Printing

Printing

Definition:
By the term " Textile printing" we mean the localized application of dyes or pigments and chemicals by any method which can produce particular effect of color on the fabric according to the design.

Differences between Dyeing & Printing:

Dyeing	Printing
1. There is no localized application	1. This is the localized application of dyes/pigments on the fabric according to design.
2. Color is applied in form of solution.	2. Color is applied in form of thick paste.
3. Fabric, yarn, and fibers are dyed.	3. Fabric is only printed
4. Generally a color is used.	4. One or more color is used.
5. Thickener is not used.	5. Thickener is used.
6. Steaming is not required on dyed material.	6. Steaming is used in the printed fabric for fixation.

7. More time is required	7. Less time is required.
8. Less expensive.	8. More expensive
9. Much amount of water is used	9. Less amount of water is used.
10. Liquor ratio is high.	10. Liquor Ratio is less.

Styles of printing: Style refers to the **manner by which** particular action is performed. It is chemical operation. Styles of printing means the manner in which a printed effect is produced-

1. Direct style,
2. Dyed style,
3. Discharge style,
4. Resist style,
5. Raised style,
6. Azoic style,
7. Metal style,
8. Flock style,
9. Creep style.

1. Direct style: The dyes are printed directly at the required places of the multi colored design on the fabric, leaving the other portions white. Thus a multi-colored print on a white ground can be produced.

2. Dyed Style: The style consists of two stages-

I). Mordanting.

II). Dyeing.

- Printing of the color with a thickened mordant.
- Fixing of a mordant.
- The dyestuffs combine with the mordant to form an insoluble color take.But the color on the unmordanted portions only adheres mechanically.
- Washing and soaping of the dyed cloth to remove all adhering color.

3. <u>Discharge style of printing:</u>

Discharge style of printing means the process which can produce a white or color effect on a previously dyed ground. Discharge style of printing is carried out by following steps:

1st step: Dyeing:

Fabric is dyed firstly with an easily reducible dye.

$$\text{Dye(-N=N-)} \xrightarrow[\text{Steaming}]{\text{Reduction (Reducing agent}} \sim NH_2 + NH_2\sim$$

2nd step: Printing:

- The fabric is printed with a thicken solution of discharging agent.
- This discharging agent destroys the color at the printed areas and leaves the dye of unprinted areas unaffected.

- If any dye is present in the solution of discharging agent which is not affected by its discharging action, can also be deposited and fixed on the ground.
- Reducing agent must be stronger than Dye.

3rd Step: Steaming

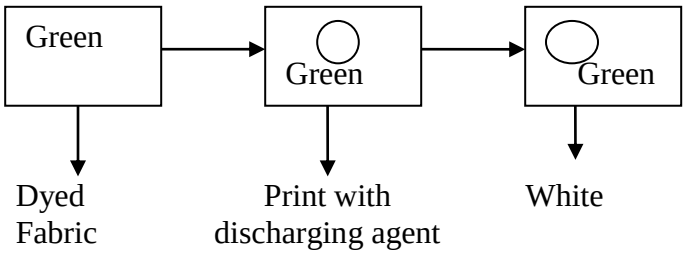
4th Step: washing

Types of discharge styles:

I) White discharge:

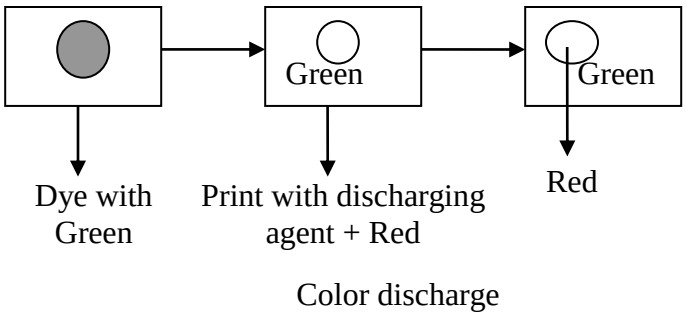
- After dyeing and printing, the discharge agents discharge the dye of printed areas and leaves the dye present on the unprinted area unaffected

  A white design is produced on color ground



II) Color Discharge:

- The colored printing paste remove the initial value from the colored ground at the same time deposit color on the original ground,



4. **Resist style of Printing:**

In this process, a substance is applied to the fabric that will prevent the fixation of any coloring agent employed afterwards on that area.

