E-notes for 3rd Semester Textile Processing students

TECHNOLOGY OF PRINTING-I

CHAPTER -I

INTRODUCTION

Printing can also be defined as localized dyeing.

It is also defined as the application of dye or pigment in a different pattern on the fabric and by subsequent after treatment of fixing the dye or pigment to get a particular design.

History:

Textile printing basically is supposed to be probably originating in East Asia and China in antiquity as a method of printing on textiles and later paper. As a method of printing on cloth, the earliest surviving examples from China date to before 220.

Textile printing was known in Europe from about the 12th century, and widely used. However, the European dyes tended to liquify, which restricted the use of printed patterns. Fairly **large and ambitious designs were printed for decorative purposes such as wall-hangings and lectern-cloths**, where this was less of a problem as they did not need washing.

Peru, Chile and the Aztecs of Mexico also practiced textile printing previous to the Spanish Invasion in 1519

During the later half of the **17th century the French** brought samples of Indian blue and white resist prints, and along with them, particulars of the processes by which they had been produced, which produced washable fabrics.

By the 1660s British printers and dyers were making their own printed cotton.. Samples of Ollive & Talwin, Joseph Talwin& Company and later Talwin& Foster fabrics and designs can be found in the Victoria and Albert Museum in London and the Smithsonian Copper-Hewett in New York.

During the last two decades of the 17th century and the earlier ones of the 18th new dye works were started **in France, Germany, Switzerland and Austria**. It was only **in 1738 that calico printing was first, practiced in Scotland, and not until twenty-six years later that Messrs Clayton of Bamber Bridge, near Preston, established in 1764 the first print-works in Lancashire, and thus laid the foundation of the industry.**

From an artistic point of view most of the pioneer work in calico printing was done by the French. From the early days of the industry down to the latter half of the 20th century, the productions of the French printers in Jouy, Beauvais, Rouen, and in Alsace-Lorraine, were looked upon as representing all that was best in artistic calico printing.

Objectives of Textile Printing:

* The main objectives of printing are the **production of attractive designs with well defined boundaries** made by the artistic arrangement of a motif or motifs in one or more colours.

*Printing is the **process of, providing a decorative look. by surface ornamentation** technique on fabric surface.

*Printing allows for great **design flexibility** and relatively **inexpensive variety of patterned fabric.**

*Controlled application of colors to the respective areas as per design for single color or multicolor patterns.

* largely it's a demand of the market.

Difference or Comparison between Dyeing and Printing:

There are different types of distinguish between dyeing and printing. They are in below:

Sl.No.	**Dyeing**	**Printing**
1	The process by which a textile product is changed physically or chemically so that it looks mono uniform colored is called dyeing.	To produce different designs on the fabric with motif in one or more colors one kind of localized dyeing that is pigments or a dye are applied locally or discontinuously is known as Printing.
2	In dyeing process, dyed in one color uniformly all over the fabric.	In printing process, color is applied in one side according to the design only.
3	It is performed on fabric, yarn in wet condition.	It is performed on fabric in dry condition.
4	Half **bleaching** is enough for fabric preparation.	Full-bleaching with optical whitener is essential.
5	Dyeing process used for fiber, yarn and fabric.	Printing process used for only fabric.
6	Color is applied in form of solution.	Color is applied in form of thick paste.
7	For dyeing there is no design.	For printing there is a specific design.
8	Dyes are applied in both side of fabric.	Dyes are applied in single side of fabric.
9	For this process only one color is generally used.	One or more colors are used in printing process.

10	In dyeing process, color penetrates through the fabric.	Color is applied only on the surface.
11	A particular temperature is maintained in dyeing process.	There is no particular temperature controlling system in printing.
12	**<u>Thickener</u>** is not used.	Thickener must be used.
13	The density of dye solution is low.	The density of dye solution is high.
14	Generally after dyeing, steaming, and curing are not required.	After printing, steaming and curing is must for fixing the dye molecules to the goods.
15	Dyed fabric is respectively soft in feeling.	Printed fabric is respectively harsh in feeling.
16	Comparatively low cost from printing.	Comparatively high cost from dyeing.
17	There is no localized application.	There is localized application.
18	Lot of water is required.	Less amount of water is used.
19	Huge time required for dye application.	Less time required for printing process.
20	Liquor ratio is high.	Liquor ratio is less.

DIFFERENT PRINTING STYLES:

A process for producing a pattern on yarns, warp, fabric, or carpet by any of a large number of printing methods. The color or other treating material, usually in the form of a paste, is deposited onto the fabric which is then usually treated with steam, heat, or chemicals for fixation

There are three different printing 'styles' used to produce patterned effects on textiles, these being termed as:

1. Direct Style of Printing
2. Discharge Style of Printing
3. Resist Style of Printing

Each of these will be described in turn.

1. Direct Printing Style

This method involves the direct application of the colour design to the fabric and is the most common method of textile printing. The dyes used for direct printing are those which would normally be used for a conventional dyeing of the fabric type concerned.

2. Discharge Printing Style

In this method the fabric is pre-dyed to a solid shade by a traditional dyeing process and the colour is then destroyed locally, by chemicals incorporated in the print paste especially for that purpose. The result is a white patterned discharge on a coloured ground. In “white” discharge printing, the fabric is piece dyed, then printed with a paste containing a chemical that reduces the dye and hence removes the color where the white designs are desired. In “colored” discharge printing, a color is added to the discharge paste in order to replace the discharged color with another shade.

3.Resist Printing Style:

In this method of printing the fabric is first printed with a substance called a 'resist' which will prevent the dye from being taken up in a subsequent dyeing process. The resist functions by either mechanically preventing the dye from reaching local areas of the fabric or by chemically reacting with the dye or the fibre, to prevent adsorption.

A printing method in which the design can be produced:

(1) by applying a resistagent in the desired design, then dyeing the fabric, in which case, the design remains white although the rest of the fabric is dyed: or

(2) by including a resist agent and a dye in the paste which is applied for the design, in which case, the color of the design is not affected by subsequent dyeing of the fabric background.

COMPARISON BETWEEN DISCHARGE AND RESIST PRINTING	
DISCHARGE PRINTING	**RESIST PRINTING**
Discharge prints are always sharp in outline, bright in appearance and give perfect and sparkling whites due to the bleaching effect of the discharging agent.	Resist prints are generally subdued and the colours are les bright, the outlines of the printed motifs are less sharp.
Since the fabric tobe discharged is fully dyed, drastic chemical action is required to destroy/remove the colour.	In resist printing, the ground is not dyed before printing, therefore, little or no chemical action is involved to prevent colour fixation.
The cost of discharge printing paste is higher and the materials have to be selected carefully to facilitate compete destruction/removal of colour	The cost of resis printing paste is lower, requiring less chemicals and auxiliaries. Eg....in Bandhni, only cotton thread is required to tie and resist the portions tobe left undyed.
This method id applicable only to those colours which can be discharged and has limitations; also it generally is difficult to get reproducible results in all operations.	This method is effective in all cases as almost all colours are capable of being resisted with wax or thread.
The percentage of rejects is higher	The percentage of rejects is lower.

DIFFERENT METHODS OF PRINTING :

BlockPrinting:

The blocks are usually made of wood and the design is hand carved, so that it stands out in relief against the background surface. The print paste is applied to the design surface on the block and the block then pressed against the fabric. The process is repeated with different designs and colours until the pattern is complete.

is a slow, laborious process and is not suitable for high volume commercial use. It is a method still practised in the oriental countries where markets exist for the types of printed fabrics produced.

Stencil printing:

Screen Printing:

Manual Screen Printing

Machine Screen Printing

Flat Bed Screen Printing

Rotary Screen Printing

RollerPrinting:

Roller printing has traditionally been preferred for long production runs because of the very high speeds possible. It is also a versatile technique since up to a dozen different colours can be printed simultaneously. The basic roller printing equipment, shown in Fig. 7.1, consists of a number of copper faced rollers in which the design is etched. There is a separate printing roller for each colour being printed. Each of the rollers rotates over the fabric under pressure against an iron pressure roller. A blanket and backing cloth rotate over the pressure roller under the fabric and provide a flexible support for the fabric being printed. A colour doctor blade removes paste or fibres adhering to the roller after contact with the fabric. After the impression stage the fabric passes to the drying and steaming stages.

This type of printing has increased enormously in its use in recent years because of its versatility and the development of rotary screen printing machines which are capable of very high rates of production. An additional significant advantage is that heavy depths of shade can be produced by screen printing, a feature which has always been a limitation of roller printing because of the restriction to the amount of print paste which can be held in the shallow depth of the engraving on the print roller. Worldwide, some 61% of all printed textile fabric is produced by the rotary screen method and 23% by flat screen printing.
There are two basic types of screen printing process, the flat screen and the rotary screen methods.

Digital Printing

HeatTransferPrinting :

Transfer printing techniques involve the transfer of a design from one medium to another. The most common form used is heat transfer printing in which the design is printed initially on to a special paper, using conventional printing machinery. The paper is then placed in close contact with the fabric and heated, when the dyes sublime and transfer to the fabric through the vapor phase.

Ink-JetPrinting :

There has been considerable interest in the technology surrounding non-impact printing, mainly for the graphic market, but the potential benefits of reductions in the time scale from original design to final production has led to much activity in developing this technology for textile and carpet printing processes. The types of machines developed fall into two classes, drop-on-demand (DOD) and continuous stream (CS).

Special methods of Printing:

CarpetPrinting:

The printing of carpets only really achieved importance after the introduction of tufted carpets in the late 1950s. Until then the market was dominated by the woven Wilton carpets and Axminster designs were well established, but by the 1980s tufted carpet production accounted for some 80% (by area) of UK production. Much of this carpet production was printed because the range of patterns possible to produce using tufting machines was limited and there was a desire to produce a greater flexibility of design for these types of carpet.

WarpPrinting:
The printing of a design on the sheet of warp yarns before weaving. The filling is either white or a neutral color, and a grayed effect is produced in the areas of the design.

PhotographicPrinting:
A method of printing from photoengraved rollers. The resultant design looks like a photograph. The designs may also be photographed on a silk screen which is used in screen printing.

BlotchPrinting:

A process wherein the background color of a design is printed rather than dyed.

Burn-OutPrinting:

A method of printing to obtain a raised design on a sheer ground. The design is applied with a special chemical onto a fabric woven of pairs of threads of different fibers. One of the fibers is then destroyed locally by chemical action. Burn-out printing is often used on velvet. The product of this operation is known as a

Tie and Dye Printing: It's a traditional method of printing by tieing the cloth and then dyeing. So basically it's a dyed style method.

Crimp Printing: Printing with strong alkali means NaOH. Creates change in properties for increased dye uptake and shrinking effect.

DuplexPrinting:

A method of printing a pattern on the face and the back of a fabric with equal clarity.

Batik Printing: It's a resist method like tie n dye . here the resisting is done with wax. And then fabric is dyed.

CHAPTER 2

PRINTING PASTE

Different Ingredients of Printing Paste:

Dye or Pigment

Basically dye or pigment is a material which is directly involve with printing and it's should be characterize by four different condition. The condition to be a dye or pigment are given blew

The material should be the Physical attributes to transfer the solution color from the water to the fabric. After making the solution of the dyes which is not soluble in water those color should be transfer from the solution to the target fabric or cloth.

Those dyes should have the ability to get into the fiber from the solution.

Those dyes should be the ability to make a strong bond with finer like this dyes a part and parcel of fiber.

Wetting agent

Hydrophobicity is a character of a material which dislikes to get soluble with the water this is also called water hating such as wax and oil type liquids. And the other hands there are such material can soluble with water are called water loving material like glycerin and TR oil. Every kind of objects has own surface tension which is don't want to be damage of break, example water. Water surface tension is 73 dynes/cm.

In textile industry almost every kind of compound are supplied in powder. If we make a direct solution with water then the solution of the dyes will not mixed properly and we will get some precipitation down of pot. Question is why? Why just having this kind of problem? Simple! Reason of this problem is surface tension of the water. To solve this problem we have a great solution is called wetting agent. After used the wetting agent the surface tension of water will be less from 73 dynes/cm to among 20 to 25 dynes/cm and let that powder solution.

Solvent

Printing pest makes from the powder of pigment or dye stuff. Solvent play the role to opposition to coagulate the molecule into the dye stuff. The main reason to use solvent or dispersing agent is keep the molecule separate to make ideal print during makes the printing pest. Basically most used solvents are Acetate, ethylene glycol, alcohol, glycerol, urea and formaldehyde. Some of these elements are also work like wetting agent. Too much usage of solvent can diminish the smoothness of design.

Thickener

Thickener is a high molecular weight prominent which is makes the printing paste perfect deep and Adhesive as it can stick with fabric and output desire printing design. This thickener makes a strong bond with fiber and pigments, as a result the print never wipe by high temperature and rubbing. Thickeners should be the ideal solution so that it can soluble with every kind of elements which is used to make printing solution or pest. Different types of printing pest viscosity are different because of the methods of printing. Like roller printing deep pest and screen printing design pest is less viscosity characterized.

