

A
Project
On
COMPRATIVE ANALYSIS OF CONVENTIONAL AND
ECO- FRIENDLY GRAVURE& FLEXOGRAPHY INK
(A Case Study of Spectra Inks & Coatings Pvt. Ltd Greater Noida U.P)

Submitted in Partial Fulfillment of the Requirement for the Award of the Degree of M. Tech.
(Print & Graphics communication)



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M. Tech. (PT)

TO GOD,

The owner of my life, the

Lights that guides me every day and every moment.

IJSER

TO WHOM SO EVER IT MAY CONCERN

This is certified that **Mr.Aayush Shriwastawa S/O Umakant Reg No. 1515040002** student of M.Tech Printing Final Year work as trainee here “Spectra Ink and Coating Pvt Ltd.” and his topic of Comparative analysis of Conventional and eco - friendly Gravure and Flexography Ink.

He gives some points and result during his work. His working during was 1st January to 22nd March 2020.

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CERTIFICATE

This is to certify that the dissertation work entitled “Comparative analysis of Conventional and Eco - Friendly Gravure and Flexography Ink.” is original and has been carried out by **Mr.Aayush Shrivastawa** in partial fulfillment of the requirement for the award of the degree of master of Technology in printing Technology & Graphics Communication, Somany Institute of Technology and Management Rewari, under My supervision and guidance during academic year 2018-2020.

It is further certified that no part of dissertation has been submitted either in part or wholly for any degree of Somany Institute of Technology and Management Rewari, M.D.U., Rohtak or any other University.

This is further certified that He has Completed all the requirements of ordinance for the dissertation.

Mr.SUMIT KUMAR (Supervisor)

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Acknowledgement

The special thanks go to my helpful supervisor, Mr. Sumit Kumar, Dept. of Printing Technology, SITM Rewari. The supervision and support that he gave truly help the progression and smoothness of the internship program. The co-operation is much indeed appreciated.

"Ideal teachers are those who use themselves as bridges,
Over which they invite their students to cross,
Then having facilitated their crossing, joyfully collapse,
Encouraging them to create bridges of their own."

It is a matter of immense pride for me to have an opportunity to work under such an elite, learned and dynamic personality. I feel overwhelmed while expressing my reverence and gratitude to my esteemed teacher. I shall have to learn a lot from his majestic personality, his practice of principles.

My Grateful thanks to Mr. Bijender, Asst. Professor, Dept. of Printing Technology, Guru Jambheshwar University of Science & Technology, Hisar for sincere support and sparing their valuable time for discussion and suggestion.

Last but not least I wish to avail myself of this opportunity, express a sense of gratitude and love to my friends and my beloved parents for their manual support, strength, help and for everything.

Above all, I pray my gratitude to Almighty for His compassion and Bountiful of blessing, which made me see this wonderful moment.

(Aayush shriwastawa)

Reg. No. 1515040002

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Introduction

Gravure&Flexography inks:- Gravure& Flexography inks are liquid inks with a low viscosity that allows them to be filled into the engraved cells in the cylinder then transferred onto the substrate. Areas of Gravure printing Flexible Packaging Laminates, Food packaging pouches, wrapping paper, Greeting cards, Magazines, Milk pouches etc.

Printing Inks and Flexible Packaging Industry, Like Soul and Body:-

Packaging industry indicates that the global flexible packaging sector is growing at a faster pace driven by replacement of traditional pack types such as metal cans, glass and plastic bottles, and liquid cartons across a wide range of end-use sectors.

Flexible packaging has also benefited from a wider range of new products being developed by brand owners in an increasingly competitive consumer marketplace. Barrier flexible packaging will continue to grow in importance as the major retail chains demand greater product protection and longer shelf life. High barrier films such as BOPET, BOPP besides paper to show the highest growth rates over the next couple of years, worldwide.

Flexible packaging has reached market maturity in the developed nations of North America and western Europe and future growth will be modest.

Flexible packaging covers materials that have undergone a conversion process including printing, lamination, coating and extrusion, and can involve different substrates such as plastic films, paper and foil. Flexible pack types include plastic bags and sacks, wrapping films, paper bags and wrappers, and aluminium foil laminates, blister packaging and foil bags, sachets and pouches.

Current Resin Systems Solvent based Gravure& Flexography Inks:-

- Vinyl Resin Based Inks
- PU Based modified inks
- Acrylic Resin Modified based Inks
- NC Based modified inks
- Polyamide based modified ink

Components of Solvent base Gravure and Flexography ink's formulations:-

- Resins: 10-30%
- Colorants (Dyes/Pigments) : 5- 20%
- Solvents : 50-80%
- Additives : 0-5%
- Common Organic solvents used in gravure inks- Toluene, Methyl ethyl ketone (MEK) ,Methyl iso butyl ketone (MIBK), Ethyl Acetate ,NPropyl Acetate ,Iso-Propyl Acetate ,Xylene,Butyl Acetate,DOP, DAA,Iso- Propyl Alcohol, NBA etc.

Resins used in Solvent base Gravure and Flexography ink's formulations:-

- Vinyl Resin
- PU Resin
- Acrylic Resin
- NC cotton
- Polyamide Resin
- Ketonic Resin
- Phenolic Resin
- Natural Gum Resin
- Chlorinated polypropylene Resin
- Eva Resin
- Alkyd Resin
- Melamine formaldehyde Resin
- Epoxy Resin
- **Additives:-**
 - Additives are used to alter the final properties of the formulation. These include:
 - Plasticizers, which enhance the flexibility of the printed film .
 - Wax, which promotes rub resistance.
 - Chelating agent, which increases the viscosity of the ink.
 - Defoamer, which reduces the surface tension in inks so that stable bubbles.

