metal may well be its reducibility from a trivalent to a divalent state. Witness the greater drying power of trivalent cobalt, manganese, and cerium.

The acidic part of the soap, however, is in some way involved. Chlorides and nitrates are rarely used as driers, while acetates and borates are good driers. Lead stearate is ineffective compared with lead linoleate and linolenate. Lead tetraethyl dissolves in linseed oil, but at low or high concentration it is an inefficient drier. Livache showed that finely divided lead could act as a drier, rather indicating that the metal content of the drier must be readily available to the varnish. Active peroxides in a drying oil can render the metallic driers ineffective.

Driers can modify the nature of a drying oil into which they are introduced. Thus boiled oils containing pyrolusite and litharge driers give hard and brittle films, distinct from films of refined oils with the same driers at the same concentration. Again, manganese driers are useful with modified phenolics, while cobalt and lead are useful for alkyds, drying oils, maleics, and pure phenolics. Further, it is established that cobalt and manganese catalyse surface drying, while lead catalyses 'through' or 'lower drying'.

Certainly a direct correlation between the metal content and its drier activity cannot be maintained, unless proper account is taken of the percentage metal available in an active form which would depend upon the precise constitution which is not accurately known, and the degree of dispersion which is uncertain. A study of the surface energies of the driers would be necessary. The rates of diffusion of oxygen products in the drying film depend on the viscosity of the material, polymerization of the products, and the change in their dispersion in the film. Another fact to remember is that the activity of metals in such solutions is vastly different from what it is in aqueous solutions.

In fact, metallic driers are not normal catalysts, but promoters absorbing oxygen selectively on the surface, followed by chemical reaction. Again, the drying of some of these inks takes place in two stages: a thickening of the film, which keeps becoming more viscous, followed by a gel structure which keeps hardening. The constitution of the drier, the concentration of 'active' metal, the degree of dispersion of the drier, the rate at which oxygen can diffuse in the drying film, the extent of the colloidal nature of the ink, and the precise nature of the chemical drying are all inaccurately known factors affecting the problem of metallic soaps aiding drying. A few empirical rules can be stated, but no rational theory of how the drying is promoted can be given.

The fact that they are efficient aids to drying is firmly established. A film of refined linseed oil which dried in 110 hours was treated with different 'precipitated linoleate' driers individually. A concentration of 0.05 per cent cobalt metal so introduced caused the oil to dry in two hours; 0.08 per cent manganese cut the drying time to five hours; 0.5 per cent lead to seventeen hours, and 0.5 per cent iron to twenty-four hours.

**METHODS OF PREPARATION OF LIQUID DRIERS**

1. By the reaction of inorganic metal compounds and vegetable oils.
   Lead acetate and lead borate can be heated with drying oils. Red lead is heated with linseed oil above 240º C., and litharge is so heated at 220º C.
   The mechanism of the reaction seems to be as follows: the litharge reacts with the free acid to form ester and water the ester is pyrolyzed to give acid, carbon dioxide, and water. The oxygen involved is obtained from the air. The drying oil is hydrolyzed by the water to give alcohol and free acid and these products react with litharge to give lead soaps and lead glyceroxide. The water evolved enables the reaction to continue. Litharge and lead linoleate yield a basic lead linoleate. The drier content is thus lead linoleate, basic lead linoleate, lead glyceroxide, and probably some dispersed litharge.
Rose pink cobalt hydrate reacts with linseed oil at 260ºC. to give a claret syrup. At the end point a drop of the medium removed should be clear when spotted on glass. Cobalt, manganese, and calcium hydroxides which have been freshly precipitated in the absence of air react with drying oils at 190º-200º C. to give pale driers.

(2) By the reaction of inorganic metal compounds and fatty acids to form 'fused driers'. The acids normally used are L.O.F.A., tung oil fatty acid, rosin, hydrogenated rosin, polymerized rosin, naphthenic, and oleic acids. Such acids react with metallic oxides to yield soaps soluble in turpentine, white spirit, or naphtha. The so-called 'terebine' driers belong to this class. The products are the fused linoleates, tungates, naphthenates, resinates, and oleates. A somewhat lower temperature can be used than when reacting the oxides with the oils; L.O.F.A. and litharge are reacted at 150º C., but with manganese dioxide the temperature is 230º C. Fused resinates are made by reacting rosin with litharge at 200º C., with cobalt hydrate at 200º C., but with manganese dioxide at 240º C. Wool grease fatty acids react with the oxides of cobalt, lead, manganese, and zinc at 155º C. Driers can be made by heating the metallic oxides with coconut oil fatty acid and dissolving the soap formed in naphtha at 100 ºC. to give a clear solution. Metallic salts in aqueous solutions have been reacted with these fatty acids. The metal soaps have also been made in the presence of solvents, e.g. by using fatty acids dissolved in solvent.