De-foaming agent

During the process of making printing pest and during the printing process the printing pest is handling by too many machines which frequently keep shaking the pest so that it's produce foam into printing pest. With so much foaming printing pest can't print properly and the foam makes so much problem during printing process. The de-foaming is used to preventing the problem of foaming into printing pest. Defamers, sulfide oil (T.R Oil) are basically known as de-foaming agent.

Catalyst and oxygen carrier

By steaming process the oxidation needs some catalyst. In this steaming process increasing temperature can damage the fiber. To prevent this kind of problem a few chemical can be used which is called catalyst. This catalyst can able to fix the color into fiber permanently.

Acid and alkali

Acid is required to dying and printing with a few dye stuff, its help those dyes to develop the color and fixing the color with fiber or fabric. Basically acid is not used in dye stuff directly so that there must used an agent which is reacting like acid. The printing pest could be used strong and medium alkali.

Carrier and swelling agent

Man made fiber or synthetic fiber, especially polyester fiber's structure is different then others. Means this fiber is so much difficult to through the pigment into the fiber molecule by general process. Its needs high temperature to done this process from (100° -102° C). Some different elements are helping this process to dying to printing in less temperature (100°C) such as Rapid ager, Hydrocarbon, filon. This type of chemicals and characterized chemical are called carrier and swelling agent can makes the fiber's molecule larger then its paste so that dye or pigments can go into the fiber molecule so easily and stuck there permanently after being the molecule get paste position as usual. These kinds of chemicals are not good for fabric and human body so its necessary to remove this after complete the process.

There is another way to make this process successful by increase the temperature from (120℃ to 130℃) if we use some carrier with this process than it's able to give better performance.

Miscellaneous agent

Type of fabric printing, process, dye, and classification are depending by some exceptional elements which is used to print like, C (Reducing agent) & with some critical element with is used in discharge.

Classification of dyes/colours used for printing:

Dye:

By definition dyes can be said to be coloured, ionizing and aromatic organic compounds which shows an affinity towards the substrate to which it is being applied. It is generally applied in a solution that is aqueous. Dyes may also require a mordant to better the **fastness** of the dye on the material on which it is applied. The dyes were obtained from animal, vegetable or mineral origin with no or very little processing. By far the greatest source of dyes has been from the plant kingdom, notably roots, berries, bark, leaves and wood, but only a few have ever been used on a commercial scale.

1. Reactive Dyes
2. Acid Dyes
3. Pre-metallized Dyes
4. Direct Dyes
5. Azoic (Napthol) Dyes
6. Disperse Dyes
7. Vat Dyes
8. Sulfur Dyes
9. Basic Dyes

1. REACTIVE DYES

Reactive dyes are the most recent of dyes. These are the most popular in the world among fibre and fabric artists, used at first only by surface designers, but recently by weavers as well. There are now reactive dyes for a wide range of fibres, e.g. cotton (PROCION), silk and wool (PROCILAN). The dye actually reacts with the fibre molecules to form colour and is, as a result, extremely fast to both light and washing. There are hot and cold water reactive dyes, in fact there is a dye for almost every need. They can be most successfully used for silk painting, with a much better colour fastness than the traditional basic dyes, and are already used by batik artists. we can identify a reactive dye by the alkali used to set off the fixation process, which requires time to take place (silk and wool reactives uses acetic acid). Assistants used are salt, soda ash and resist salt, and sometimes bicarbonate of soda and urea. Reactive dyes are equally suited to screen printing polychromatic printing, fabric painting yarn and piece dyeing.

2. ACID DYES

These are acidified **basic dyes**, intended for use on protein fibres but can be used on nylon and acrylics. They have a fair light fastness but poor wash fastness

3. PREMETALLIZED DYES

These are an acid dyes with the addition of one or two molecules of chromium. The dyes give mute tonings, not unlike those of natural dyes. They are the synthetic dyes mostly used by weavers who dye their own yarns.

4. DIRECT DYES

These **substantive dyes** colour cellulose fibres directly in a hot dyebath without a mordant, to give bright colours. They are not very fast to light or to washing. Direct dyes are generally any dyes which use salt as their only fixative, e.g. Dylon dyes (not to be confused with reactive dyes, which use salt plus other chemicals).

5. AZOIC (NAPHTHOL) DYES

These are another sort of direct dye, but ones that are extremely fast to washing, bleach and light. They are intended for cellulose fibres and can be used successfully on protein fibres, although the colours are different. These dyes are widely used all over Asia and Australia for batik and direct application. They can be used to give interesting texture colour effects on fabric, thread or paper. Their use for straight silk painting is minimal because of the difficulty in achieving evenness of painted colour.

6. DISPERSE DYES

Originally developed for acetate fibres, these are now the major dyes for synthetics. They are not soluble in water, but in the actual fibres themselves. They require a carrier to swell the fibres so that the finely ground particles can penetrate. They are dyed hot, like direct dyes, but do not use salt. Disperse dyes are widely used for heat transfer printing (Polysol). Dye is printed or painted onto paper and heat pressed onto fabric. Prints have excellent light and wash fastness and strong bright colours. Their major disadvantage is that only synthetic fabrics can be used.

7. VAT DYES

Vat dyes are the fastest for cellulose fibres. The dye is made soluble with alkali, put in a 'vat' with a reducing agent, usually sodium hydrosulphite, which removes all oxygen from the liquid, and the fabric is dyed, then oxidized in the air to achieve the true colour. Synthetic indigo is a characteristic vat dye, but there are many colours available

8.BASIC DYES

The colours are very bright, but not very fast to light, washing, perspiration. Fastness is improved if they are given an after-treatment or steaming, e.g. French Silk dyes are basic dyes and should be steamed to fix.

Classification of Thickners

Thickener or printing paste are traditionally made by weighing out and, if necessary, dissolving the colorants and auxiliary chemicals and then stirring them into the required weight of pre-prepared thickener. A thickener is a colourless, viscous paste made with one or more thickening agents. The use of terms such as thickener, and thin, long or short, to describe print pastes is of course descriptive rather than scientific, but is long established and a useful reminder that the materials being handled possess complex properties, not easily defined.The thickener must be stable and compatible with the dyes and dyeing auxiliaries to be used.

Thickener:

Thickener is a thick mass which imparts stickiness and plasticity to the print paste so that it may be applied on the fabric surface without bleeding or spreading and be capable of maintaining the design out lines.

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Function or Object or Purpose of Thickener:

1. To give the required viscosity to the **printing paste**.
2. To prevent premature reactions between the chemicals contained in the print paste.
3. To hold the ingredients of the print paste on the fabrics

Factors to be considered to select/choice of a thickener:

1. Type and quality of material to be printed.
2. Compatibility with dyes and chemicals.
3. Printing paste stability.
4. Styles and methods of printing.

5. Properties of the dried thickener film.
6. Effect on color yield, such as diffusion, fixation.
7. Preparation and removal of the thickener.
8. Cost.
9. Biological oxygen demand.

Essential quality of printing thickener:

1. Stability to keeping should be good.
2. It should have certain physical and chemical properties such as viscosity, flow property, ability to wet and adhere to the internal surface of etchings of the engraved roller.
3. It must be compatible with the other ingredients of the printing paste.
4. The thickener film should dry properly on the fabric to prevent spreading of the color by capillary action.
5. The thickener should not have affinity for the dye and should not keep the dye from the fabric.
6. Proper extraction of water from steam during steaming should be ensured to provide free space for the dye molecules to move towards the fabric.
7. The thickener molecule should have a control over the free water pick-up and not carry the dye beyond the boundaries of the impression.
8. The thickener should be cheap and available in abundance.
9. After perform printing, the useable media i.e. block, roller, screen should be easily cleanable.
10. Once the dye is transferred from the thickener film the removal of the exhausted thickener film without fetching water soluble dye should be easy.

Four significantly different approaches may be used to produce thickeners, using:

1. A low concentration of a polymer of high relative molecular mass (r.m.m.)
2. A high concentration of a material of lower r.m.m. or of highly branched chain structure
3. An emulsion of two immiscible liquids, similar to the emulsions used as cosmetic creams, or a foam of air in a liquid
4. A dispersion of a finely divided solid, such as bentonite.

The first approach is the most important but all four have been used, sometimes in combination. Practical printers long ago discovered natural polymers with suitable properties and, by trial and error, acquired the art of using them. Because the natural products are variable materials and the requirements are complex and ill-defined, experience and subjective judgements were essential. Now that the chemistry and physics of polymers are better understood, it is possible to select and use them more scientifically. We also have available a wider range of thickening agents, including completely synthetic polymers, and this has increased our knowledge. It must not be assumed, however, that our understanding of these complex materials and their behavior is adequate.

In the selection of thickening agents, it is necessary to take into account requirements other than viscosity, which can usefully be classified in five categories: print paste stability, good adhesion of the dried thickener film, minimum effect on colour yield, ease of removal and acceptable cost.

Types of printing thickener:

Basically thickener is two types. Natural thickener and synthetic thickener

1. Natural thickener:

Starch

British gum

Locust bean gum

Guar gum

Alginates

Gum Arabic

Gum tragacanth

2. Synthetic polymer thickener

Reasons behind using of synthetic thickener:

Uncertainties concerning the availability.

Increasing petroleum prices.

Environmental protection measures.

CHAPTER 3 PREPARATION OF CLOTH FOR PRINTING

Steps of preparation of fabric for Printing.

PROCESS SEQUENCES OF CHEMICAL PROCESSING

Grey fabric Inspection & Stitching Shearing & Cropping SingeingDesizingScouringBleachingDryingMercerising Dyeing Printing Soaping & Drying Finishing Folding & Packing

Preparation / Pretreatment Processes used to remove impurities from fibres to make it dye able or printable. Natural fibers and synthetic fibers contain primary impurities that are contained naturally, and secondary impurities that are added during spinning, knitting and weaving processes. Textile pretreatment is the series of cleaning operations .All impurities which causes adverse effect during dyeing and printing is removed in pretreatment process.

Objective of Pretreatment: To Convert fabric from hydrophobic to hydrophilic state. To remove dust, dirt etc from the fabric.To achieve the degree of desire whiteness.

Preparation Following are the steps to be taken before going wet processing :

Grey inspection⇒ Stitching⇒ Shearing and cropping⇒ Singeing⇒Desizing⇒Scouring⇒ Bleaching⇒ Mercerization

Typically a woven cotton fabric would be prepared by sequence of process as shown. In case of knitting sizing step is not involved Preparation/Pretreatment Singeing

1. **SHEARING & CROPPING** In shearing ,thefibres are cut in an angular manner on the surface of the fabric itself, resulting in a soft feel Singeing and shearing are almost the same in effect. In singeing the fibres in the interlacement of the fabric are burnt by flames whereas in shearing the fibres are cut in an angular manner on the surface of the fabric itself, resulting in a soft feel.
2. **Singeing** Burning of protruding fibres from the surface of fabric or yarn - A mechanical process singeing refers to the burning-off of Loosefibres not firmly bound into the yarn and/or fabric structure. Textiles materials are most commonly

singed in woven or knitted fabric form or in yarn form. Makes fabrics smooth Prevents pilling Improves luster

Advantages of Singeing Singeing of a fabric is done in order to obtain a clean fabric surface which allows the structure of the fabric to be clearly seen. Fabrics, which have been singed, soil less easily than un-singed fabrics. The risk of pilling, especially with synthetics and their blends, is reduced in case of singed fabrics. randomly protruding fibres are removed in singeing which could cause diffused reflection of light.

Necessity of Singeing in Textile Cotton materials are valued for their smooth appearance. After□ the formation of fabric it has a fuzzy or hairy appearance due to projecting fibers, thus affecting the luster and smoothness Unsigned fabrics are soiled easily The protruding fibers obstruct the subsequent dyeing and printing process Goods which are to be mercerized are signed to maximize the luster In fabrics of polyester and cellulosic fiber blends singeing is the best method to control pilling, sometimes double singeing is done to minimize the pilling.

Singeing Process Singeing process is as follows: To produce a smooth surface finish on fabrics made from staple fibers first the fabric surfaces are brushed lightly to raise the unwanted fiber ends. Then the fabric is singed with or passed over heated copper plates or open gas flames. The fiber ends burn off. The fabric is moved very rapidly, and only the fiber ends are destroyed. As soon as the fabric leaves the singeing area, it enters a water bath or desizing bath. This stops any singeing afterglow or sparks that might damage the cloth.

TYPES OF SINGEING

Plate Singeing

Roller Singeing

Gas Singeing

3.DESIZING Desizing is the process of removing the size material from the warp yarns in woven fabrics. Sizing agents are selected on the basis of type of fabric,

Desizing Starch Once a starch solution dries, the resulting film will not readily re dissolve in water; therefore, to completely remove starch from a fabric, the polymer must be chemically degraded to make it water soluble. Three chemical methods can be used to degrade starch into water soluble compounds namely, Enzymes, Acid Hydrolysis and Oxidation.