Components of Water-base Gravure and Flexography ink's formulations:-

- Acrylic Emulsion
- Colorants (Dyes/Pigments)
- Polyethylene wax
- Isopropyl Alcohol
- Water
- Silicone anti-foam
- Surfactant
- Wetting & dispersing agent

Process of Manufacture:-

Printing ink is a recipe oriented product having four basic materials as essential input:

- Pigments: To provide colour to the ink
- Resins & Vehicles: to transport the pigment on substrate through engraved printing cylinders.
- Solvents: Act as diluents for the ink and to maintain rheological properties.
- Additives: Used to achieve printing inks with special applications and properties.

Printing inks are manufactured by proper incorporation of pigments in resin or vehicles by grinding. The pigments and vehicles along with additives are mixed in suitable proportions using high speed mixers. This mix is sent to grinding process. The Grinding is done by either by Dynomill or Attritor as required. The grinding is continued till the pigment fineness (less than 3 microns) is achieved. After grinding, Solvents and additives are mixed in required proportions to achieve required characteristics and quality parameters of ink.

Why we should not be using toluene-based inks:-

Toluene is a product containing migrants is consumed or comes into contact with the skin or other Membranes, these migrants can get absorbed by the human cells.

Toluene is known to have several deleterious and harmful effects on humans. Some of these are listed below:-

- Breathing difficulties
- Eye and throat problems
- Exhaustion
- Dizziness
- Hallucinations
- Memory loss
- Confusion
- Skin irritation/Dermatitis
- Suspected damage to unborn children
- Ototoxicity – imbalance, the hardness of hearing

Eco-friendly Solvent-base inks and its specifications:

A solvent is one component of ink that works as a carrier for the dye and resin, and is crucial to the application process as it can impact properties such as dry time and adhesion. Many chemicals can be used as solvents including MEK; however, an increasing number of companies are looking for ways to reduce their use of such solvents in their production. Ideal for: bread and pastry packaging and other food packages that are coded in close proximity to the food filling process and tobacco products packaging No-MEK Even though MEK is not classified as a HAP (hazardous air pollutant) nor an ODC (ozone depleting chemical), local regulations and preferences can limit use of MEK-based inks. The MEK-free ink range matches to a wide variety of surfaces, coding processes and durability requirements. Some of these inks can also offer increased printer operating efficiency to further reduce solvent

consumption Ideal for: food containers, cans, pouches, bottles, etc., comprised of LDPE, HDPE, polypropylene, polystyrene, PVC, ABS, polycarbonate, stainless steel, tinfoil, aluminum and glass Fast dry As a fast drying solvent, MEK and Toluene free.

Eco-friendly Water-Based inks and its specifications:-

A water-based ink is an ink that has either the pigments or the dyes in a colloidal suspension in water. All though the main solvent in water-based inks is water, there can also be other co-solvents present. So these inks system are ecofriendly. These co-solvents typically are VOC's. Water-based inks have been in existence since around 2500 B.C. The first water based inks were black writing inks that were typically carbon in water suspensions that were stabilized by either egg albumen or a natural gum. Even though water-based inks have existed for over 4500 years; they were used very little up until the late 1960's. Water-based inks have inherent problems, and thus ignored as a viable option to other solvent based inks for some time. In the 1970's a crude oil shortage, combined with a new awareness of the damaging effects that the solvents in ink could have both on humans and the environment, new laws were put into effect forcing the ink industry to seek an alternative in the form of water-based inks. The goal of using water-based inks is to completely remove hazardous chemical from ink, not just reduce the VOC's that are present.

Review of Literature

BIS bans use of toluene in printing food packets:-

Abstract:

By-SounakMitra

BIS has decided to restrict use of toluene, titanium acetylacetonate and phthalates in printing of packaging materials used for food products. Packaged food companies in India will now have to stop using a few chemicals, including toluene, widely used in printing texts and images on materials used for external packaging.

The Bureau of Indian Standards (BIS), in an internal meeting has decided to restrict use of toluene, titaniumacetylacetonate and phthalates in printing of packaging materials used for food products.

According to ParthaPratimSanyal, independent consultant and convener at BIS Panel on packaging inks. The above mentioned materials will be included in the existing exclusion list in the current standard (IS 15495).

Toluene, which is a chemical that is used in paint and ink thinners, is known to migrate between layers of packaging and potentially cause damage to liver and kidneys in humans. Though widely used in India to print on packaging materials, toluene is banned in food industry across the developed nations. On the other hand, industry associations in smaller countries, such as Sri Lanka, have voluntarily stopped using toluene in printing of packaging materials used as food packets.

"It is a big step forward by the regulatory body which will push the industry to move towards healthy and safe packaging," about 80% of inks used in printing of packaging materials by packaged goods companies in India are currently toluene-based.

Substitutesuggested on toluene-based inks:-

Abstract:

By-Dr Jens Klabunde

The substitution of hazardous toluene with a safe and sustainable alternative such as Propyls is also a huge opportunity for the Indian printing market. With Oxea's expertise and knowledge that we intend to share, the Indian printers could avoid the pitfalls of choosing the wrong solvent. Initially,

ethyl acetate and ethanol replaced aromatics and ketones in the printing market due to their lower

toxicity. However, improvements in technology and increasing demand for better printing quality are forcing the industry to look for better solvent options. Propyls have been replacing conventional systems like NTNK (non-toluene non-ketone) inks and ethyl acetate in many world-regions.