(3) By the reaction of metal compounds with mixed drying oils and their fatty acids. A well-known example is to prepare freshly precipitated, wet cobalt hydroxide in the absence of air, and convert it into a paste with linseed stand oil. The paste is heated at 95º C. with 50 per cent rosin in mineral oil.

(4) By the precipitation method. Metal compounds are reacted with the sodium, potassium, or ammonium salts of organic acids. Suitable metal compounds are the acetates, sulphates, nitrates and chlorides. Suitable acids used as their alkali salts are L.O.F.A., tung fatty acids, perilla fatty acids, stillingia fatty acids, wool grease fatty acids, rosin, naphthenic acid, oleic acid, tall oil, and 2-ethyl hexoic acid. The theoretical quantity of aqueous caustic soda, potash, or ammonia, is heated with the fatty acid. Alternatively, drying oils are saponified with caustic soda, the soap formed being boiled for an hour or more with efficient stirring. A floating tar of unsaponifiable matter may have to be removed by muslin straining. The hot, aqueous metallic salt solution is added to the boiling soap solution, until the mother liquor becomes neutral to litmus. The precipitated metal soap is slowly heated at 115º-120º C. with stirring to remove all occluded water. Vacuum heating or suction filtration followed by drying at 40º C. have been used. The heating must be cautious and curtailed since metallic soaps tend to darken in colour and decompose. If skinning occurs there is loss of solubility.

Fluxes have often been added to the soap just before dehydration to keep it liquid. Plasticizers such as tricresyl phosphate, dibutyl phthalate, and benzyl benzoate, have been used. The metal soaps are more stable in aromatic hydrocarbons than in aliphatic hydrocarbons. Instability is characterized by semi-colloidal soap dispersions in highly viscous media which slowly gel and precipitate part of the soap during storage. Basic soaps are always present in these driers. The fusion method usually gives more stable driers, because the reaction is incomplete and leaves some free acid to have a peptising effect on solutions. Often stabilizing acid mixtures are specially added. Recommended mixtures are stearic, mandelic, and cinnamic acids; palmitic and benzoic acids; or hippuric and salicylic acids. The amount varies from 0.5 per cent benzoic acid to 7 per cent of high molecular weight acids. About 7 per cent palmitic acid is suitable for cobalt linoleate. Basic stabilizers have been used such as ethanolamines and diamines. Sometimes dehydration of the drier is effected by solvent treatment and distillation. The bulk of water is decanted from the precipitated soap to which a solvent like white spirit or benzene is added. The solvent is distilled to leave the dried soap in solution. Precipitated soaps which are flocculant are alcohol washed. Another method of making these driers involves using organic solvent at the time of precipitation. Mineral
spirit and xylene have been used.

(5) By reacting castor oil with metal compounds. The hydroxyl group in castor oil is replaced by metal by heating the oil with the metal or metal compound at 240Â°C. The products are soluble in turpentine or white spirit at 100Â°C.

To make a solution of a drier it is usual to add the solvent - white spirit, turpentine, or naphtha - slowly with much stirring, and gently warm to 50Â°-100Â°C.

PROPERTIES OF LIQUID DRIERS

1. Optimum concentration. Increasing the metal concentration improves drying systematically only up to a certain limit. The upper limit for refined linseed oil is lead 0.8 per cent, manganese 0.1 per cent, and cobalt 0.04 per cent. For tung oil the limits are lead 0.25 per cent, manganese 0.03 per cent, cobalt 0.02 per cent. The varnish itself can cause a difference and dry better with a specific catalyst. Zinc is better than manganese for some alkyds. Excess driers are not in any way helpful; it is the controlled use of driers which is important to the ink maker.

2. Drying characteristics. Cobalt, manganese, and iron cause surface drying, while lead, cerium, and calcium promote 'through' or 'lower' drying; this may be connected with the effect of the drier on the surface tension of the varnish. Lead reduces the surface tension of linseed oil, but cobalt and manganese increase it.