Major Desizing Processes

1. Rot steeping
2. Enzymatic desizing
3. Oxidative desizing
4. Acid steepimg

Rot steeping Fabric is stored in warm water at 40-60o C overnight It remove the starch and water soluble impurities with natural reaction Drawback: Time consuming One can not certain that in the given duration size will remove completely

Oxidative steeping: Starch and other added impurities are hydrolysed through oxidation process followed by washing process. Oxidizing agents: Sodium Hypochlorite: 2.0-5.0 gm/lit. at room temperature at pH 7.0 Hydrogen peroxide:3.0-6.0 gm/lit of H_2O_2 and 7.0-15.0 gm/lit Sodium Hydroxide, 40oC for 12-16 hours Drawback: Time consuming Process Some time bleaching effect also obtain(If not require in the end product)

Acid steeping Acid hydrolysis lowers the molecular weight and reduce starch to glucose. Fabric is treated with Sulphuric Acid (0.5% to 1.0 %) at 40o C It also remove the starch and water soluble impurities with natural reaction Drawback: Tendering of cellulosic fibre if precautions are not taken If the acid remain in the fabric, whole lot may get seriously damage or tendered

Oxidative Desizing of strachThe oxidative desizing methods are relatively unimportant and when using them, damage to fiber can never be completely avoided.

Enzymatic Desizing Enzyme solution in water with 0.5% to 2.0% on weight of fabric enzyme Require quantity of Common salt is also required Neutral pH Other method fabric is run continuously in machine having enzyme solution.

ENZYME Enzymes are high molecular weight protein biocatalyst that are very specific in their action. Enzymes are named after the compound they break down, for example: Amylase breaks down amylose and amylopectin, Maltase breaks down maltose and Cellulase breaks down cellulose. For desizing starch, amylase and maltase are used.

4.Scouring It is process to remove all undesirable impurities (Natural: like dirt, vegetable matter, grease wax etc and Added: like remaining size material, stains etc.) Natural Impurities: Based on the composition of natural material like cotton, wool, silk etc.

SCOURING Natural fibers contain oils, fats, waxes, minerals, leafy matter and motes as impurities that interfere with dyeing and finishing. Synthetic fibers contain producer spin finishes, oils and/or knitting oils, grease. These impurities are not soluble in water, they can be removed by Extraction, dissolving the impurities in organic solvents, Emulsification, forming stable suspensions of the impurities in water and Saponification, Converting the contaminates into water soluble components.

Objectives To make the fabric highly hydrophillic. To remove impurities such as oil, wax, gum, husk as nearly as possible. To increase absorbency of fabric or textile material with out physical or chemical change.To produce a clean material by adding alkali to make the fabric ready for next process.To remove non cellulosic substances in case of cotton.

Mechanism of Scouring :

Saponification

Detergency

Chemical used in scouring process : Normally strong Alkali like Sodium Hydroxide and a detergent with other auxillaries are used in scouring .

Form of scouring Yarn scouring : Hank♣ Package♣ Fabric scouring : open width Jigger♣ Pad batch♣ Rope form Kier♣

Methods of scouring There are two principal methods of scouring

1. Discontinuous or Batch method (winch , jigger kier)
   Kier was the machine used extensively used for bulk cotton scouring in any form and used today. Capacity of the kier machine can be upto 20 tons .
2. Continuous method (scouring in j box)

SOLVENT SCOURING Certain organic solvents will readily dissolve oils fats and waxes and these solvents can be used to purify textiles. Removal of impurities by dissolution is called Extraction. There are commercial processes where textiles are cleaned with organic solvents. Fabrics processed this way are said to be "Dry Cleaned".

5. **Bleaching** This is a process of whitening-fibers, yarns, or fabrics having natural colour. It is carried out by using oxidising agents like
   Sodiumhypochlorite (NaOCl)
   Hydrogen peroxide (H_2O_2)
   Sodium Chlorite ($NaClO_2$)

Objective: The color producing agents in natural fibers are often organic compounds containing conjugated double bonds. It is known in dye chemistry that conjugation is necessary for an organic molecule to perform as a dyestuff. Decoloration can occur by breaking up the chromophore, most likely destroying one or more of the double bonds within the conjugated system.

Bleaching Oxidative bleaches oxidize color bodies into colorless compounds. For example, double bonds are known to be oxidize into epoxides which easily hydrolyze into diols. The major bleaching agents used in textile preparation are sodium hypochlorite, hydrogen peroxide and sodium chlorite.

Type of Bleaching agents

a.Oxidative Bleaching Agents

b.Reductive Bleaching Agents

c.Enzymatic Bleaching Agents

Bleaching with hypochlorites.

Bleaching Powder

Calcium hypochlorite is usually a white or grayish-white powder, but it is also available as tablets. It is a strong oxidizer and is considered more stable than sodium hypochlorite. It is also believed to provide more chlorine.

Sodium Hypochlorite

Sodium Hypochlorite is a greenish-yellow liquid commonly referred to as "Bleach." The chemical compound formula for Sodium Hypochlorite is NaOCl.Sodium Hypochlorite is prepared by reacting dilute caustic soda solution with liquid or gaseous chlorine, accompanied by cooling. It is used extensively as a bleaching agent in the textile, detergents, and paper and pulp industries.

The active ingredients in hypochlorite bleaches vary with pH. At pH <>2 is the main component in solution; at pH 4 to 6, HOCl is the dominant species; at pH > 9, OCl^- is the only component present. It is the hypochlorite ion in basic solution that is the active ingredient in household bleach, which is typically about 5 to 6 percent NaOCl. The OCl^- ion oxidizes chromophores in colored materials, and is itself reduced to chloride and hydroxide ions.

Hypochlorite Bleaching process

The conditions of the bleaching agent varies according to the result required, the concentration depends upon the fabric quality, degree of whiteness required, types of machine and next operation.

Quantity Required:-

Normally 2.5-3.0 gpl of available chlorine is sufficient for good bleaching , but it is necessary to optimize it on a possible lower value for safe bleaching process.

pH :-General PH range is 10-11 or 10.5-11.5 during bleaching if PH reaches 9 then it is a danger level and at 7 PH the bleaching is worse and causes extreme damage to the cloth.The PH value is maintained by adding sod ash or by buffering agent.

Temperature:-The suggested temperature for hypochlorite bleaching is 37-40oC. Generally reaction is accelerated with increases of temperature.

Water Quality:-water for bleaching should be soft and even hard water can be used but should be free from Cu++ and Fe++.

Effect of metals

The bleaching equipment should be made of stainless steel , to avoid the catalytic degradation of the cellulose in the presence of copper and iron.

Substrate preparation

The substrate must be pre scoured in the presence of chelating agents , it should be free from rust spots and traces of metallic impurities when bleaching with hypochlorites.

Bleaching Time :-The time factor depends upon the following consideration.

(a) Concentration.

(b) PH value.

(c) Degree of Whiteness.

(d) The type of machine used in bleaching.

Roughly for normal machine the time is 2-3 hrs is required for completion of bleaching process.

antichlor and proper neutralization treatments should be followed by proper wash for removal of reagents after hypochlorite bleaching process.

H_20_2 Bleaching Hydrogen peroxide was first used to bleach cotton in the 1920's. By the invention of the J-box which lead to continuous processing. Today, it is estimated that 90 to 95 % of all cotton and cotton/synthetic blends are bleached with hydrogen peroxide.

Mechanism Hydrogen peroxide is a weak acid and ionizes in water to form a hydrogen ion and a perhydroxyl ion. The perhydroxyl ion is the active Hydrogen peroxide can also decompose. This reaction is catalyzed by metal ions e.g. Cu++, Fe+++. This reaction is not desired in bleaching because it is an ineffective use of hydrogen peroxide and causes fiber damage.

Effect of pH At pH < 10, hydrogen peroxide is the major specie so it is inactive as a bleach. pH 10.2 to 10.7 is optimum for controlled bleaching. Sodium hydroxide is used to obtain the proper pH. At pH > 11, there is a rapid generation of perhydroxyl ions. When the pH reaches 11.8, all of the hydrogen peroxide is converted to perhydroxyl ions and bleaching is out of control.

StabilizersStabilizers must be added to the bleach solution to control the decomposition of hydrogen peroxide. Stabilizers function by providing buffering action to control the pH at the optimum level and to complex with trace metals which catalyze the degradation of the fibers. Stabilizers include sodium silicate, organic compounds and phosphates. **Sodium Silicates** Sodium silicates are the most commonly used and most effective hydrogen peroxide bleach stabilizers. silicates have a natural affinity for ferrous ions and ferrous ions are naturally present in cotton. The silicates are adsorbed onto the ferrous ions in the fiber, producing a species that catalytically enhances bleaching while reducing bleach decomposition and fiber damage.

Test For Degree of Bleaching Whiteness Index-CCM .Whiteness The standard ceramic tile is measured and set to equal 100. The other specimen are rated against this standard. Unbleached fabrics will give values in the 50 to 60 range. Well breached fabrics will rank 95 or better.

OPTICAL BRIGHTENERS Certain organic compounds possess the property of fluorescence which means that they can absorb shorter wave-length light and re-emit it at longer wave-lengths. A substance can adsorb invisible ultra-violet rays and re-emit them within the visible spectrum. Therefore a surface containing a fluorescent compound can emit more than the total amount of daylight that falls on it, giving an intensely brilliant white. Compounds that possess these properties are called Optical Brighteners or OBA's.

6.Mercerization This is the process applicable only on cellulosic fibres especially cotton. The main purpose of mercerization is to alter the chemical and physical properties of the fibre.

Effects: Change in cross section 1.Cross section of cotton before mercerisation 2-5 swelling process in 18% NaOH 66 Rinsing process after swelling 7 Final state Change in cross section

Mercirization /Causticization Both Mercerization and causticization require cotton to be treated with concentrated solutions of sodium hydroxide (caustic soda). Mercerization requires higher concentrations of caustic soda (19 to 26 % solutions) whereas causticization is done with concentrations ranging between 10 to 16%. One major difference between the two is that causticizing improves the dyeing uniformity and dye affinity of cotton without improving luster.

Procedure If cotton is dipped into a strong alkaline solution such as lithium hydroxide, caustic soda, or potassium hydroxide,The fibers will swell and shrink. If the fibers are placed under tension while in this swollen state and then rinsed with water, the alkali will be removed and a permanent silk-like luster will result.

Effect of alkali on cotton fibres

PHYSICAL CHANGE Improved in strength Improved in lusture (under tension) Change in cross section from bean shape to almost circular change in longitudinal view convoluted to cylinderical

Chemical change Improvement in moisture regain improvement in dye uptake Formation of celluloseIIThe cellulose is changed into hydro- cellulose or cellulose-hydrate. Cellulose cannot be dyed so easily. Hydro- cellulose on the other hand, absorbs almost any kind of dye readily. Mercerised cotton takes dyes so fast, that chemicals are added in the dye bath to check the process in order that the dyes may not enter so rapidly as to render the shading uneven.

CHAPTER 4. FIXATION AND AFTERTREATMENTS

Printing is an art. It is one kind of localized dyeing that is dyes or pigments are applied locally or discontinuously to produce various design on the fabric with a motif or motives in one or more colors. After printing of fabric, aftertreatment is very essential for fixation of dyestuff on fabric. In this article I will explain fixation methods after printing with disperse dyes

Fixation Methods After Printing:
After printing with disperse dyes the dyes is fixed on the fabric by one of the following dye- fixation methods, namely-

Thermo fixation

Super Heated Steaming

High Pressure Steaming

Now they are mentioned below:-

Thermofixation:
The features of this method of dye fixation are mentioned below:-

No steam is used.

Dye is fixed by subjecting the print to hot air at 2100C for 1 minute.

The fixation is carried out in a backing oven or in a stenter where heat setting can also be done simultaneously.

The process productivity is high.

The dye which have good sublimation fastness are subjected to this thermofixation process.

There is 10-15% loss of colour in thermofixation, so the shade becomes dull.

It is a continuous process of dye fixation which gives high production.

Super Heated Steaming :
The features of this method of dye fixation are mentioned below:-

It is a continuous process of dye fixation.

This method is the best of the three methods.

Dye is fixed at 1000-1800C for 2-1 minutes by radiators.

Higher productivity.

No loss of colour.

Dyes with medium sublimation fastness can be applied.

The fabric handle is very soft.

High Pressure Steaming:
The features of this method of dye fixation are mentioned below:-

Discontinuous process of dye fixation

Low productivity.

Dye fixation is done by high pressure steam.

Low production so costly process.

Dyes with low sublimation fastness can be applied.

It gives good Colour yield and bright print & smoothness.