There are many advantages to the use of Propyls: They improve printability, re-solubility, brightness, image definition, and printing speed. They also reduce scrap, retained solvent, plugging, cleaning setup time, ink usage, solvent volume usage and VOCs (volatile organic compounds) from the solvent use reduction. As we move towards a more eco-friendly environment, several changes and advancements are being made. One of those changes is the development of usage of eco-friendly inks. By switching to eco-friendly ink, we still get the high printing quality without the harmful additives found in traditional inks. By using traditional printing cleaners, inks and additives, we are contributing a constant population that is emitted from printing businesses. Not to mention many of these chemical and petroleum based solutions are harmful to the health of those using them. The gravure ink in solvent based ink as well as using will in future in free toluene and oil based ink by choosing more eco-friendly versions; it can not only save money but also protect themselves, their employees and environment. Many printers are switching to eco-friendly inks.

Environmental protection:-

Abstract:-

By-Lucia Paniagua

Environmental protection has become a high priority in India just now as we speak, and reduction is an important issue. A printer or packaging firm can easily save up to 20 per cent ink and 30 per cent solvents on an average only by exchanging conventional solvents or much more toxic toluene for Propyls. This means that 30 per cent fewer VOCs are released into the environment and that the material expense for ink can be reduced without any

disadvantage. This measure immediately saves resources and supports India to make a big step forward in terms of food safety and protection of worker's health.

Gravure ink with best powdering resistance:-

Abstract:-

By-china invention CN102648252B

The present invention provides a substrate capable of preventing the occurrence of affinity, improved powdering resistance, improve the quality of intaglio printing ink, which is capable of low cost, low amount of ultraviolet irradiation, to reduce blocking. One kind of gravure ink, containing at least an ultraviolet curable composition, polymerizable composition oxide, a photopolymerization initiator, a pigment and the oxidation polymerization catalyst, the curable composition using an epoxy acrylate and a polybasic acid anhydride containing as the ultraviolet into acid-modified epoxy acrylate, epoxy acrylate is a molecule having an epoxy acrylate and a compound having two or more acryloyl groups in one molecule and a carboxyl group having two or more epoxy rings .

A Review of Recent research for ink industry:-

Abstract:-

By-AIPIMA Magazine (All India printing ink manufacturer association)

“The Bureau of Indian Standards (BIS) has recommended a ban on toluene in food packaging printing applications in 2019 to improve the safety of food packaging. This ban will affect thousands of printers in India - from small print shops to large converters - as they will have to switch to new ink and solvent systems.”

Gravure and flexography Inks are widely used in the flexible packaging industry, particularly for food products. Mainly supply gravure inks for Surface Printing and Reverse Printing.

To meet the critical quality demand of the customers and eco friendly environment, technical team had developed new inks to obtain improved printing visual effects as well as improving the operational efficiency in our customers day by day. the new generation of inks that cater for current and future trend of printing demand in the printing industry.

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Research Objectives

The objective of this research project is:

1. To make a Comparative Analysis of composition of Eco friendly Gravure and flexography ink.
2. To study and Compare Manufacturing process of eco-friendly Gravure and Flexography ink.
3. To make comparative Quality compression of conventional and Eco friendly Gravure and Flexography ink.

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Research Methodology & Data Analysis

The work will be carried out from R&D lab of “Spectra inks & coatings private Limited.” Greater Noida . The primary source of data has from to the gravure ink from making ink in development lab. Secondary source of data have include the information of gravure ink with books, internet, and handbook of print media. This above type’s analysis and study of gravure ink.

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Data Collection & Analysis

1. To make a Comparative Analysis of composition of Eco friendly Gravure and flexography ink.

Composition Of Conventional Gravure and Flexography Solvent Base inks:-	Composition Of Eco friendly Gravure and Flexography Solvent Base (NTNK) inks:-
1.Resin- <ul style="list-style-type: none"> • Vinyl Resin • PU Resin • Acrylic Resin • NC cotton • Polyamide Resin • Ketonic Resin • Phenolic Resin • Natural Gum Resin • Chlorinated polypropylene Resin • Eva Resin • Alkyd Resin • Melamine formaldehyde Resin • Epoxy Resin 	1.Resin- <ul style="list-style-type: none"> • Vinyl Resin • PU Resin • Acrylic Resin • NC cotton • Polyamide Resin • Ketonic Resin • Phenolic Resin • Natural Gum Resin • Alkyd Resin • Melamine formaldehyde Resin
2. Pigments- <p>(i)Organic Pigment</p> <p>(A)-Polycyclic pigments-</p> <ul style="list-style-type: none"> ➤ Green 7 ➤ Blue15:3 	2. Pigments- <p>(i)Organic Pigment</p> <p>(A)-Polycyclic pigments-</p> <ul style="list-style-type: none"> ➤ Green 7 ➤ Blue15:3