3. Mixed Driers. A combination of driers is often used to secure the best characteristics of all the driers present. The following mixture is popular and effective: lead; manganese; cobalt, in the ratios 5:1:1.

4. Nature of Acid Radicle. This has a definite effect and has already been alluded to. The linoleates are the most popular, but the naphthenates are firmly established as useful driers and have many advantages. These are:

   1. Higher metal content and less drier is consequently added.
   2. They dissolve more readily and are more stable. Lead naphthenate is an exception.
   3. They skin less and are not so inflammable in storage.
   4. They have a reduced tendency to become poisoned driers.

Alchemy Ltd. manufacture a 12 per cent cobalt octoate drier and a colourless 32 per cent lead octoate drier which have the advantage of higher metallic concentration with solutions of only syrupy consistency. Renewed interest is being shown in rare metal octoate driers which contain cerium as these are only mid-yellow in color. Zirconium octoate solutions are now readily available as 'cobalt drier catalysts'. The zirconium ensures that all the cobalt metal present is actively available in promoting drying instead of part remaining ineffective. Ink makers will always search for pale driers, although the ones available at present are weak even in high concentration because of the urgent need in some cases to keep down the colour of the varnishes. Obvious uses are gloss varnishes, very light-coloured inks, and cases where only mild drying action is required.

The 2-ethyl hexoates are perhaps even better driers than the naphthenates.

(5) The absorption of drier by pigment. Pigments with large specific surface areas show the greatest power of removing driers, e.g. carbon black, siennas, umbers, madder lake, zinc oxide. Trivalent metals are absorbed faster than when they are in the divalent state.

APPEARANCE OF THE DRIERS

Pure cobalt linoleate is a violet, viscous liquid. It is used diluted with linseed oil, L.O.F.A., or mineral oil; and is usually supplied at about 5 per cent metal concentration. Cobalt naphthenate is a solid, M.Pt. 130Â°C. In mineral oil cobalt naphthenate tends to thicken on storage and stabilizers are normally added, such as acids or butanol. Cobalt soaps give dark green solutions in turpentine.

Most manganese drier solutions are red. Precipitated manganese linoleate is orange, but the fused variety
Fused lead linoleate is a brown, cheesy solid. The white-spirit solutions are cloudy. Lead resinate is a solid, and lead naphthenate is orange with M.Pt. 100º C. The naphthenate gives a clear solution in white spirit. Lead driers must be used with caution because of their tendency to precipitate from solution. Calcium linoleate is a white powder, and calcium naphthenate is a viscous, straw-coloured liquid.

**STANDARD SPECIFICATIONS**

Paste driers must be smooth, homogeneous pastes which can be broken up into a smooth mixture when stirred well with four volumes of linseed oil and one volume of turpentine. The paste must consist of a mixture of drying agents and insert mineral matter, together with refined linseed oil. Not more than one-half of the mineral matter must be calcium compounds calculated as the sulphate. A representative sample must contain less than 0.5 per cent of skins and coarse particles, and less than 5 per cent water.

Liquid driers must satisfy certain specifications. The drier, after being stored at 60º-70º F. for a week in the dark, in a closed container, must be clear and free from deposit. It must not contain more than 80 per cent turpentine and white spirit. The drier must not be darker than an agreed standard sample, when compared in similar glass tubes and viewed transversely in transmitted light. The flash point of the drier must be below 78º C. The drier must not show any precipitate when left to stand at 60º-70º F. for six hours with twenty volumes of raw linseed oil, and also with sixteen volumes of raw linseed oil and four volumes of white spirit.

**THE USE OF DRIERS IN PRINTING INKS**

Liquid driers are available from a number of reliable makers, e.g. 'Curgon' driers from Scott Bader. They are usually made and prepared by somewhat special methods, but the percentage metal content (i.e. 5 per cent) is known.