Reduction Cleaning:
After the fabric is applied dye fixation method it is subjected to reduction cleaning process.
Reduction cleaning process is carried out for obtaining deep shade (>5%-15%)
For reduction cleaning a bath is prepared containing:-

Caustic Soda : 2 gm/litre

Hydrosulphite : 2 gm/litre

Na-ionic Datergent : 2 gm/litre

M : L Ratio : 1:5

Time : 30 Minutes

In the bath caustic soda and Hyd- rosulphite are taken for the stripping of dye and non-ionic detergents is taken for washing off. After passing the printed fabric through this bath then the fabric is washed off, by hot air & then with cold water.

Mechanism of Dye Fixation Processes in Fabric

Introduction:

If a typical textile print is washed soon after printing and drying, a substantial part of the colour is removed. An appropriate fixation step is therefore necessary. Complete fixation can rarely be achieved, however, and the removal of unfixed dye, thickening and auxiliary chemicals in a subsequent washing process is usually required.

The efficiency with which these processes of fixation and washing are carried out is vitally important, to both the quality and the cost of the prints. The proportion of faults in the final

product that are introduced at this stage can be disastrously high. The objective of this chapter is to direct attention to the details of the processes and the understanding of their mechanism

Steamers:
Printed dyes are usually fixed by steaming processes, the steam providing the moisture and rapid heating that brings about the transfer of dye molecules from the thickener film to the fibre within a reasonable time.

Historically, the process of developing printed mordants was known as 'ageing' and took a long time, as the term implies. Printed fabric was draped over poles and left in a room with a warm and humid atmosphere for some days, allowing the processes of diffusion and chemical reaction to occur. The term has been retained in use for steaming treatments, especially for short processes and machines; it has given rise to the descriptive, and euphonious, terms 'rapid ager' and 'flash ageing'. Some authors have attempted to distinguish between steaming and ageing (with steam). This can lead to confusion, so the two terms can be used interchangeably.

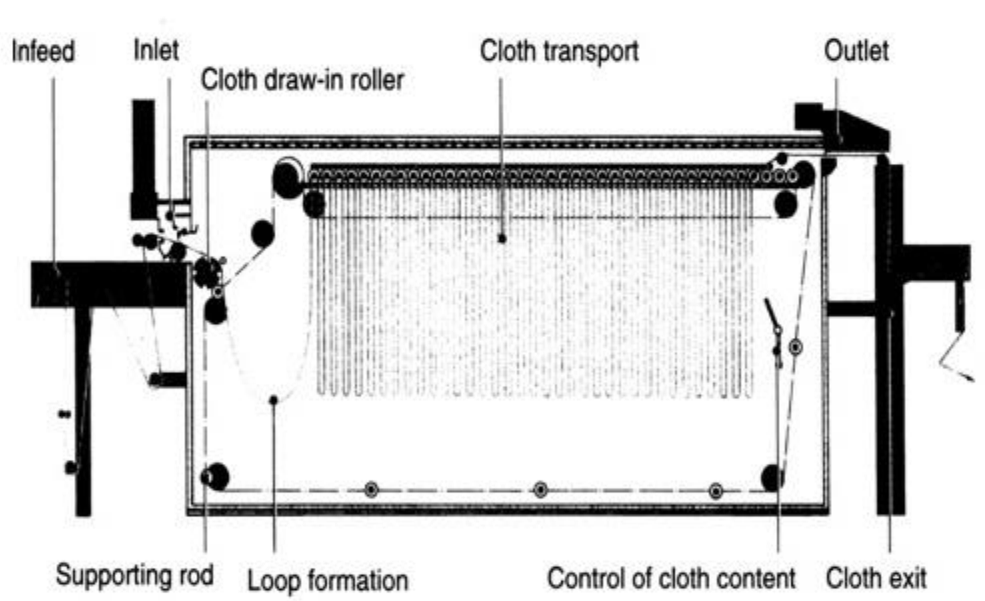
The time and conditions for fixation in steam vary with the properties of the dyes and fibres used, ranging from 10 s to 60 min in steam at 200 to 100 0C. Technical and economic factors have encouraged the use of higher temperatures and shorter times,and the change from batchwise to continuous processes. A constant feature in the design of all printing steamers, as distinct from steamers for other textile processes, is the need to prevent the marking-off of printed colour on to pale-coloured areas.

Batch Steamers:

For expensive fabrics and small quantities, there are obvious advantages in using lowcapacity steamers that can be quickly raised to their working temperature and that produce no creasing, stretching or other damage to the fabric. Batch steamers also show advantages when colour yields are improved by steaming at above-atmospheric pressure or for extended times, as in the case of deep colours on polyester fabrics. A successful design for such a **textile steamer** is shown as star or bell steamer. Up to 500 m of fabric is attached by hand, along one selvedge, to the hooks on a star-shaped carrier frame, to form a spirally wound load with a space of about 1 cm between the fabric 'layers'. An interleaved back-grey is used to eliminate all risk of marking-off, as the weight of the fabric and the uniformity of winding are unlikely to be adequate to prevent adjacent layers from touching. The steam chamber is a cylindrical pressure vessel, mounted vertically and closed at the top (hence likened to a bell) with a door that can be swung into position at its base. It is elevated because steam is lighter than air, so that with this arrangement the bell can remain filled with steam and either the star frame can be raised into the steam, or the bell lowered on to the star frame. Less air is taken in with the fabric, and the air is more easily displaced by steam, than in any other possible arrangement. The steam supply should be air-free and, ideally, dry but saturated. If there is significant superheat in the steam, a humidifier is used to increase its relative humidity.Wet steam is undesirable because splashes and drops of water inevitably cause local bleeding of dye or auxiliary chemicals.The older-style cottage steamers were often larger vessels into which the printedfabric on a carrier was wheeled horizontally. Substantial flow of steam is required to displace air from such a steamer.

Continuous Steamers:

A logical development of the ageing of prints while looped on rods led to the continuous transport of printed fabric in festoon steamers . Long loops areformed on rods, touching only the unprinted face, which are moved slowly along atrack near the top of a large steam chamber, constructed in brick or steel. The rods maybe slowly rotated to avoid bar marks due to non-uniform accessibility to steam. Withloops (festoons) of up to 5 m in length, long steaming times or high through put velocities can be achieved without the tension and mark-off problems associated with top and bottom carrying rollers. Several ingenious mechanisms for the formation of festoons of equal length are available. At the end of the steaming period, the fabric is withdrawn at the same high speed as at the entry point. A fabric content of overall though put speed of 80 m min–1 with a 10 min steaming time. Capacity can be doubled by introducing two layers of fabric, with an intermediate back-grey, if the printed area is not large. The larger the steamer dimensions and the more densely it is packed with fabric, the more difficult it will be to maintain uniform steaming conditions.



Festoon steamers

It is now considered essential to have fan-assisted circulation of steam. In older designs a flow of steam through a water tank at the base, which reduces the superheat of injected steam, to exhaust ducts in the heated roof was used to help to maintain uniformity and provided a valuable cooling effect. In most early festoon steamers, the fabric entry and exit were through slots in the roof, provided with heated roller seals. The seals could never be perfect and escaping steam, absorbed by the print, increased the mark-off from the printed surface to the sealing roller. A doctor blade was therefore required to clean the roller surface, before it again contacted the fabric. In modern equipment the fabric entry and exit ports are usually positioned in or near the base of the steam chamber, which reduces the sealing problem significantly (as steam is lighter than air).

Popular steamers made by Stork or Babcock have steam circulation arrangements whereby steam is extracted by fans from the base of the steamer, passed through heatable radiators, sprayed with water as needed, and forced through ducts to the top of the steamer, whence it passes down the folds to the bottom. In this way festoon steamers are increasingly being produced as universal steamers, so that any temperature between 100 and 200 0C may be employed. Since many knitted fabrics can be satisfactorily handled in festoon steamers, provided the loops are not too long, the term 'universal steamer' can in fact be justified.

Where the steaming time required is short (up to 2 min), more compact machines with fabric-carrying rollers have been used. The term 'Mather and Platt Roller Ager' was often applied to such steamers, in which the fabric path resembled that in a roller curing oven. With the increasingly important screen prints, which usually have more surface colour than engraved-roller prints, marking-off via the rollers became more probable. The Krostewitz steamer overcame this difficulty by adopting a spiral movement of fabric, using rollers that contacted only the back face of the print . At the centre of the spiral it is, of course, necessary to withdraw the fabric by rotating it into a normal plane so that it can be taken through a slot in the side wall.

This is achieved by passage around a stationary sword bar (rod) at an angle of 45 to 55 the fabric path. A double rotation of plane and a second, outward-moving, spiral allows fabric exit through the entry slot as in Steamers of this type, with a fabric content of 60 m, are used to give 30 s steaming at speeds of 120 m min–1, but are suitable only for stable, woven fabrics. Some of the carrying rollers must be driven, to prevent the build-up of high fabric tensions.

Double-spiral steamer (Krostewitz):
For steaming times of about 30 s, again without touching the print face until fixation is complete, an alternative fabric transport system has been used, where a compact arrangement is not essential. This is the rainbow or arch steamer.

An important application of either type of such flash agers has been in pad–steam(sometimes called two-phase) processes. Vat prints on cotton, for example, are efficiently fixed by application of alkali and reducing agent solution to the printed and dried fabric immediately before steaming. A thickener that gels on contact with alkali is required, and the time of contact between print and solution must be limited to avoid bleeding. The application of a minimum add-on of solution (about 30% on mass of fibre) using one of the 'MA techniques' can give higher visual colour yields than obtained by conventional padding . In the case of prints obtained with reactive dyes, the advantage can be even greater . For short steaming times at low running speeds, the simplest possible arrangement is a chimney or tower steamer, mounted above the pad mangle.

Mechanisms of Fixation Processes:
Is a stimulating review of dye-fixation processes, has pointed out that when buying and running process machines we must not forget that the fundamental requirement is the efficiency of the molecular processes. This is a necessary reminder when considering the mechanism of steaming processes, where we find easily overlooked, but significant, molecular phenomena. It is desirable, in the first place, to understand the properties of steam itself.

Steam:Terms and Properties:
Water vapour at 1000C and standard atmospheric pressure is known as saturated steam, and as dry saturated steam if it contains no droplets of liquid water. Steam at 1000C is very rarely found in a printworks, however, and the differences are significant.Boilersare designed to provide steam at pressures substantially above atmospheric pressure. This allows the use of smaller-diameter pipes to convey the substantial weights of water vapour from the boiler to the steamer and other steam-using machines.Saturated steam at 35 kPa above atmospheric pressure (5 lbf in–

2 gauge pressure) occupies three times the volume of the same mass of steam at 350 kPa. At pressures above atmospheric, water boils at a temperature above 100 0C, more heat is required to evaporate a given mass of water and the steam produced has a high temperature. The temperature of saturated steam at 350 kPa above atmospheric pressure is 1480C. Any cooling would produce condensation, and this is why steam at a certain pressure, and a temperature corresponding to the boiling point of water at that pressure, is known as saturated steam.

Saturated steam is often deliberately superheated in the boiler house, giving a gas which does not condense until it has given up its superheat. This ensures that steam pipes do not carry a significant volume of troublesome water. Superheat is also introduced when saturated steam is allowed to expand rapidly as it passes through a valve into a chamber at lower pressure. For example, steam at 700 kPa and 170 0C when allowed to expand at 70 kPa falls to 148 0C.

Dye Fixation in Steam:
Steam can be a convenient source of both water and heat as both are transferred rapidly and uniformly over the surface areas of printed fabric entering a steam chamber. As we have seen, however, steam may be wet or dry, saturated or superheated, and the conditions of use must be chosen and maintained.

The essential requirements in all print fixation processes using steam are:

1. The pick-up of enough water to swell the thickener film, but not so much as to cause the print to spread.
2. Dispersion and solution of the dye, and production of a liquid medium through which the dye can diffuse to the fibre surface.
3. Absorption of water by fibres such as cotton, nylon and wool, which must be swollen to allow penetration of dye.
4. Raising the temperature to a level that accelerates the processes of diffusion,especially into the fibre.

In some cases steam can satisfy all the requirements but, as in all coloration processes, auxiliary chemicals may be introduced to assist dye solution and diffusion, or to make the process less critically dependent on the maintenance of ideal conditions. In order to illustrate the phenomena that can occur during the steam fixation of prints, one of the most critical and best-studied processes is considered here in detail.

Vat Dye Prints (all-in process) on Cotton:
The insoluble vat dyes must be reduced to their soluble leuco forms, to allow diffusion into the fibre. A stabilised reducing agent, sodium formaldehyde sulphoxylate (CI **Reducing Agent** 2), is activated when the print temperature approaches 100 0C and reduction therefore occurs inside the steamer, the highly soluble potassium carbonate providing the required alkalinity. It has been shown that the vat dyes must be selected from those with aqueous leuco potentials smaller than –

920 mV. A typical paste formulation is shown in Recipe; the print would be dried rapidly, cooled and then steamed for 8–20 min in air-free steam, before rinsing, oxidising, soaping and drying.