<ul style="list-style-type: none"> ➤ Blue 15:4 ➤ Violet23 etc. <p>(B)-Azo Pigments-</p> <ul style="list-style-type: none"> ➤ Yellow 12 ➤ Yellow 13 ➤ Yellow 14 ➤ Orange13 ➤ Red146 ➤ Yellow83 ➤ Violet27 ➤ Red53:1 ➤ Red57:1 etc. <p>(C)- Anthquinone Pigments-it is non toxic pigment, mostly use in paper manufacturing.</p> <p>(ii).Inorganic Pigments</p> <ul style="list-style-type: none"> ➤ White pigment(titanium dioxide etc.) ➤ Colour pigment-Ultramine,cd,Ironoxide. 	<ul style="list-style-type: none"> ➤ Blue 15:4 ➤ Violet23 etc. <p>(B)-Azo Pigments-</p> <ul style="list-style-type: none"> ➤ Yellow 12 ➤ Yellow 13 ➤ Yellow 14 ➤ Orange13 ➤ Red146 ➤ Yellow83 ➤ Violet27 ➤ Red53:1 ➤ Red57:1 etc. <p>(C)-Anthquinone Pigments-it is non toxic pigment, Widly use in paper manufacturing.</p> <p>(ii).Inorganic Pigments</p> <ul style="list-style-type: none"> ➤ White pigment(titanium dioxide etc.).
<p>3. Organic solvents -</p> <ul style="list-style-type: none"> ➤ Toluene ➤ Methyl ethyl ketone (MEK) ➤ Methyl isobutyl ketone (MIBK) ➤ Ethyl Acetate ➤ N Propyl Acetate ➤ Iso-Propyl Acetate ➤ Xylene ➤ Butyl Acetate ➤ DOP ➤ DAA ➤ Iso- Propyl Alcohol ➤ NBA etc 	<p>3. Organic solvents -</p> <ul style="list-style-type: none"> ➤ Ethyl Acetate ➤ N Propyl Acetate ➤ Iso-Propyl Acetate ➤ Butyl Acetate ➤ Iso- Propyl Alcohol
<p>4.Additives-</p> <ul style="list-style-type: none"> ➤ Plasticiser ➤ Wax ➤ Chelating agent etc. 	<p>4.Additives-</p> <ul style="list-style-type: none"> ➤ Plasticiser ➤ Wax ➤ Chelating agent etc.

<p align="center">Composition Of Conventional Gravure and Flexography Solvent Base inks:-</p>	<p align="center">Composition Of Eco friendly Gravure and Flexography Water Base inks:-</p>
<p>1. Resin-</p> <ul style="list-style-type: none"> • Vinyl Resin • PU Resin • Acrylic Resin • NC cotton • Polyamide Resin • Ketonic Resin • Phenolic Resin • Natural Gum Resin • Chlorinated polypropylene Resin • Eva Resin • Alkyd Resin • Melamine formaldehyde Resin • Epoxy Resin 	<ul style="list-style-type: none"> • Acrylic Emulsion
<p>2. Pigments-</p> <p>(i) Organic Pigment</p> <p>(A)-Polycyclic pigments-</p> <ul style="list-style-type: none"> ➤ Green 7 ➤ Blue 15:3 ➤ Blue 15:4 ➤ Violet 23 etc. <p>(B)-Azo Pigments-</p> <ul style="list-style-type: none"> ➤ Yellow 12 	<p>2. Pigments-</p> <p>(i) Organic Pigment</p> <p>(A)-Polycyclic pigments-</p> <ul style="list-style-type: none"> ➤ Green 7 ➤ Blue 15:3 ➤ Violet 23 etc. <p>(B)-Azo Pigments-</p> <ul style="list-style-type: none"> ➤ Yellow 12

<ul style="list-style-type: none"> ➤ Yellow 13 ➤ Yellow 14 ➤ Orange13 ➤ Red146 ➤ Yellow83 ➤ Violet27 ➤ Red53:1 ➤ Red57:1 etc. <p>(C)- Anthquine Pigments-it is nontoxic pigment, mostly use in paper manufacturing.</p> <p>(ii).Inorganic Pigments</p> <ul style="list-style-type: none"> ➤ White pigment(titanium dioxide etc.) ➤ Colour pigment- Ultramine,cd,Ironoxide. 	<ul style="list-style-type: none"> ➤ Yellow 14 ➤ Orange13 ➤ Red146 ➤ Yellow83 ➤ Violet27 ➤ Red53:1 ➤ Red57:1 etc. <p>(C)-Anthquine Pigments-it is nontoxic pigment, Widely use in paper manufacturing.</p> <p>(ii).Inorganic Pigments</p> <ul style="list-style-type: none"> ➤ White pigment(titanium dioxide etc.).
<p>3. Organic solvents -</p> <ul style="list-style-type: none"> ➤ Toluene ➤ Methyl ethyl ketone (MEK) ➤ Methyl isobutyl ketone (MIBK) ➤ Ethyl Acetate ➤ N Propyl Acetate ➤ Iso-Propyl Acetate ➤ Xylene ➤ Butyl Acetate ➤ DOP ➤ DAA ➤ Iso- Propyl Alcohol ➤ NBA etc 	<p>3. Solvents –</p> <ul style="list-style-type: none"> ➤ Iso- Propyl Alcohol ➤ DM Water
<p>4.Additives-</p> <ul style="list-style-type: none"> ➤ Plasticiser ➤ Wax ➤ Chelating agent etc. 	<p>4.Additives-</p> <ul style="list-style-type: none"> ➤ surfactant ➤ Wax

Composition of Solvent base Gravure and Flexography ink's formulations:-

- Resins: 10-30%
- Colorants (Dyes/Pigments) : 5- 20%
- Solvents : 50-80%
- Additives : 0-3%

Composition of Solvent base(NTNK) Gravure and Flexography ink's formulations:-

- Resins: 10-30%
- Colorants (Dyes/Pigments) : 5- 20%
- Solvents Alcohol & Ester based : 50-80%
- Additives : 0-3%

Composition of Water base Gravure and Flexography ink's formulations:-

- Acrylic Emulsion 25-40%
- Colorants (Dyes/Pigments) : 5- 20%
- Iso propyl alcohol : 10-15%
- DM Water 25-40%
- Additives : 0-3%