Cobalt paste driers used in printing-ink making usually contain a fair percentage (10-20 per cent) cobalt linoleate or other cobalt liquid drier and 25 per cent of mixed metal acetate and borate ground into linseed stand oil varnish to produce a smooth and homogenous paste. The paste drier consequently consists of a minor soluble driers constituent and a major insoluble drier feeder. The soluble drier makes the drier active, while the feeder tends to decompose and feed lead, cobalt, or manganese metal in an active state to the drier. In other words, the feeder slowly decomposes in the acidity of the varnish. These paste driers can decompose faster than carbon black can absorb driers. Carbon black letterpress inks containing paste as well as liquid driers always have the same drying time after any period of storage, as the paste driers have generated enough drier to the ink to counterbalance the amount of drier absorbed. Most letterpress inks work best with a mixture of liquid and paste driers adjusted so that the inks have a satisfactory drying time as measured on the testing machines. Liquid driers are appreciably acidic, with acid values of about seventy, and this is too acid for litho offset inks. Appreciable liquid drier in an offset ink causes it to scum badly, consequently paste driers, and only a low concentration of liquid driers, are used. In many litho-offset inks, paste driers only are included. It has already been mentioned that printing inks are treated with driers until the drying time is satisfactory.

The concentration of 5 per cent liquid driers in an ink normally varies from 0.5-3 per cent, and the amount of paste driers used varies from about 1-4 per cent. An ink which contains both driers might contain 1.5 per cent liquid driers and 2 per cent paste driers. These figures are only intended to convey a general picture of the amount of driers introduced into an ink, and obviously a great deal depends on the general drying properties of the medium.

If paper has been treated with a small amount of cobalt sulphate during its manufacture, it is known to have better drying properties than untreated papers. It is possible that paper makers will develop treatments during the making stage and produce papers on which the ink will dry in a considerably shorter period of time; the inks used will still have the usual drying time on the machine.
Ink on Surfaces other than Paper

GENERAL PRINCIPLES

A VITAL property of an ink is good adhesion to the printing surface after drying. Many surfaces are more difficult to print than paper because the normal types of ink adhere very badly. Inks adhere better to rough surfaces where some mechanical interlocking is possible, consequently formulating inks for cloth, felt, and wood presents no serious problem. With very smooth surfaces such as Cellophane, polythene, P.V.C., and Bakelite, only physico-chemical forces are available for adhesion and, moreover, the surface energy of this type of material is usually completely compensated, leaving little free surface energy available for interfacial reactions of the type required to bind a film of ink to the surface. The ink must be responsible for imparting sufficient free energy to the smooth surface to form an adequate adhesive bond, not only under wet conditions, but when the ink is thoroughly dry and the print has aged. The general principles which can be used to promote the adhesion of an ink to a difficult printing surface are:

1. Thermoactivate the surface
   Heating the surface, before or after impression, often improves the printing quality. The adhesion of an aniline ink to Cellophane is always promoted by passing the printed web over a hot roller.

2. Incorporate in the vehicle either a solvent or a swelling agent for the surface
   Glycol-ether solvents are used in inks for cellulose acetate film, as they soften the printing surface. An evaporating solvent can normally only be expected to make the ink adhere when wet, due to some of the solvent being present, and not when the ink is dry; unless the surface is softened and slightly distorted by the wet ink, enabling it to key on the mildly attacked surface and adhere fairly well under dry conditions. Blistering of the surface, or other defect, due to fierce attack, must be avoided. In other words, a solvent for the surface, present in the ink vehicle, may promote adhesion by causing optimum softening, roughening, or altering the surface below the printed film of ink.

3. Use a resinous binder in the vehicle compatible with the material to be printed
   A suitable ink for P.V.C. printing must be based on a resin compatible with P.V.C., otherwise the ink film will adhere only in the presence of a solvent or swelling agent for P.V.C. A common technique is to use P.V.C. powder dispersed in a suitable solvent or swelling agent. Similarly, a vehicle for polythene film can be made by dissolving polythene in toluene or decahydronaphthalene and adding a stabilizer, such as lithographic varnish, alkyd resin, or polyisobutylene (German Patent 898,906).

4. Use a resin of maximum polarity
   Viscous film can be printed with nitrocellulose or shellac inks, because of the intrinsic polarity of these resins. Inks for smooth plastic materials sometimes contain resins of high acid value. If using a polar resin in an ink leads to inadequate press performance, this may be overcome by changing the process, e.g. print the work letterpress instead of offset.

5. Use a polar solvent
   A ketone, alcohol, or other organic solvent which contains polar functional groups, should be better than mineral oil or white spirit.

6. Ensure optimum plasticity
   The plasticity of the ink should be similar to that of the surface, to avoid any tendency of the dried ink to crack or flake. Adhesion is improved in some cases by introducing a small amount of plasticizer into the medium.

7. Print by a two-stage process
   If the surface is underprinted with a clear varnish formulated to be practically invisible or else roller-coated with a stoving enamel, overprinting may be an easy matter.