The steaming stage was known to be critical, especially where the cover of the design was high. Difficulty was experienced in keeping the temperature of the steam below 103 0C, and dye fixation was reduced when the temperature rose above this level. The incorporation of glycerol in the print paste, to act as a humectant, improved the fixation. Thorough and rapid drying of the print was, however, found to be essential because the stability of the reducing agent in air under damp conditions was not satisfactory . In practice, after thorough drying a cooling procedure was necessary.In this discussion the steam conditions can be assumed to be ideal, that is, no droplets of liquid water are present, and that it has a temperature of 100 0C, with no superheat. When the dry print enters the steam, three exothermic reactions occur.

Recipe :

- Vat dye paste ....7 g
- Potassium carbonate............. 15 g
- CI Reducing Agent .... 2 8 g
- Glycero..................................l 5 g
- Thickener ....24 g
- Water 41
- Total .... 100 g

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In practice, after thorough drying a cooling procedure was necessary. In this discussion the steam conditions can be assumed to be ideal, that is, no droplets of liquid water are present, and that it has a temperature of 100 0C, with no superheat. When the dry print enters the steam, three exothermic reactions occur. Firstly, steam will immediately condense on the cold fabric, giving up its latent heat

Similarly, anhydrous potassium carbonate has a heat of solution of 27.6 kJ mol–1 (6600 cal mol–1), and the amount used in the print paste could provide up to 25 kJ kg–1 (6 cal g–1) fibre. The third reaction is the oxidation of active reducing agent (sulphoxylate ion) , which is strongly exothermic (+560 kJ mol–1).

HSO2– O→ HSO3

The air content of the steam should be kept low (less than 0.3%), but the required reduction of vat dye means the equivalent oxidation of sulphoxylate will occur and the production of heat is inevitable . If only 20% of the total sulphoxylate were oxidised in the early stages of the steaming process, about 50 kJ kg–1 (12 cal g–1) of dry fibre would be liberated.

It is clear, therefore, that a total heat input of about 85 kJ kg–1 (20 cal g–1), over and above the heat of condensation, is likely for a fabric of low moisture content and for 100% print cover. This could lead to a fabric temperature of 140 0C, but actual temperatures will not be so high because the exothermic reactions occur slowly and evaporation from the print and cooling by the surrounding steam also occur. Fabric temperatures of 115 0C have been recorded

The practical answer to the problem was the addition of glycerol and the use of the deliquescent potassium carbonate, rather than the cheaper sodium carbonate. Water absorption by the print paste is therefore substantially higher than by the cotton fibre, especially under adverse steam conditions. Some of the glycerol and carbonate will have entered the fibre, thereby increasing fibre swelling. Measurements of water content during steaming showed that a typical vat print paste film absorbed about 20% of water after 2 min and 30% after 10 min, under ideal steam conditions.

The steaming of any other class of printed fabric is less complex but may involve one or more of the interactions of physical and chemical factors discussed above. Forexample, nylon is very sensitive to superheat in the steam (which can arise from theheat of wetting of the fibre), lower colour yields being the consequence.

High-Temperature Steaming:

In some circumstances the use of superheated steam shows advantages of faster heating, shorter fixation time and less colour spread; this is the case if the print has not been dried and also in the pad–steam situation, where there is usually more than sufficient water in the fabric. The term high-temperature (HT) steaming, however, is normally restricted to the treatment of dry prints in superheated steam at temperatures substantially above 100 0C and at atmospheric pressure.

Lockett, the first to advocate this approach, showed that reactive dyes on cellulosic fibreswereefficiently fixed in 1 min in steam at 150 0C, provided that a suitable concentration of urea was included in the print paste . The same dyes might require 5 min in steam at 100 0C or in dry air at 150 0C. Reactive dyes can be of small molecular size and low substantivity, so that diffusion occurs more readily than in other dye–fibre interactions, but a liquid medium is required for transport and for chemical reaction. For fixation in dry air, it was known that urea was required to act as the liquid medium, providing good dye solubility both in the later stages of drying and at temperatures above its melting point (132 0C).

When a printed cotton fabric at 20 0C and 7% regain enters HT steam, the steam will rapidly give up its superheat and then condense on to the fibres. The amount of condensed steam will be similar to that for saturated steam (5.5% o.w.f.), the reduction due to the temperature rise before condensation being outweighed by the strong heat absorption (240 kJ kg–1, equivalent to 58 cal g–1) occurring as the urea goes into solution. If the print has provided 20% o.w.f. urea and 12.5% water is also present, the total liquid phase is substantial. A fraction will be retained by the thickener, but the major part will enter the cotton fibres, which can absorb 30% by mass of waterat200C.

The moisture content will then fall, as steam at 150 °C has only 20% RH and the equilibrium moisture content of pure cotton in this atmosphere is only 1%. Lockett pointed out that urea forms a eutectic mixture with water, however, and holds some water very tenaciously. The temperature of the dye–fibre system therefore rises rapidly to 100 0C, stays at that level as long as the loss of heat by evaporation is high, and then rises towards the temperature of the steam . Reaction between dye and fibre, therefore, proceeds efficiently because the fibre is swollen and molecules the diffusion of dye to ionised sites in the fibre can occur. Diffusion of the larger reactive dye into viscose rayon under these conditions is slow, however, and colour yields are often unsatisfactory. As reaction approaches completion the water content has dropped and the amount of dye–fibre bond hydrolysis may therefore be smaller than in saturated steam. The large amount of urea required adds to the cost of the process and some decomposition occurs, with the production of ammonia and biuret-type products.

Some reactive dyes give low colour yields under these conditions, perhaps as a result of reaction with ammonia and of loss of alkali. There is also a need to reduce the nitrogen level in effluents, and alternatives to urea have been sought . The controlled application of water, as a foam, before steaming may provide the ideal alternative .

The use of HT steaming for prints on polyester and polyester blend fabrics hasbecome extremely important because the only satisfactory alternative is the batchwise pressure-steaming method. Although continuous pressure steamers have been used (for continuous bleaching, for example), the difficulty of avoiding mark-off at the entry seal is so great that they have never successfully been employed for prints. Steaming at atmospheric pressure and 100 0C is possible if carriers are incorporated in the print paste, but colour yields are limited and only a few disperse dyes are suitable At a temperature of 180 0C it is possible to achieve satisfactory fixation of many disperse dyes in 1 min, as compared with 30 min pressure steaming at 120 0C or 1 min in dry air at 200 0C. With the increased availability of festoon steamers, longer times (5–20 min) at temperatures in the range 160–180 0C have been preferred. The presence of urea improves colour yields, but also increases the fixation of thickener and causes undesirable build-up of deposits in the steaming equipment. Urea can be substantially replaced by liquid ‘fixation accelerators', typically nonionic surface-active agents of high boiling point and low water solubility, in which disperse dyes are soluble at high temperatures.

To understand the mechanism of fixation, it is important to recognise that, for polyester/cellulosic blends, there are three steps:

- diffusion of dye through thickener film
- diffusion across a vapour gap
- diffusion into polyester fibre.

Comparison with the transfer print mechanism is clearly valid. The presence of steam probably has little effect on the passage across the gaps between fibres. It is in the diffusion through thickener films that the combined effect of condensed steam and liquid urea or other fixation accelerator will be important, both from within the thickener film to a surface where sublimation can occur and through the films surrounding polyester fibres. At a high temperature, such as 180 0C, this would be the slow step because the moisture content and thickener swelling would both be low. Lower temperatures and longer times allow the retention of more moisture and a better balance of diffusion rates in the three steps. Diffusion into the polyester fibre is faster in high-temperature steam than in dry air because of the increased molecular mobility.

Thermofixation:

The features of this method of dye fixation are mentioned below:

1. No steam is used.
2. Dye is fixed by subjecting the print to hot air at 2100C for 1 minute.
3. The fixation is carried out in a backing oven or in a stenter where heat setting can also be done simultaneously.
4.Theprocess productivity is high.
5. The dye which have good sublimation **fastness** are subjected to this thermofixation process.
6. There is 10-15% loss of colour in thermofixation, so the shade becomes dull.
7. It is a continuous process of dye fixation which gives high production.

CHAPTER 5. BLOCK PRINTING

BLOCK PRINTING

What is block printing?

Block printing is making use of a carved piece of wood or any other type of wooden block to imprint an image on fabric or paper. In the early days of printing, it was used to print entire books. Today the process of block printing is popularly associated with making designs on fabrics by printing on them, with the help of a block made for that purpose. Believed to have its origin in China, block printing has been in use around the world now, for quite some time.

Significance of Block Printing:

Block printing or hand block printing is popular on account of a number of contributing factors.

1. It has simplicity and ease of execution.

2. There is the sharpness, accuracy and fine detailing of prints made on the fabrics.

3. The huge possibilities of match and mix of different block designs in various colors on the same fabric as in large canvas fabrics like the saree and salwarkameez is stupendous. A large number of wooden blocks are always kept in readiness for use based on the intended patterns and designs.

4. Creating a new block with a new design is fairly quick and easy.

5. Blocks are of good quality wood and so they have durability. Metallic blocks are sometimes used but maneuverability limits their use compared to wooden blocks.

6. Intricate and sharp detailing for complicated designs can be etched out in the blocks which is possible only in these wooden blocks. Accessories like hair brushes are used for filling in the blank areas between outlines of the design.A point on the block serves as a guide for the repeat impression, so that the whole effect is continuous and not disjoint.

7. The extensive choice of colors make the designs vibrant and fresh-feel.

- Block prints and brush prints having been tried out successfully on fabrics like **cotton**, **silk**, and others

Brief historical data on block printing

There is archaeological evidence that an early form of block printing on textiles existed in India as far back as 3000 BCE, during the period of the ancient Indus Valley Civilisation. It was not until the 12th century that the traditional art of **block printing** began to flourish. The states of **Gujarat** and **Rajasthan** are particularly renowned for manufacturing and exporting magnificent **printed cotton** fabrics. The art is not traditional to eastern India and was introduced to **West Bengal** in the 1940s. Highly skilled local craftsmen quickly mastered the textile art form.

Today, as in the past, the main hubs for the manufacture and export of block printed fabrics and garments are Ahmedabad, Surat and the Kutch district in Gujarat and Jaipur, Bagru and the Barmer district in Rajasthan. Today, Serampore city in West Bengal continues to be prominent in the production of block **printed silk sarees** and fabrics. As in the 20th century, motifs and patterns from West Bengal are market driven, thus block printing from this state is young. West Bengali block printed patterns adapt to contemporary fashion trends while Gujarati and Rajasthani block printed patterns perpetuate its tradtional motifs.

Block printing is a form of textile art that diffuses itself into thriving cultures, at the same time enriching them. In the 17th century, the Mughal Emperor Shah Jahan and his court were widely known for their love of the arts. This gave motifs in block printing visibility to a wider audience in and outside of India. The British were in India from the early 17th century and were receptive to native culture even before the Raj formally came into being in the mid 19th century. This popularised many floral and vegetal motifs, such as birds and the famous Paisley, or boteh or buta, design that can still be seen in contemporary motifs.

Two centuries later, from the mid 1800s, the British Raj led designers from Britain to draw inspiration from these traditional Indian motifs. Thus the widely adored Paisley pattern became embedded into the culture and history of the Scottish town of Paisley, an established hub of the British textile and weaving industry which were ‘Cottage Industries' before the rise of the Industrial Revolution. The states of Gujarat and Rajasthan are regarded as the birthplace of Indian block printing and traditional techniques that are still used in the contemporary designs and colours.

Types of Blocks and their Making:

1. **Wooden Blocks**
2. **Metal Blocks:**
   - **A) Pin Blocks**
   - **B) Strip Blocks**
   - **C) Castings**

Preparation of wooden blocks

The heart of hand block prints lies in the wooden blocks created for the purpose.

Selection of Wood: Woodblocks for textile printing are made of box, lime, holly, sycamore, plane or pear wood, the latter three being most generally employed. They vary in size considerably, but are mostly between two and three inches thick, otherwise they are liable to warping. Warping is additionally guarded against by backing the wood chosen with two or more pieces of cheaper wood, such as deal or pine.

Printing Blocks

The several pieces or blocks are tongued and grooved to fit each other, and are then securely glued together, under pressure, into one solid block with the grain of each alternate piece running in a different direction. The block, being planned is quite smooth and perfectly flat.

Next the design is drawn upon, or transferred to it. This latter is effected by rubbing off, upon its flat surface, a tracing in lamp black and oil, of the outlines of the masses of the design. The portions to be left in relief are then tinted, between their outlines, by ammoniacal carmine or magenta, for the purpose of distinguishing them from those portions that have to be cut away.

As a separate block is required for each distinct colour in the design, a separate tracing must be made of each and transferred (or put on as it a termed) to its own special block. Having thus received a tracing of the pattern, the block is thoroughly damped and kept in this condition by being covered with wet cloths during the whole process of cutting. The block cutter commences by carving out the wood around the heavier masses first, leaving the finer and more delicate work until the last so as to avoid any risk of injuring it during the cutting of the coarser parts.