Resist style of printing is carried out-

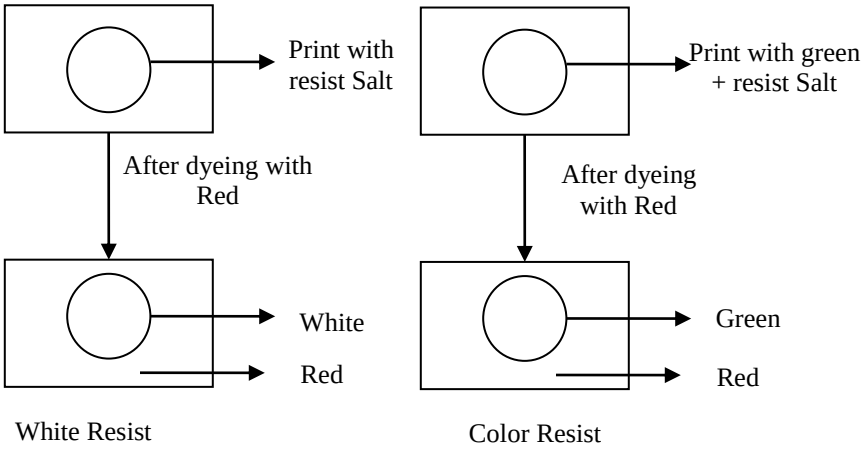
I) Printing: The fabric is printed with a resist salt solution which is sprayed on the fabric mechanically or manually.

II) Dyeing: The fabric is dyed with a suitable dye as a result the areas covered by the resist salt will not be dyed and other portions would be dyed.

Types of resist style of printing:

White Resist:

- No color is added to the print paste solution with resist salt
- After dyeing the printed area remains white.



Color resist:

- Coloring material is added to the print past with resist salt
- The printed area contains the color added to print paste and the remaining areas will contain the color of dye sol.

Differences between Discharge & Resist style of printing:

Discharge Style	Resist style of printing
1. It is always sharp in outline, bright in appearance	1. It is less sharp in outline and less bright
2. Discharging agent used	2. Resist salt used
3. Strong chemical reaction is required	3. No chemical reaction due to pre dyeing
4. At first the fabric is dyed and then discharging printing	4. At first resisting salt printed, and then fabric is dyed.
5. Two or more colored can be dyed at a time	5. Only two class can be dyed

Discharge Style	Resist style of printing
6. Discharging agent destroy pre fixed dye of fabric	6. Resisting salt resist to be fixed of color on the fabric
7. The cost of discharging agent is high	7. Cheap
8. More wastages of dye	8. Less wastage of dye

5) Flock style: Flock is a branch of short fiber.

In the **electrostatic method** of flocking, the fabric is printed **with on adhesive** and passes on a **moving belt** through an electric charge. The flock made from **cotton, rayon**, is **filtered** from the **flock hopper** on to the fabric and is attracted to the **adhesive in perpendicular** form. After a bleaching process the **sharp fibers** are removed.

(6) Creep style: In this style, printing is performed **after alkali treatment or heat setting**.

Methods of Textile Printing:

Method of printing means **the method of producing** printed pattern. Followings are the important textile printing methods-

- Block printing
- Screen printing (Flat screen printing and Rotary screen printing)
- Stencil printing
- Roller printing
- Transfer printing
- Flock printing
- Duplex printing
- Batik printing
- Air brush painting
- Spray Printing
- Digital ink-jet printing

Block printing

It is the **oldest and most artistic** printing method. It is an **easy manual process** for printing **single color**. The block used has a general size **of 3″x4″–9″x12″.**

Block preparation

A suitable **piece of wood**, free from all defects is cut to size. The next step is '**putting on'** of the pattern. A careful outline tracing of the design is transferred by on it and the ground between the color parts are removed.