8. Test the trial ink thoroughly
The trial ink should be carefully tested on the surface and the formulation improved from the practical experience gained from laboratory tests and machine trials. Finally, it should be pointed out that the difficulty in formulating suitable ink for a smooth surface is often one of degree. An ink suitable for Cellophane is easier to formulate than an ink for Bakelite, which is an exceptionally difficult surface, as it is very smooth, insoluble, infusible, and can provide no free surface energy, leaving little scope for the ink maker except the use of heat and polar materials. In a more general case, such as an ink for smooth rubber sheeting, an ink containing rubber dispersed in a swelling agent for rubber should prove adequate, providing the ink does not damage the printed material, is suitable for the process and does not cause trouble on the press.

CELLOPHANE PRINTING

Printing inks for cellulosic materials—celluloid, Cellophane, and highly glazed transparent papers such as glassine—present special problems due to the thickness of the sheets which prevent them from clinging well to the inked forme in some cases, and the non-absorbency of the printing surface which causes drying and adhesion problems. Drying oils are unsuitable because they are long drying, and give scratchable films of poor adhesion. The ink used should have a slight solvent action on the material so that it penetrates the surface and sets within the top surface. It is customary to use a plasticizable base, and a liquid which is a solvent for both the printing surface and the ink constituents. The medium may include a cellulose derivative or a natural or synthetic resin. Cellulose esters and ethers have been employed, including nitrocellulose, acetylcellulose, methylcellulose, and cellulose butyrate. A low viscosity ester penetrates the surface better. A combination of a cellulose ester with resins can be effective, such as cellulose nitrate or acetate with ester gum or copal. To produce a smoother, more coherent film, as well as to help some penetration by softening the printing surface, plasticizers are added in some cases. Suitable plasticizers are tricresyl phosphate and dibutyl phthalate. Often small amounts of volatile solvent, such as acetone, alcohol, or ethyl acetate, promote the solution of the surface in the plasticizer. Suitable solvents are butanol, diethylene glycol, diacetone alcohol, methyl ethyl ketone, and the cellosolves. By using a mixture of two or more solvents of different evaporation rates the drying rate of the ink can be varied and controlled. Gentle heat can be applied to the prints to assist adhesion.

Cellophane is a transparent film of regenerated cellulose specially made by forcing a viscose, cellulose xanthogenate, through a long thin slot in an acid bath. It is not waterproof unless it is specially treated. Some inks have been set on Cellophane by dipping the undried print into molten paraffin wax at 100º C. In such cases, the ink should contain dimethyl phthalate, or other high-boiling solvent, miscible with the hot wax. The solvent is absorbed by the hot wax and the pigment is precipitated.

<table>
<thead>
<tr>
<th>White Cellophane L/P Ink</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rutile</td>
<td>60</td>
</tr>
<tr>
<td>Wood oil phenolic</td>
<td>30</td>
</tr>
<tr>
<td>Refined linseed oil</td>
<td>9</td>
</tr>
<tr>
<td>Mild driers</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

A great deal of Cellophane is printed aniline, using shellac in alcohol media and including up to 3 per cent plasticizer. The prints should be passed over a hot roller at about 100º C. to aid drying and improve
MOISTURE-PROOF VISCOUS FILM PRINTING

Moisture-proof viscous film or moisture-proof Cellophane is hydrophilic in nature and is usually coated with waxed or unwaxed nitrocellulose lacquer. It is normally printed gravure as well as aniline, and is easily wetted and often softened by the solvents in those inks. Suitable solvents are alcohols and esters of low surface tension and boiling point, which are preferably compatible with the nitro cellulose lacquer to help adhesion. The prints should be passed over a steam-heated roller as quick drying promotes adhesion. Rollers heated to 120º-130ºC. should not be used as nitrocellulose discolours at these temperatures.

POLYETHYLENE OR POLYTHENE FILM PRINTING

Polythene provides a hydrophobic, inert hydrocarbon surface which melts about 105º C. A medium of low polarity thinned with hydrocarbon solvent should be used. Adhesion is aided by cautious heating to ensure blending the ink film with the underlying surface. Such prints are seldom good on rub-resistance. Polythene-coated paper and plastic film are now available and manufacturers of packaging inks are keeping a keen eye on this development. The Telegraph Construction and Maintenance Co. Ltd. (Telcon) coat paper with a one-thou polythene film by an extrusion process, e.g., 30-40 lb. D.C. Kraft used for paper sacks, and manufacture Telephone, which is regenerated cellulose film coated with polythene; the cellulose film is very impermeable to gas and the polythene film is very impermeable to moisture. Polythene-coated aluminium foil has become a popular wrapper.