Color Blocks:

When large masses of colour occur in a pattern, the corresponding parts on the block are usually cut in outline, the object being filled in between the outlines with felt, which not only absorbs the colour better, but gives a much more even impression than it is possible to obtain with a large surface of wood. When finished, the block presents the appearance of flat relief carving, the design standing out like letterpress type.

Block Carving

Metal Blocks:

Making of Strip Block and Castings:

Fine details are very difficult to cut in wood, and, even when successfully cut, wear down very rapidly or break off in printing. They are therefore almost invariably built up in strips of brass or copper, bent to shape and driven edgewise into the flat surface of the block. This method is known as coppering, and by its means many delicate little forms, such as stars, rosettes and fine spots can be printed, which would otherwise be quite impossible to produce by hand or machine block printing.

In this case the metal strips are driven to a predetermined depth into the face of a piece of lime-wood cut across the grain, and, when the whole design is completed in this way, the block is placed, metal face downwards in a tray of molten type-metal or solder, which transmits sufficient heat to the inserted portions of the strips of copper to enable them to carbonize the wood immediately in contact with them and, at the same time, firmly attaches itself to the outstanding portions.

When cold, a slight tap with a hammer on the back of the lime wood block easily detaches the cake of the type-metal or alloy and along with it, of course, the strips of copper to which it is firmly soldered, leaving a matrix, or mold, in wood of the original design.

The casting is made in an alloy of low melting-point, anti, after cooling, is filed or ground until all its projections are of the same height and perfectly smooth, after which it is screwed onto a wooden support and is ready for printing. Similar molds are also made by burning out the lines of the pattern with a red-hot steel punch, capable of being raised or lowered at will, and under which the block is moved about by hand along the lines of the pattern.

They are two to three inches thick, of different sizes and re-inforced by two or more wood pieces of deal or pine. The fabric for the prints is laid out on flat tables and the hand block printing done.

Earlier dyes used were natural and vegetable colours. But today with synthetic dyes easily available, much cheaper comparatively and easy in usage, they are widely preferred.

Very small detailing can be etched and preserved in the block by special provisions. So small stars and very minute designs otherwise not possible, are available for the beautification of the fabric. Flowers, fruits, trees, birds, geometrical designs and figurative patterns are some of the popular motifs in block printed sarees.

Equipments required for Block Printing:

1. **Engraved Blocks**
2. **Printing Table**
3. **Color Sieve or Tray**

In addition to the engraved block, a printing table and colour sieve are required.

Printing Table:

The table consists of a stout framework of wood or iron supporting a thick slab of stone varying in size according to the width of cloth to be printed. Over the stone table top a thick piece of woolen printers blanket is tightly stretched to supply the elasticity necessary to give the block every chance of making a good impression on the cloth.

At one end, the table is provided with a couple of iron brackets to carry the roll of cloth to be printed and, at the other, a series of guide rollers, extending to the ceiling, are arranged for the purpose of suspending and drying the newly printed goods.

Colour Sieve:

The colour sieve consists of a tub (known as the swimming tub) half filled with starch paste, On the surface of which floats a frame covered at the bottom with a tightly stretched piece Of mackintosh or oiled calico. On this the colour sieve proper, a frame similar to, the last but covered with fine woolen cloth, is placed, and forms when in position a sort of elastic colour trough over the bottom of which the colour is spread evenly with a brush.

Steps of Block Printing:

1. Spreading the cloth: The printing commences by drawing a length of cloth, from the roll, over the table, and marks it with a piece of colored chalk and a ruler to indicate where the first impression of the block is to be applied.
2. Charging of block
3. Registration: He then applies his block in two different directions to the colour on the sieve and finally presses it firmly and steadily on the cloth, ensuring a good impression by striking it smartly on the back with a wooden mallet.

   The second impression is made in the same way, the printer taking care to see that it fits exactly to the first, a point which he can make sure of by means of the pins with which the blocks are provided at each corner and which are arranged in such a way that when those at the right side or at the top of the block fall upon those at the left side or the bottom of the previous impression the two printings join up exactly and continue the pattern without a break.

4. Each succeeding impression is made in precisely the same manner until the length of cloth on the table is fully printed. When this is done it is wound over the drying rollers, thus bringing forward a fresh length to be treated similarly.
5. If the pattern contains several colors the cloth is usually first printed throughout with one, then dried, re-wound and printed with the second, the same operations being repeated until all the colors are printed.

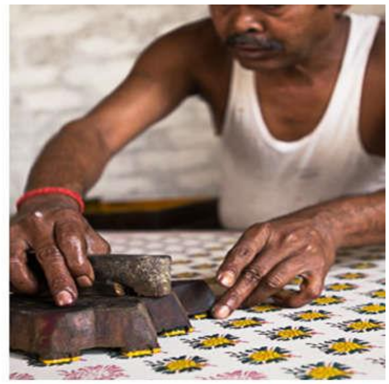
BLOCK PRINTING PROCESS -1

BLOCK PRINTING

- The main tools of the printer are wooden blocks in different shapes and sizes called bunta.

- The underside of the block has the design etched on it. Each block has a wooden handle and two to three cylindrical holes drilled into the block for free air passage and also to allow release of excess printing paste.

- The new blocks are soaked in oil for 10-15 days to soften the grains in the timber.

Hand Block Printing

Wooden trolleys with racks have castor wheels fastened to their legs to facilitate free movement. The printer drags it along as he works. On the upper most shelf trays of dye are placed. On the lower shelves printing blocks are kept ready.

- The fabric to be printed is washed free of starch and soft bleached if the natural grey of the fabric is not desired. If dyeing is required as in the case of saris, where borders, or the body is tied and dyed, it is done before printing.

- The fabric is stretched over the printing table and fastened with small pins (in the case of sarees the pallu is printed first then the border).

- The printing starts from left to right. The color is evened out in the tray with a wedge of wood and the block dipped into the outline color (usually black or a dark color). When the block is applied to the fabric, it is slammed hard with the fist on the back of the handle so that a good impression may register.

A point on the block serves as a guide for the repeat impression, so that the whole effect is continuous and not disjoined.

- The outline printer is usually an expert because he is the one who leads the process. If it is a multiple color design the second printer dips his block in color again using the point or guide for a perfect registration to fill in the color. The third color if existent follows likewise.

- Skill is necessary for good printing since the colors need to dovetail into the design to make it a composite whole. A single color design can be executed faster, a double color takes more time and multiple color design would mean additional labor and more color consumption.

- Different dyes are used for **silk** and **cotton**. Rapid fast dyes, indigo sol and pigment dyes are cotton dyes. Printing with rapid dyes is a little more complicated as the dyes once mixed for printing have to be used the same day.

Standard colors are black, red, orange, brown and mustard. Color variation is a little difficult and while printing it is not possible to gauge the quality or depth of color, it is only after the fabric is processed with an acid wash that the final color is established.

BLOCK PRINTING PROCESS -2

BLOCK PRINTING

- Beautiful greens and pinks are possible with indigo sol colors but pigment colors are widely popular today because the process is simple, the mixed colors can be stored for a period of time, subtle nuances of colors are possible, and new shades evolve with the mixing of two or three colors. Also the colors are visible as one prints and do not change after processing.

Colors can be tested before printing by merely applying it onto the fabric. The pigment color is made up of tiny particles, which do not dissolve entirely and hence are deposited on the cloth surface while rapid dyes and indigo sols penetrate the cloth.

- Pigment colors are mixed with kerosene and a binder. The consistency should be just right, for if it is too thick it gives a raised effect on the material, which spoils the design. Small plastic buckets with lids are ideal for storing the mixed colors over a few days.

- **Cotton sarees** after pigment printing are dried out in the sun. This is part of the fixing process.They are rolled in wads of newspapers to prevent the dye form adhering to other layers and steamed in boilers constructed for the purpose.

- **Silks** are also steamed this way after printing. After steaming, the material is washed thoroughly in large quantities of water and dried in the sun, after which it is finished by ironing out single layers, which fix the color permanently.

- The printer commences by drawing a length of cloth, from the roll, over the table, and marks it with a piece of coloured chalk and a ruler to indicate where the first impression of the block is to be applied.

- She then applies the block in two different directions to the colour on the sieve and finally presses it firmly and steadily on the cloth, ensuring a good impression by striking it smartly on the back with a wooden mallet.

- The second impression is made in the same way, the printer taking care to see that it fits exactly to the first, a point which he can make sure of by means of the pins with which the blocks are provided at each corner and which are arranged in such a way that when those at the right side or at the top of the block fall upon those at the left side or the bottom of the previous impression the two printings join up exactly and continue the pattern without a break.

Each succeeding impression is made in precisely the same manner until the length of cloth on the table is fully printed. When this is done it is wound over the drying rollers, thus bringing forward a fresh length to be treated similarly.

- If the pattern contains several colours the cloth is usually first printed throughout with one, then dried, re-wound and printed with the second, the same operations being repeated until all the colours are printed.

b) Direct block printing is a method of bleaching and dyeing the fabric. Colourful, vibrant designs are then printed onto the dyed fabric using carved wooden blocks. This method is practiced on silk and cotton fabrics, though block printing is mostly done on the latter.

c) Mud-resist or dabu printing is commonly associated with block printing from Rajasthan and Paithapur families of **Gujarat**. This method makes use of wooden blocks to apply a resist made of resin and clay or wax. The fabric can be said to be dyed in reverse; when the entire fabric is dyed, motifs created by the wooden blocks do not take on dye due to the resist.

Regardless of the printing technique the dyed fabric is treated again before being dried in the sun and later washed to remove excess dye. It is then wrapped in newspaper to protect the dye and steamed in special boilers before being dried in the sun again. Such production techniques ensure the pigments remain rich and colourful.

BLOCK PRINTING

ADVANTAGES

1. Simple method of printing
2. No expensive equipment required
3. No limitation in repeat of size of style
4. Prints produced have great decorative value and stamp of craftsmanship

DISADVANTAGES

1. Involves much manual work
2. Method is slow and therefore low output
3. Good skilled labors needed for multi color design
4. Fine and delicate designs hard to produce

CHAPTER 6 STENCIL AND SCREEN PRINTING

STENCIL PRINTING:

INTRODUCTION

Stencil making involves cutting a design through a thin sheet and then transferring colour on to the surface to be printed through the cut out of the design. Printing with the help of stencils is one of the basic fabric ornamentation techniques. This is an art through which designing, printing and decoration can be experimented on different materials apart from fabrics. In this chapter, you will learn about the technique of making stencils and equipments required for it.

Historical Background Stenciling technique is an ancient art which is said to have started in China and Japan, and was one of the widely used methods of printing. North Americans were amongst the first to start ways by which the stencils could be used in home decoration. 3 In the 18th century, American wallpaper was considered to be a luxury which only the wealthy could afford. However, the people soon found out that with a little imagination and patience, and by repeating the same motif again and again they could achieve a uniform overall pattern just as good as the one produced by fine printing techniques. The origin of this technique in India can be traced to the Gupta period (6th to 8th century) though even before the Gupta period, this process was used in the execution of paintings.

INTRODUCTION TO STENCIL MAKING AND PRINTING :

The process of Stencil making and printing with the stencil is the first step to modern screen printing technique which is described in Unit 5 (Lessons 13, 14 & 15) of this course. In this lesson you will be introduced to the stencil making and stencil printing processes: The next two lessons will deal with stencil cutting and printing with stencils in greater detail. 7.0 Objectives After going through this lesson you will be able to: • Understand the basics of stencil making and stencil printing technique • Describe the tools and materials used for stencil making and stencil printing. • Select designs for stencil printing and transfer them to the stencil • Explain how further value addition could be done to a stenciled piece of work. • Carry out stencil printing on different objects.

The Stencil Making and Printing Processes

The stencil making and printing processes proceed as follows: 1. Selection of an appropriate design. 2. Transfer of the design on to the stencil material. 3. Cutting of the stencil. 4. Painting through the stencil on to the fabric. 5. Cleaning up of the stencil and brushes.

Advantages

a.Cheap
b.Little training is required
c.Adaptable
d.Various colors can be used

Disadvantages

a. Poor quality
b. Mass production is difficult
c. It may pollute the environment

Screen Printing:

inkjet technology. Inkjet printing on fabric is also possible with an inkjet printer by using fabric sheets with a removable paper backing. Today major inkjet technology manufacturers can offer specialized products designed for direct printing on textiles, not only for sampling but also for bulk production.

What is Screen Printing?

Screen printing is the most multipurpose process among all the printing processes. It is utilized on different mediums of substances like paper, paper board, metals, fabrics, and numerous other substances like plastics, glass, nylon and even cotton. The products produced as finished goods from the printing press include a wide range of products like posters, labels, signage and all types of textiles and electronic boards.

Screen Printing Process

- Hand screen.
- Semi-automatic flat screen.
- Rotary Screen.