2. To study and Compare Manufacturing process of eco-friendly Gravure and Flexography ink.

Milling part of conventional Gravure and Flexography Solvent Base inks:-

1. Resin Varnish
2. Wetting & Dispersing agent
3. Pigment
4. Solvents
5. Additives

Milling part of Gravure and Flexography Solvent Base inks (Toluene&MEK Free):-

1. Resin Varnish
2. Wetting & Dispersing agent
3. Pigment
4. Solvents (Non Toluene & Ketones)
5. Additives

Milling part of Gravure and Flexography Water Base inks :-

1. Acrylic Emulsion
2. Wetting & Dispersing agent
3. Pigment
4. Solvents
5. Additives

Plant, Machinery & Equipment

S. No.	Description
1.	High speed mixers with 7.5 HP Motor
2.	High speed mixers with 15 HP Motor
2.	Slow Speed Mixers
3.	Dynomill
4.	Attritors
5.	Mixing Pots (300 Litre& 600 Ltr. capacity)
6.	Mixing Pots (1000 Ltr. capacity)
6.	Storage vessels for 1000 Litre capacity
7.	Weighing Balance (30Kg capacity)
8.	Weighing Balance (200 Kg capacity)
9	Weighing Balance (1.5MT capacity)
10.	Pallet Truck/ hydraulic lifter
12	Pallet Stacker
11.	Drum Tilter
12.	Chilling Unit
13.	Laboratory equipment's
14.	Other Equipment or Tools
15.	Furniture and office equipment's
16.	Safety equipment's
17.	Pre-operative expenses

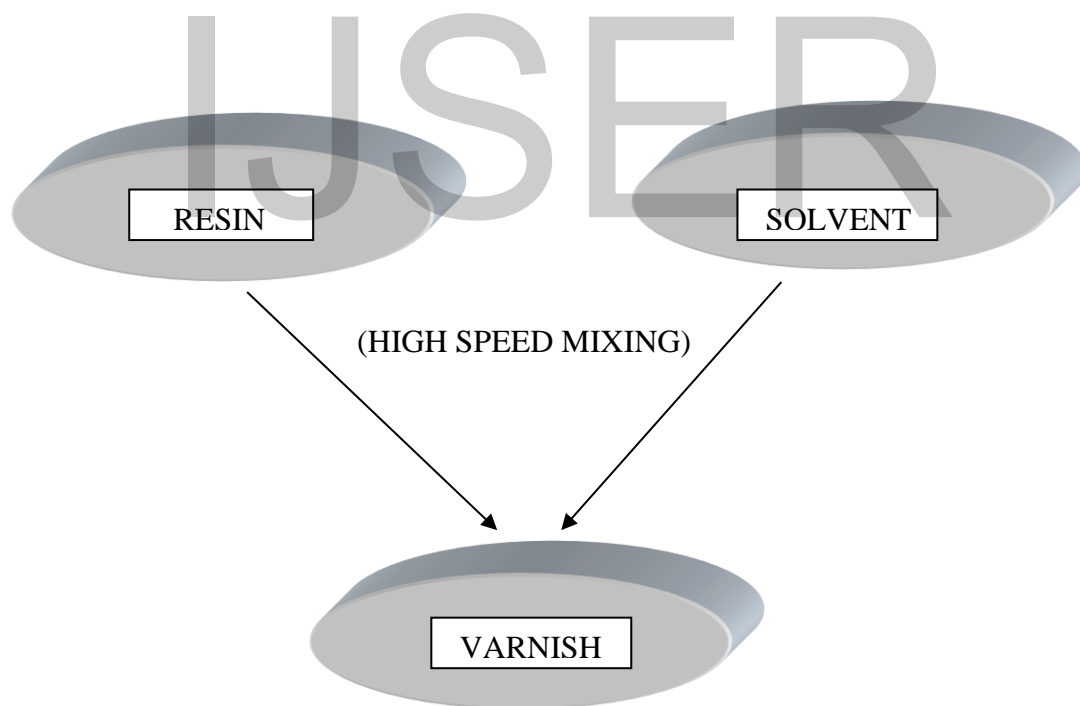
List Of Laboratory Equipments-

S. No.	Description
1	VibroShekar
2	Draw down Pad
3	Bar Coater
4	GC machine
5	Weighing Balance(0.2Kg)
6	Karl Fischer Titrator
7	Universal Tester
8	Printing proofer
9	Lab Oven
10	Colour Matching Cabinet