PRINTING ON LACQUERS AND VARNISHED SURFACES

The inks should partially penetrate the surfaces by softening or dissolving the top layer of the coating. Shellac films should be printed with a medium of dibutyl phthalate and some ethyl lactate in alcohol. Nitrocellulose lacquer coated sateen requires a medium of nitrocellulose dissolved in methylated spirit, butanol, and some ethyl acetate. Another method advocated is to use cellulose ester or ether dissolved in water-soluble glycol mono-or di-formates (Brit. Pat. 311, 795; 1928).

PRINTING ON RUBBER

The pigments and driers used must be free of lead, iron, copper, or manganese, since they form dark sulphides and react on vulcanization. Chrome pigments tend to leave an after tack, but cadmium yellows and ultramarine are suitable pigments. Solvents which swell rubber must be avoided, notably petroleum ether and benzenoid hydrocarbons. In most cases the unvulcanized rubber is printed, dusted with powdered sulphur, and vulcanized after printing. Printed transfers have been used and removed after vulcanization. The Callender Cable and Construction Co. Ltd. mark rubber by a similar method, Bowyer (Brit. Pat. 347, 620; 1928). Rubber has been printed by penetrating inks, alcohol-soluble indoline dissolved in tetrahydronaphthalene with some methyl-ethylene glycol being used (Allman and Norris, Brit. Pat. 296, 461; 1927).

PRINTING ON P.V.C.

If P.V.C. is polymerized in the absence of interpolymer components a white powder results which softens at 90º C. and has to be shaped at about 150ºC. To prevent decomposition and discolouration when the substance softens, a heat stabilizer is used, such as lead compounds, sodium carbonate, and diphenylthiourea. Dilute solutions can be obtained in chlorinated hydrocarbons, dioxan, and cyclohexanone. The substance can be plasticized with up to 50 per cent plasticizer, such as T.C.P. and D.B.P., and worked into a plastic mass at 130º- 150º C. to give sheets which are resistant to acids, alkalis, and oxidation. Letterpress inks for P.V.C. printing can be based on vinyl resins; the solvents present in the ink soften the P.V.C. sheets and this ensures good adhesion. A great deal of P.V.C. is printed silk-screen; this has been dealt with in the chapter on screen inks.

PRINTING ON METAL AND METAL FOIL
Aluminium has a good affinity for oily inks and ordinary drying oil inks can be printed on the metal. Alkaline pigments should be avoided as aluminium is amphoteric in character, but the metal is passive to weak acids. The underlying sheen of the metal reinforces transparent inks with a fascinating brilliance.

Transparent aniline inks printed on such foil are suitable for Easter-egg wrappings because of the attractive appearance. Inks must have good adhesion and full colour strength to ensure the best results, particularly with very glossy foils. The surface is non-absorbent and either letterpress inks drying by chemical methods, or suitably formulated gravure or aniline inks must be used. The film should be cleaned and free from grease; the vapour of trichlorethylene is an efficient degreaser. Printing on a varnish film of nitrocellulose or synthetic resin is easier, but deliberately to make the printing a two-stage process is unduly expensive and should be avoided. A lacquer drying by heat hardening can be used to print on either the printed or unprinted area to obtain a special type of effect. In gravure printing of foil, the printed metal is passed over a heated cylinder to aid drying and improve adhesion. Trichlorethylene is useful in gravure inks for foil and Cellophane printing, as it speeds up evaporation and leaves a more brilliant print. Methyl cellosolve is often added in small amount. Paralac 21 in methyl ethyl ketone can be used as a gravure foil medium.

PRINTERS' USE FOR ROLLER COATING
Offset lithography was first introduced into Great Britain in the middle of the nineteenth century specifically for tin printing. Frequently tin printers had to produce masses of white or tinted backgrounds and this could not be done economically or very easily. A white offset tin-printing ink has to have a suitable consistency and flow, must contain about 60 per cent rutile for adequate whiteness and opacity due to the small lift of ink, must not contain materials which damage the press rollers or blankets, must give hard films after stoving, while good gloss may also be expected. Good gloss is difficult to achieve due to the high pigmentation and limited amount of medium, while the latter must not be tacky as tackiness builds up on the machine and lowers the printing quality, due to erratic splitting of the ink film at impression. Even when a suitable white ink has been formulated it will not be cheap, and printing masses of solid forme offset, often the entire sheet of tin, is too expensive for normal commercial consideration. Further, intense white backgrounds are impossible at one impression as offset films are too thin. The modern method adopted is to print the solid background on a roller coating machine and not only white and tinted inks but any colour ink can be printed.