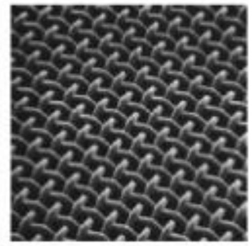
Screens

- Made of cotton, silk, nylon cloth, polyester or metal gauze
- Screen mesh refers to the number of threads per inch of fabric. The more numerous the threads per inch the finer the screen.
- The usual mesh of screen employed for cotton and silk printing is 80 threads per inch.
- The finer the screen the sharper are the outlines but more effort is needed to force the printing paste through the screen.

Screen Frames

- There are two types of screen frames, metal and wood.
- Screen frames for commercial use are usually made of steel, or a lighter metal, with a hollow cross section to provide rigidity with minimum weight.
- Screen frames are usually 26" x 55" (measured externally) and 23" x 52" (measured internally) for printing 45" wide cloth

Screen Fabric



There are two types of threads for screen fabric:

- Monofilament - single strands weaved into fabric

- Primarily used in commercial printing and other applications
- Advantage: Monofilament is easier to clean than multifilament

- Multifilament - multiple strands wound together like a rope, then weaved into fabric.

- Primarily used in textile printing.
- Disadvantage: ink tends to build up on screen, more difficult to clean. Monofilament mesh has become the industry standard.

Screen Fabric Types

1) ***Silk - multifilament weave***

- loses toughness with frequent use
- reclaiming chemicals containing bleach or chlorinated solvents destroy the silk
- Today silk is primarily used for printing art, not commercial use as before

2) ***Nylon - multifilament or monofilament***

- good for stretching
- compared to polyester, lacks stability
- less rigid than polyester
- unsuitable for closely registered colors

3) ***Polyester - multifilament or monofilament (calendared monofilament polyester, metallized monofilament polyester)***

- primary material used in commercial screen printing
- Polyester is strong and stable when stretched

4) ***Other screen materials - carbonized polyester***

- glass

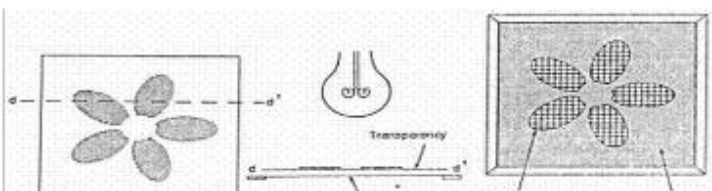
- wire mesh
- stainless steel

Screen Preparation

Photochemical method is most widely used for preparing the screen. This is based on the principle that when a coating of a solution of ammonium dichromate-gelatine or ammonium dichromate-polyvinyl alcohol is dried and exposed to light, Insolubilisation takes place Other method for screen preparation is lacquer and laser screen.

Photochemical method

- Coat the flat screen with light-sensitive polymer, and dry it in the dark.
- Position a positive transparency of the pattern on the polymer-coated screen.
- Expose the screen to ultraviolet light. Ultraviolet light rays pass through the transparent (non-pattern) areas of the transparency on to the screen and harden the polymer.
- Wash the screen in warm water to remove the polymer from the unexposed (pattern) areas of the screen through which the printing paste will pass.
- Dry the screen



(a) Positive transparency of pattern (b) Light exposure (c) Photo patterned screen

Preparation of Sensitising solution

Sensitising solution may be prepared as follows:

(1) Chrome-Gelatine Solution

Solution A: 200 g Pure gelatin

500 g Boiling water

Total 700 g

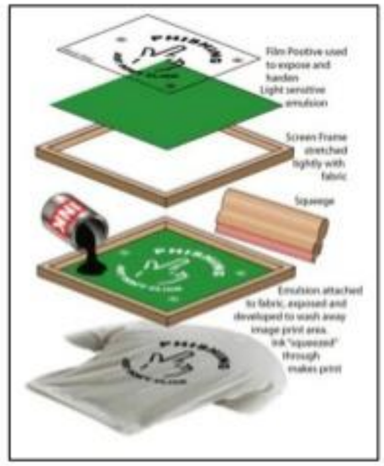
Solution B: 70 g Ammonium dichromate

150 g Boiling water

80 g Liquor Ammonia

Total 300 g

Solution A and Solution B are mixed in a dark room.



(2) Chrome-Polyvinyl Alcohol Solution

600 g polyvinyl alcohol (15% solution)

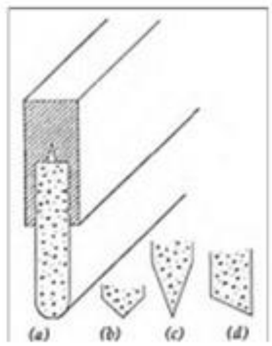
120 ml Ammonium dichromate (33% solution)

240 ml Cold water

1 litre with cold water

Squeegee system

- Rubber Squeegee
- Double Squeegee
- Magnetic rod Squeegee



1) Rubber Squeegee

- These vary in Shore hardness from 55 (soft) to 70 (hard). Softer blades give a heavier print. The edge shape of the rubber blades is chosen to suit requirements.
- Round ones [Figure (a)] suit, for example, wool and fleece fabrics, where a heavy print is needed to penetrate the fibrous surface.
- Long, tapered edges [Figure (c)] are used when penetration is not important as on flat and woven fabrics.
- The stubby edge [Figure (b)] is good for one-stroke printing on interlock. The chisel shape
- [Figure (d)] is used to flood the screen with printing paste while the screen is raised in preparation for the print stroke when only one print stroke is to be used.

Various Equipments used in Hand Screen Printing

1. **Screen Printing Table**
2. **Squeezee**
3. **Screens**

Screen Printing Table

All the three have been already explained one by one.

Screen Printing Process:

Textile table printing process or hand printing process

Textile table printing or hand printing process is a part of textile industry. The manual process used to print a roll of cloth with the help of manpower on the wax table is called is textile table printing process.

Textile table printing is done on a 45 meter to 75meter long table which is coated with wax . The wax is applied on that long 45 meter to 75 meter table. The purpose of applying wax on that is to hold that cloth which is to be printed. Wax act as a glue for that cloth so that the cloth remain stretched on that table and the priniting process can be done easily and accurately on that.

Textile hand printing involves a careful examination of what is to be done on a roll of cloth and when it is to be done. Hand printing process is very much dependent on the climatic and weather condition. This is so because it is mostly done under the unfinished or raw roof, because it requires sunlight to absorb colour and make it dry within a time interval.

The total production capacity of hand printing process ranges from 1500 meters to 3000 meters per day. The reason of low production capacity is due to the involvement of hand process. As it is totally a labour oriented work.

Factors affecting Screen Printing:

The table printing or hand printing process includes the following

1. **The design to be printed** : the very first process includes the design to be printed on the roll of cloth, which means the total number of colour to be used in that particular design. Whether the design is of printed scarves, ladies scraf, printed pareo, etc.
2. **Metal frame or screen**: the very next step is the development of the screen. The screen is made of metal fram with a thin layered fabric in the center on which the design is made. The development of the screen depends on the number of colour in the design. For example if the total number of colour is 5 in a particular design then a separate screen is made for an individual colour so 5 screens are made for a 5 design colour.
3. **Fabric to be used:** the fabric to be used. There are plenty of fabric in the field of textile. It may be cotton printed, viscose printed, camric printed, twill printed, chiffon printed, georgette printed, saton, voil, etc. The fabric decision is made by the buyer and he only decides which fabric he or she wants for this particular production.
4. **Chemicals used: :** the colour and chemical plays an important role in the production process. This process needs a very careful and detailed examination of the chemical to be used. As a point mistake can change the overall presentation. There is a separate staff for this process who keep on working to provide a exact and accurate level of the printing design.

5. **Silicate process:** the next step is of silicate processing. This process is done to make the printed cloth colour fastness. Which means after passing through this silicate process the colour of the cloth gets fastened and which remains intact after use. This process makes the colour of the cloth permanent.
6. **Washing and drying:** after silicate process the cloth is kept in a tank of water for more that 6 to 12 hours and after that the cloth is washed so that the silicate layer wahses off and the colour gets brightened. After wahsing the cloth is then dryed with the help of machine or in the sunlight.
7. **Finishing :** after the step no. 6 the cloth is sent in the felt unit. Felt unit is one where the cloth gets finished and the wrinkles gets off the fabric. The felt process is machinery oriented. The range of felt machine is divided into segments like zero felt, gotta felt, etc. These segements are used according to the buyer demand.
8. **Meterage :** the next process is of meterage that is measuring. This process involves the measurement of the cloth in terms of meter unit. This is done manually.
9. **Packing &dispatch :** the last and final process is of packing. Packing is normally done in poly bag and then in a carton as a master packing. The packed goods are then dispatched at their particular destination.

Faults/Defects/Problems, Causes and Remedies of Screen Printing

Faults/Defects/Problems in Screen Printing:

Major problems/faults/defects of screen printing are pointed out below:

1. Choking of screens
2. Misfitting of the design
3. Stains
4. Conveyor stain
5. Blanket stain
6. Misprint or no print on selvedge
7. Design not washed out properly
8. Slippage on the cloth
9. Pinholes
10. Pilling of the lacquer

11. Placement
12. Consistency of placement
13. Colour correctness
14. Colour consistency
15. Colour smear
16. Dye migration
17. Scorching
18. Improper curing
19. Fibrillation or frosting
20. Fibrillation or frosting
21. Distortion
22. Opacity
23. Poor wash fastness
24. Registration
25. Hand
26. Colour out
27. Scrimps

Causes and Remedies of Screen Printing Defects:

Choking of screens: High viscosity of printing paste, improper profile of squeeze blades, improper cleaning of screens, deposition of thickening agent under or over the screens and frequent stoppages of printing are the normal reasons for choking of screens.

Misfitting of the design: Improper tension of screens, worn out thermoplastic coating, deviations in blanket guide controlling system, loose end rings, and pressure roll not working, insufficient quantity of colour in the screen, defective working of printing head, magnetic clamps and inadequate temperature are the normal reasons for misfit of the design.

Stains: Stains on the garment can be caused by a variety of factors. The printer could get a little over zealous about his inking or the folders could have a Java disaster or the mill could leak a bit of machine oil during the sewing process. Stains are clear defects and the printer should be informed about even subtle discolouration on the garment. The solutions include good work practices, wiping the machine and floor thoroughly after oiling, ensuring that workers keep their hands clean, using of dry lubricants wherever feasible, keeping the work area always clean and covering the materials with clean covers.

Conveyor stain: Improper drying, improper cleaning of conveyor, improper speed synchronisation between the machines and the dryer, uncleaned nozzles and strainers are the normal reasons for this defect.

Blanket stain: Failure of water supply or the washer pump, uneven thermoplastic coating or lines on thermoplastic are the normal reasons for this defect.

Misprint or no print on selvedge: Improper setting, defective guiders, and uneven width of the fabric at stitches are the reasons for misprint on selvedge.

Design not washed out properly: Positive permeable to light rays, too warm a drying before exposure, insufficient contact pressure, too long a delay before exposure, copying emulsion too cold and exposure time too long are the reasons for design not getting washed out properly.

Slippage on the cloth: Frames not properly roughened, adhesive not evenly applied causing bubbles on the surface and cloth strip not applied properly to avoid water or colour penetration.

Pinholes: They are tiny breaks in the emulsion that coats the screen and appear as small dots of ink where there ought not to be any. They can be removed, (except in garment dyed shirts), with a spotting gun. Unfiltered photo emulsion in use, dust in the working area, insufficient light source and low concentration of hardener are the normal reasons for pinholes. Verify the screen thoroughly beforetaking it for printing.

Pilling of the lacquer: Too thick an emulsion coating, improper degreasing and wrong proportion of hardener are the normal reasons for this defect.

Placement: There are general rules for placement of an image on a garment, but since all garments are of varying dimension and proportion, exact placement can be a judgment call. It also depends on the size and shape of the image itself. The rules of thumb are; full front- 3-4 inches down from the collar, full Back- 4-6 inches down from the collar and left chest-bottom aligned with bottom seam of sleeve. All of these are general rules, however, in the end the decision on the part of the printer considering aesthetic look is important. If there is an intended placement that deviates significantly from the above guidelines then one should make it clear to the customer before printing. A normal practice is taking a photocopy of the image at full size and sticking it onto the shirt to see how it looks. If you determine that it needs to have an unusual placement then send your 'mock-up' to the printer.

Consistency of placement: Minor deviations are found in the placement from shirt to shirt. The printer generally loads the shirt onto the platen the same way every time but shirts can be quiteirregular dimensionally. Hence often the printer must make a judgment. If you have exceedingly specific criteria for placement consistency you should make this clear from the outset.

Colour correctness: Because the gamut for process printing on garments is much smaller than most other printing methods colours do not match exactly. A carefully engineered separation and a skilled inker should be able to deliver a pleasing print that captures the essence of the range of tones and the levels of contrast in the original. Often touch plates are used to achieve colours that are out of range. Process printing on dyed shirts yields a much narrower range than on white shirts. For spot printing the range of colours is similar to offset. Specifying colours from any of the standard matching systems, including pantone, focoltone and trumatch shall help the printer. It also helps if their ink department and print areas have a good graphic standard 5000k light source to match colours.