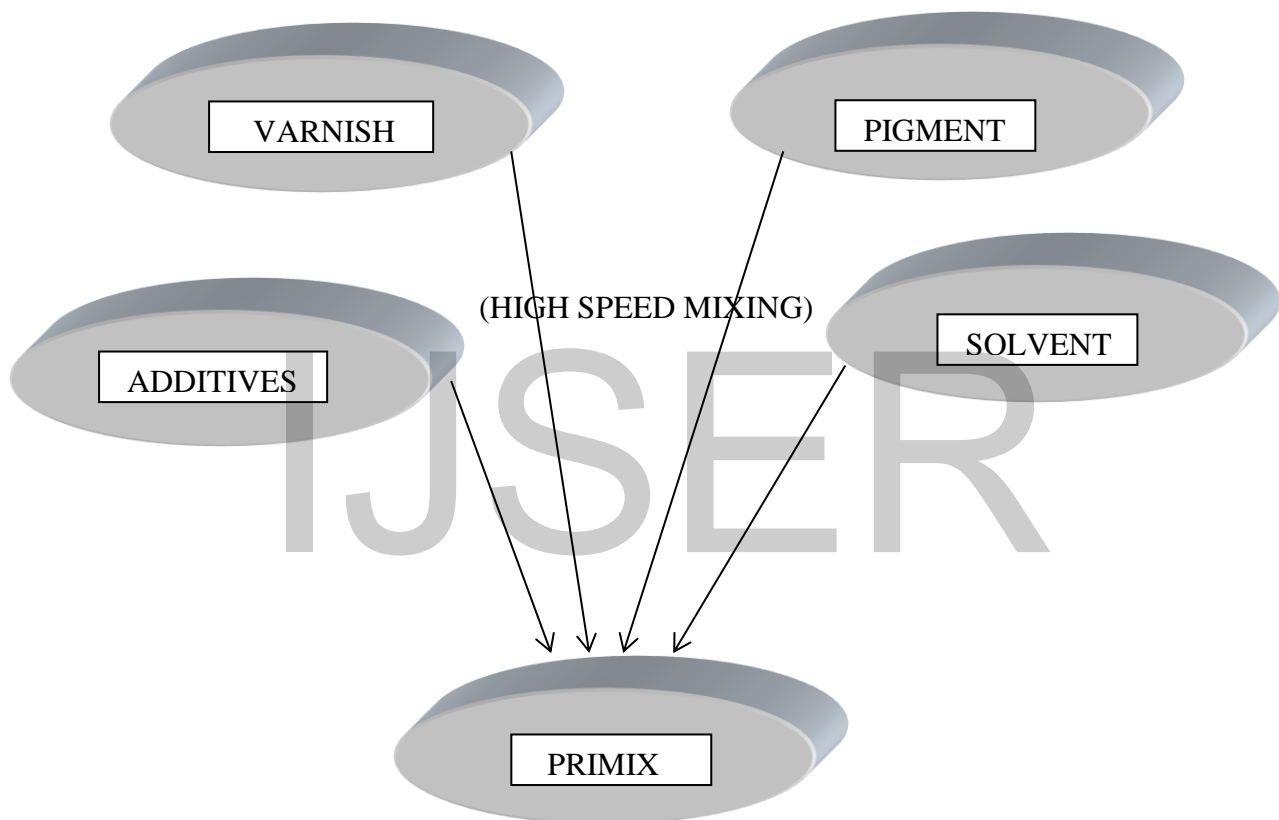
Steps During Ink Manufacturing:-

1. Varnish Preparation
2. Premixing
3. Grinding
4. Final & Packing

1.Varnish Preparation :- Varnish is the clear liquid that is the base of any ink. Different varnishes are made for different inks, but they are all made by mixing the resins, solvents and additives to form a homogeneous mixture.



2.Premixing :- The premix stage involves pre-dispersion of the pigment in a mixture of varnishes. In fact, several varnishes with different properties are used in a single ink and it is through their judicious combination that series of inks with completely different properties are obtained. Certain varnishes have very specific properties, while others may be used in the composition of several references.



3.Grinding :- The purpose of the Grinding and dispersion process is to break down pigment aggregates and agglomerates to their optimum pigment particulate size and distributes these pigment particles evenly <3 microns.

Different types of Grinding processes and equipment's can be used. The most widely used are three roll mills and bead mills.

Three roll mill:-

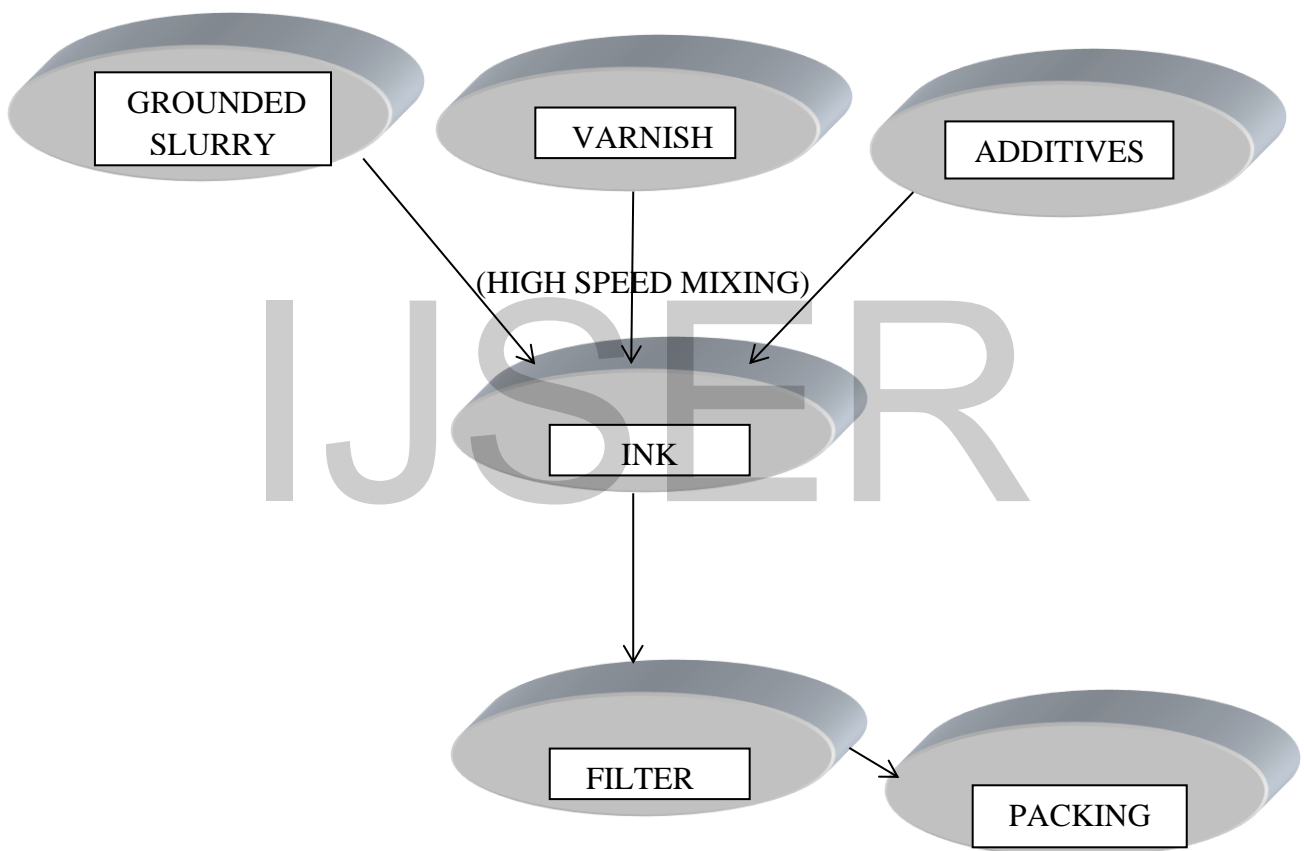
the mill comprises three cylinders through which the ink circulates. Normally, the ink is passed through the mill three different times. Certain more difficult to mill pigments may need to be passed through the mill an additional time. The three passes follow on from each other with increasing pressure between the cylinders that perform the milling: the first milling stage, which fines down the premixed ink, the second milling stage, which breaks up any remaining agglomerates and the final milling stage, which completes the dispersion.