Roller coating has the following advantages:
1. The machine used is simple in design, occupies little space and is easy to operate.
2. Very even films can be printed if the machine is set properly and the ink is properly formulated. If the coating is badly formulated, it is possible to obtain a ribbed film of ink on the rollers which is transmitted to the panels during coating and if the ink has poor flow-out the coating dries with a crinkled appearance.
3. Not only thick films, but films of a required thickness can be accurately obtained by careful setting of the machine, thus ensuring the opacity required. This enables a lower percentage pigmentation to be used in the coating, e.g. 30 per cent rutile, and also avoids any necessity for printing several times to obtain thick films.
4. A wider range of solvents can be used, e.g. esters, ketones, aromatic white spirit, or mixtures of solvents.
5. A wider range of resins can be used, due to the opportunity to choose from an extended range of thinners.
6. High gloss is much easier, due to the lower pigmentation and wider choice of materials.
7. It is cheaper than offset tin printing.
8. Stoving vehicles can be used which give a harder finish, while possessing adequate flexibility and exceptional adhesion to the sheet of metal.

Roller coating machines can be used for the utterly different process of overprinting transparent
nitrocellulose lacquers which, since they contain alcohol and cellosolve solvents, cannot be printed offset. Such lacquers are colourless and dry with a good gloss in about fifteen minutes by solvent evaporation. The inks used for the original printing must not bleed in nitrocellulose. By not staining the paper and by having an exceptionally quick drying time, these varnishes are superior to oleoresinous varnishes. If the coated film is rather thick this method will not be cheap and production is much slower than offset for a long run. Using better colour overprinting varnishes does not matter, except above pale tints and bare stock, and a drying time of four hours is rarely a handicap to lithographers providing the sheets do not stick in the stack. Roller coating never gives quite as smooth a film as offset printing, but the quality of the work is good and in selected circumstances it is cheaper and more expedient.

ROLLER COATINGS
Most roller coatings are whites, supplied at 5 p. viscosity, and should have excellent properties when stoved at 120° C. for twenty minutes. A roller coating clear should stoe under these same conditions to produce:
1. Perfectly clear films.
2. Films of excellent scratch hardness.
3. Films as near water-white as possible.
4. Films of good colour retention.
5. Films of good flow properties.
6. Films of good adhesion to tin plate.
7. Films which are satisfactory in bending and in tin lid stamping tests. This implies good flexibility. Stamped lids should be autoclaved to see whether any faults develop, such as cracking off or peeling.
8. Good films when staved in a foul oven at 120° C. for twenty minutes. This oven is heated with a luminous flame through a small entrance hole, and has no vent or chimney. The films should be free of rivelling and gas checking defects.
NIIR Project Consultancy Services (NPCS) is a reliable name in the industrial world for offering integrated technical consultancy services. Its various services are:
Pre-feasibility study, New Project Identification, Project Feasibility and Market Study, Identification of Profitable Industrial Project Opportunities, Preparation of Project Profiles and Pre-Investment and Pre-Feasibility Studies, Market Surveys and Studies, Preparation of Techno-Economic Feasibility Reports, Identification and Selection of Plant and Machinery, Manufacturing Process and or Equipment required, General Guidance, Technical and Commercial Counseling for setting up new industrial projects and industry. NPCS also publishes varies technology books, directory, databases, detailed project reports, market survey reports on various industries and profit making business. Besides being used by manufacturers, industrialists and entrepreneurs, our publications are also used by Indian and overseas professionals including project engineers, information services bureau, consultants and consultancy firms as one of the input in their research.

NIIR PROJECT CONSULTANCY SERVICES
106-E, Kamla Nagar, New Delhi-110007, India.
Tel: 91-11-23843955, 23845654, 23845886, +918800733955
Mobile: +91-9811043595
Email: npcs.ei@gmail.com ,info@entrepreneurindia.co
Website: www.entrepreneurIndia.co