Colour consistency: Maintaining colour consistency in halftone printing is a challenge. Hues in process are determined by the proportional densities of the 4 process colours. These proportions can be disrupted by many factors that determine the amount of ink flowing through a particular screen. The most common cause is uneven level of platens which changes the critical off contact distance, often causing a visible shift in the hues. Process colours are difficult to match from run to run if all of the critical variables are not recorded and controlled. The tools necessary to control this myriad ofinterrelated parameters are not standard equipment in the vast majority of screen print shops. The absence of tools such as deltascopes, colorimeters, off contact gauges, and print pressure meters willindicate to the prospective shirt buyer that the shop may not be capable of the consistency. The solution include colour matching from run to run by employing a structured colour matching system, presence ofa quality digital scale and a catalogue of achievable ink colours.

Colour smear: In printing the colour gets smeared by distorted patterns. Proper colour paste, applying required pressure while printing and avoiding lateral movement of screens while placing onfabric for printing or removing after printing can prevent this problem.

Dye migration: This is an effect generally seen on shirts containing polyester. Since the dyes used for garments don’t readily bind themselves to polyester fibres the colour can affect the printed area. This effect can be seen immediately after curing or can appear weeks after. Red shirts with white ink are the most notorious for this effect but many other combinations can also give trouble. Selection of dyes compatible with polyester and strictly adhering to process parameters and timings is very important.

Scorching: Scorching is caused by improper heating of the shirt between colours on press in the flashing stage or in the main dryer during curing. Scorching can evidence itself in a range of hues, fromalmost undetectable yellow to a Cajun blackened. Plastisol inks are the most durable but require heat to cure. Large areas of yellow or brown as well as brittle fibres are indications of a scorched shirt. Adelicate balance of temperature and time to properly gel or cure the inks is to be made and if diligent measurements are not taken shirts can be easily torched. Occasionally, this phenomenon can be caused by sizing left in the shirts from the mill. Under normal curing conditions this sizing can create a light, yellowish cast.

Improper curing: Improper curing can be seen as inks loose much of their vibrancy or opacity after washing. This should not be confused with fibrillation. One of the most carefully monitored factors in screen printing with plastsols is the curing process. The ink must reach a certain temperature to completely cure.

Fibrillation or frosting: This effect occurs on light shirts and is often confused with improper curing. The effect is visible on prints employing transparent inks using the whiteness of the shirt to achieve certain bright hues. When these inks are washed the lack of a heavy plastic coating allows some of the unprinted fibres to break through the ink layer and dull out or "frost" the image. This has recently become more of an issue as market is demanding heavier weight shirts that feel smoother. The fibres in these super heavyweight garments are the most susceptible to this effect. Process printing isvulnerable to frosting as all of the inks used, except black, are transparent. Adhering strictly to the process as designed while developing the sample, and training the people adequately is very important to avoid this problem.

Distortion: The flexible nature of fabric can yield a distorted image if not loaded correctly. The adhesive that is used to hold the panel on the platen can catch part of the garment when it is being loaded and pull it out of shape. There are loading techniques that can alleviate this effect but certain shaped prints, such as hard geometric boxes, will show distortion much more than others. Training the operators adequately is the solution for this problem.

Opacity: There is no specific benchmark for opacity. In halftone printing it is especially problematic to balance dot gain and opacity considerations. On light shirts one should not be able to see the weavepattern of the shirt thorough the ink, even under minor stretching. On dark shirts the problem is compounded by the need to cover the shirt colour with a thick enough layer of opaque lighter colourswithout making the shirt stiff. In most cases the level of acceptability is a judgment and one should know poor coverage when seen. The solutions include training the operators adequately and educating thecustomers on basic concepts can reduce the grumbling.

Poor wash fastness: Improper curing of ink leads to poor wash fastness. Adhering strictly to the process as designed while developing the sample, and training the people adequately is essential toovercome this problem.

Registration: The registration tolerances of the various presses used by screen printers range wildly. Any gap between colours that are visible from more than a foot or two away are generally not accepted. A well trained operator with decent well tuned equipment should be able to make product with very little or no visible error. The best way to achieve a pleasing graphic image is to butt register theseparations, which requires nearly-perfect registration to print successfully.

Hand: This term describes the amount of ink on a shirt. In certain printing styles, such as athletic, a heavy deposit is acceptable and even, to a degree, expected. In most other styles of printing any largeink area that stiffens the fabric is objectionable. In extreme cases the weight of the ink can be felt and the print will not breathe, causing a nasty adhesive effect on the wearer's chest on summer days.Developing a library of techniques to achieve decent coverage is suggested.

Colour out: While printing, if the colour paste runs low in the reservoir resulting in blank skips in the print pattern it is called as Colour out. Continuous monitoring of the level of the colour pastes can overcome this problem.

Scrimps: Scrimp is a printing defect characterized by lengthwise strips of fabric that are unprinted. This can happen because of the folding of fabrics length wise and not getting spread properly on theprinting table.

TOPIC-NO 8

ROLLER PRINTING

INTRODUCTION:

Screen printing is a printing technique that uses a woven mesh to support an ink-blocking stencil. It is done either with flat or cylindrical screens made of silk threads, nylon, polyester, vinyon or metal. The printing paste or dye is poured on the screen and forced through its unblocked areas onto the fabric. Screen printing is also a stencil method of print making in which a design is imposed on a screen of polyester or other fine mesh, with blank areas coated with an impermeable substance, and ink is forced into the mesh openings of the mesh by the fill blade or squeegee and onto the printing surface during the squeegee stroke. It is also known as silkscreen, serigraphy, and serigraph printing.

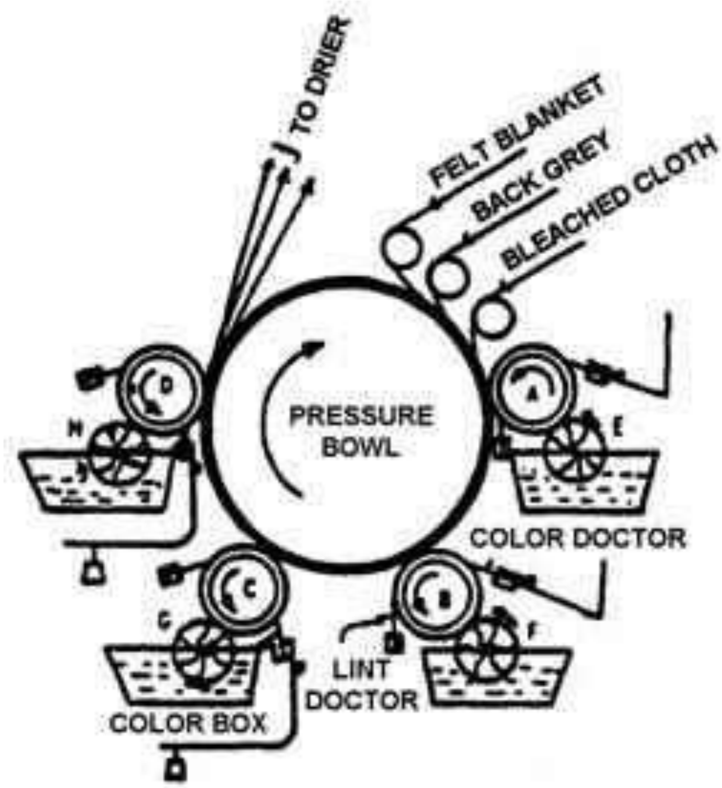
CONCEPT OF ROLLER PRINTING

Engrave Roller Printing

Roller Printing also called engrave roller printing. It is a modern continuous printing technique. In this method, a heavy copper cylinder (roller) is engraved with the print design by carving the design into the copper. Copper is soft, so once the design is engraved, the roller is electroplated with chrome for durability. This printing technique developed in the late 19th and early 20th centuries. Until the development of rotary screen printing; it was the only continuous technique. Designs with up to 16 colors present no problem in Roller Printing.

Main parts of Roller Printing and their purpose:

1. Central Metallic Drum: To provide solid support to the fabric for printing.
2. Color doctor: To remove extra colour from the design roller
3. Lint doctor: To remove short fibres from the design roller.
4. Blankets: To provide resilient effect under the printing fabric.
5. Back grey: To save the blanket from soiling or getting dirty.
6. Furnisher Roller: To charge the design roller with colour paste.
7. Color trough : To store the colour paste.
8. Color unit: Its one assembly of design roller, furnisher, colour box etc. one colour unit is for printing one colour.



Roller Printing Machine

Working Process of Roller Printing:

This machine has a main cylinder that is fitted with a large gear.In this printing, the print paste is supplied from reservoirs to rotating copper rollers, which are engraved with the desired design. These rollers contact a main cylinder roller that transports the fabric. By contacting the rollers and the fabric the design is transferred to the fabric. As many as 16 rollers can be available per print machine, each roller imprints one repeat of the design. As the roller spins, a doctor blade in continuous mode scrapes the excess of paste back to the colour trough. At the end of each batch the paste reservoirs are manually emptied into appropriate printing paste batch containers and squeezed out. The belt and the printing gear (roller brushes or doctor blades, squeegees and ladles) are cleaned up with water.

ENGRAVEING OF THE DESIGN ROLLER:

Following are the methods of engraving of copper rollers for Roller Printing:

There are three different methods of Engraving.

By hand with a graver which cuts , the metal away.

By machine, in which the pattern is simply indented.and followed by chemical etching the pattern is dissolved out in nitric acid; and

By photo method in which the pattern is simply transferred by coating the liquor and exposing to light,followed by chemical etching the pattern is dissolved out in nitric acid; and

Details of these are as under:

1. **MILL ENGRAVING METHOD:**

It's a process of die and mill method: steps are as follows

1. At first the repeat of design is transferred to a smallmild of steel roller, Then is called die.
2. The top side of this roller is burnished.
3. The circumference of the printing roller is must be proportional to the die.
4. The burnished die is padded in solution of coppersulphate.
   $Fe + CuSO4 \rightarrow Cu + FeSO4$
5. The design is art in the paper by the solution ofsodium sulphite.
6. Then the die is covered by the design paper.
7. Then binding with tightly by canvas.

8. This process is run continuously 1 to2 hrs.
9. In this process is used bone ash and charcoal andheated.
10. After this die is attached by the clamp at mild steelroller contact, then the steel roller is called mill.
11. The die and mill is rotated at high pressureand the design is replaced in the mill.
12. Then the pressure is removed.
13. Thus the roller is engraved.

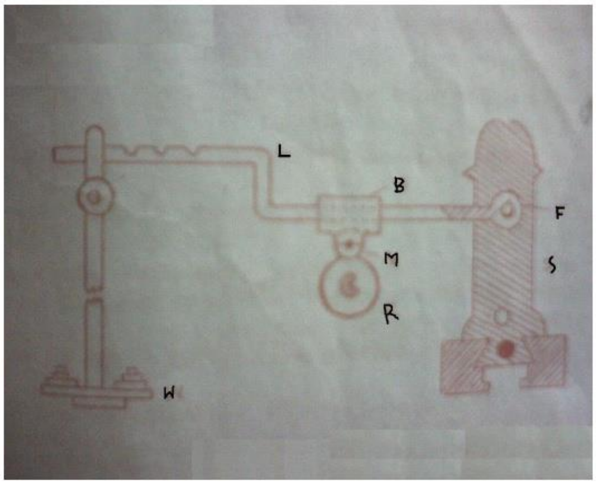


Diagram of Mill Engraving

Where-M=Mill B=Block S=Adjustable support F=Fulcrum R=Copper roller W=Weight

2. **PANTOGRAPH ENGRAVING METHOD:**

   In this method a pantograph with a diamond head is used for engraving the pattern on the roller coated with carbon varnish. Once the varnish is cut, this reveals the bare metal design. Which is then put in an etching bath for chemical engraving.
   Chemical Engraving Bath:

It contains HNO_3 acid which dissolves the copper in the design areas up to the required depth and we get the engraved roller.After this the design roller is washed and hardened.

3. **PHOTOENGRAVING METHOD:**

In this method procedure is similar to that of making a screen by photo chemical method. There is only difference in method of design transfer on the design roller. After that secong step is same means that of the chemical engraving.

The Defects in the Engrave Roller Printing

1. Scratches
2. Snappers
3. Litts
4. Streaks
5. Scumming
6. Uneven printing
7. Lobbing

Advantages of Engrave Roller Printing Machine

1. Higher production without rotary screen printing machine.
2. 14 colors can be used for printing.
3. Medium design can be produced.
4. Can be used for printing any style.
5. Any color is used for printing without higher alkali or conc. acid.
6. Repeats do not exist as printing is continuous.
7. Higher production by using single color.
8. Complex design is possible.

Disadvantages of Engrave Roller Printing Machine

1. Large design is not possible.
2. Generally, shedding fault is found.

3. Higher coloring effect is not possible as like block printing.
4. Lower production by using more than one color.
5. Changing time is high.
6. Engraving the printing roller is expensive Operation

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