Bead mill:-

All types of inks can be milled by this procedure, with only the configurations of the mills differing. In this case, the milling is assured by the balls (of variable diameter and made out of various materials) within the mill being brought into movement within a cylinder (stator) via the rotation of an rotor. The stator and rotor are fitted with "fingers", which are cooled to avoid too much overheating. The ink circulates inside the milling chamber and the agglomerates are broken up under the impact of the balls. The quality of the milling is optimised by adjusting the temperature and flow rate of the ink.



4. Final & Packing :- In these process of ink manufacturing mixed all required varnishes Grounded slurry and additives then ensure the ink complies with the specifications, it may be released for packaging.



Comparative process of manufacturing

Process Instructions Conventional Gravure and Flexography Solvent Base inks:-	Process Instructions Eco friendly Gravure and Flexography Solvent Base (NTNK) inks:-
1. Take clean pot of appropriate size and ensure the cleanliness of pot.	1. Take clean pot of appropriate size and ensure the cleanliness of pot.
2. Preparation of required resin system varnish with solvents.	2. Preparation of required resin system varnish with solvents.
3. Mount the pot on balance, connect the earthling and take item varnish, pigment, wetting and dispersing agent.	3. Mount the pot on balance, connect the earthling and take item varnish, pigment, wetting and dispersing agent.
4. Mix the above mixture 10 min at 200 RPM add the pigment weight separately with slow speed stirring .	4. Mix the above mixture 10 min at 200 RPM add the pigment weight separately with slow speed stirring .
5. Grinding on milling machine dyno mill or Atritorand maintain <3 micron on HegmenGuage.	5. Grinding on milling machine dyno mill or Atritorand maintain <3 micron on Hegmenguage.
6. Adjust the flow rate 3.00 to 3.5 kg / min .	6. Adjust the flow rate 3.00 to 3.5 kg / min.
7. Remove the pot from machine and mix the final part of ink varnishes and solvents.	7. Remove the pot from machine and mix the final part of ink varnishes and Non toluene and ketones solvents.
8. Remove the pot from balance and mount under clean HSD.	8. Remove the pot from balance and mount under clean HSD.
9. Mix the complete mixture for 30 min at 900±100 RPM .	9. Mix the complete mixture for 30 min at 900±100 RPM .
10. Solvent Loss makeup .	10. Solvent Loss makeup .

3.To make comparative Quality compression of conventional and Eco friendly Gravure and Flexography ink.

S. No.	PROPERTIES	CONVENTIONAL GRAVURE & FLEXOGRAPHY INKS	ECO FRIENDLY GRAVURE & FLEXOGRAPHY INKS
1	Effects on humans.	Use Of Toluene (Toluene is a product containing migrants is consumed or comes into contact with the skin or other Membranes, these migrants can get absorbed by the human cells.)	No Use Of Toluene.
	➤ Breathing difficulties	Yes	No
	➤ Eye and throat problems	Yes	No
	➤ Exhaustion	Yes	No
	➤ Ototoxicity – imbalance, the hardness of hearing	Yes	No

	➤ Dizziness	Yes	No
	➤ Hallucinations	Yes	No
	➤ Memory loss	Yes	No
	➤ Confusion	Yes	No
	➤ Skin irritation/Dermatitis	Yes	No
	➤ Suspected damage to unborn children	Yes	No
2	Use of petroleum-based solvents	Use of petroleum-based solvents, which increase levels of VOCs, toxic substances and energy consumption.	No Use
3	Environmental impact ➤ Use Of Heavy metals ➤ Use Of lead or ozone-depleting chemicals such as CFC's and HCFC's	Failed to adopting environmental regulations. (National and international governments are now adopting environmental regulations which specifically address the content of ink) Yes Yes	Passed to adopting environmental regulations. Not Use Not Use
4	Process Defects During Printing	No	No

5	Resolubility Test	Ok	Ok
6	Tack Test	Ok	Ok
7	Adhesion Test	Ok	Ok
8	Blocking Test	Ok	Ok
9	Nail & Scuff Test	Ok	Ok
10	Another Rheological Properties test	Ok	Ok
11	Moisture Resistance Test	Ok	Ok
12	Bond Strength	Ok	Ok

Specifications of Conventional and Eco-Friendly inks-

Conventional solvent Based Liquid Inks for pet-

Conventional inks are optimally pigmented , Vinyl based Gravure Inks, specially formulated for quality routine lamination jobs using various grades of Polyester films. These inks have excellent printability; maintain stable adhesion, and minimum solvent retention levels. These inks are specially designed with a Solvent Balance optimized to give best results at high press speeds due to their excellent technical specifications and the chemistry employed. These inks are highly stable on the printing machines, thereby enabling management of long as well short job runs with ease - a very commonly used ink system for the lamination work in Indian sub-continent.

Advantages:

- High colour strength
- Good bond strengths
- Almost instant adhesion
- Low solvent retention
- Reliable, high performance results
- Free from migrating plasticizer resins.
- Good Resolubility
- Good on tack properties
- Good moisture resistance
- Economical ink cost

Dis-advantages:

- Use of banned solvent (Toluene, MEK and others) and migrating plasticizer and resins.

Eco-friendly NTNK Liquid Inks for pet-

Eco-friendly inks are highly pigmented, Polyurethane based Gravure Inks, specially formulated for lamination job. These inks have excellent printability, maintains stable adhesion and exhibit minimum solvent retention levels. These inks are specially designed with solvent and resin system Balanced to optimize best results at high press speeds. This has been achieved by intelligently managing the chemistry of the whole ink system so as to achieve precise specifications with excellent technical outcome.

Advantages:

- High colour strength
- Low solvent retention
- Good Resolubility
- Good on tack properties
- Good moisture resistance
- Prints on wide range of plastic films
- Reliable, high performance results
- Free from banned solvent (Toluene, MEK and others) .
- Does not contain pigments based on heavy metals.
- Does not contain plasticizers banned in certain countries.

Dis-advantages:

- These inks are cost effective against compression of conventional ink system.

Water Base Eco-friendly inks-

The latest innovation in the Flexography and Gravure inks mainly concern water based inks. New emulsions (resin / water suspensions) enable new water based inks to be formulated, providing alternative solutions to solvent based inks and thereby limiting problems linked to the environment (emissions of VOCs) and the safety of users (toxicity, flammability, etc.).Eco-friendly inks are highly pigmented, Water based Gravure and Flexography Inks, specially formulated for food Grade jobs.

Advantages:

- High colour strength
- Excellent printability
- Good Resolubility
- Prints on wide range of plastic films
- Reliable, high performance results
- Free from banned solvent only use IPA and DM water.

- Does not contain pigments based on heavy metals.
- Does not contain plasticizers banned in certain countries.
- Low cost During Running on printing machine use of DM water in dilution for application viscosity.

Dis-advantages:

- These inks are issue of drying during running on printing machine.
- Issue of surface tension adjustment of ink during running printing machine foaming defect observed many times.

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Results & Discussion

The Future of Gravure and Flexography ink is almost environmental based and using also in other process, Possible Solution for Gravure inks Eco-Friendly solvents usage in inks as well as printing process. Promotion of Water Based Inks Efficiency in printing can be done immediately Replacement of hazardous Solvents, colorants and Additives Promotion of Water based inks for most of absorbent substrate's printings Carbon Credit systems Smart design for printing place Smart design of packages Transparent, feasible, usable and required regulations. Barriers in Green Chemistry for Gravure Printing Cost of eco-friendly alternates Market competition for cheaper printing cost Lack of regulations and restrictions .

The solvent based fluids contain less than 25% volatile organic compound , less than 1 hazardous air pollutants and less than 0.1% carcinogens. Ink also offers a selection of water based fluids. Water based fluids contain at least 50% water, less than 20-30% alcohol, less than 1 hazardous air pollutants (HAP's) and less than 0.1% carcinogens. Environment-responsibility is the key factor of our sustainability and developing.

The primary targets are developing new products of toluene-free inking system and compression with conventional ink system, Water based Eco-Friendly Gravure and Flexography ink.

Conclusion

This Project is main point of result, comparative analysis of Conventional and Eco-friendly Gravure and Flexography inks with Toluene-free Gravure ink, MEK-free Gravure ink, Water based surface Gravure ink, Environmental friendly water based Flexography ink ,and use of ingredients such as pigments , resin ,solvents and additives , the Gravure and Flexography ink widely used in flexible packaging industry, so that the primary targets are developing new products of toluene-free inking system, water based printing ink on plastic substrates and its comparative analysis against conventional process. The future of Gravure and Flexography ink is almost environmental based and using also in other process, Possible Green Chemistry/Solution for Gravure inks Eco-Friendly solvents usage in inks as well as printing process. The printing industry is standing up and taking notice when it comes to printing with inks that are safe for our environment and safe for us all.

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Future Scope

Eco-friendly printing inks are newer inks that are more environmentally friendly. They do not cause the same damage and pollution to the earth and the atmosphere. In the conventional inks used for printing were mainly petroleum based, and these substances were often very high in toxic metals and other harmful substances

The gravure and Flexography ink in solvent based ink as well as using will in future in free toluene and free of Toluene ink by choosing more eco-friendly versions; it can not only save money but also protect themselves, their employees and environment. Many printers are switching to eco-friendly inks.

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