Process of block printing:

The fabric is stretched on a flat table covered with resilient substance, back grey and gunny cloth. The print paste is kept on a color pad. The color pad is kept in a color tray. The block is carefully placed on the color pad. Then it's raised and the impression of the design is obtained by stamping the block smartly by hand on cloths. After each transfer of print paste the color pad is resupplied evenly with color by means of tie ring brush**.**

Advantages:

1. Any design can be done.
2. No need of elaborate and extensive equipment.
3. Low initial cost.
4. Simple to operate.

Disadvantages:

1. Slow method and low output.
2. Time consuming.
3. Skilled operator and great care needed.
4. Difficult to join up each repeat perfectly.
5. Difficult to produce multicolor design. (No of blocks = no of color)

Screen printing

Screen printing is an easy process to produce multicolor design. This system requires the use of screen and squeegee. With the help of this squeegee, color is moved on to the fabric. The screens, used are mainly rotary screen and flat screen.

Classification of screen printing machines:

There are **four types** of screen printing machines.

1. Hand screen printing machine (flat)
2. Semiautomatic screen printing machine.
3. Automatic (fully) flat screen printing machine.
4. Rotary screen printing machine.

Advantages of hand screen printing:

1. Low initial cost.
2. Machinery problem not present.
3. Drying system not necessary.
4. Suitable for small scale production.
5. Multicolor produce possible.

Disadvantages of hand screen printing:

1. Fastness is poor because after treatment cannot be carried out properly.
2. Not suitable for large scale of production.
3. Skilled operator required.
4. Slow process rate.
5. More labor required.

Semi-automatic screen (flat) printing machine:

This is almost same as hand screen printing, but the manual process has been semi-automated by mounting the screen on a carriage and driving the squeegee mechanically across the screen. Long tables, typically 20 – 60 m long, are used and some provisions are usually made for drying the printed fabric.

Fully automatic screen-printing machine (flat bed):

In fully automatic screen-printing machine, all the screens for the design (one screen for each color) are positioned accurately along the top of a long endless blanket. This is the most used process and 8 – 12 colors can be used & no. of screen is more (from 7 to 12).

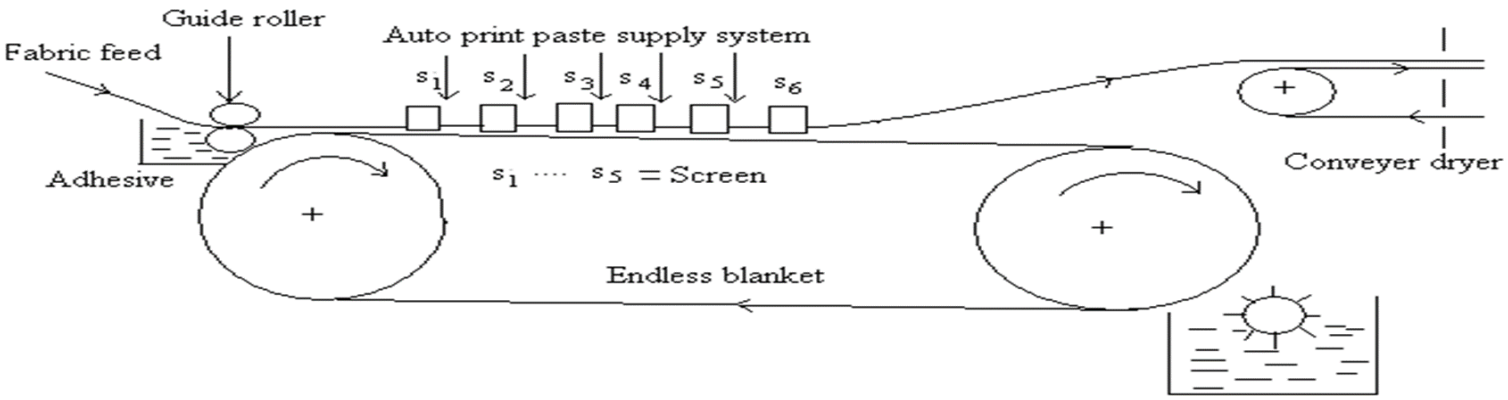


Fig: Schematic diagram of a fully automatic flat screen printing machine

Process description:

1) **Gumming** the fabric using **water soluble adhesive** at entry zone. adhesive helps the fabric to be **firmly attached** with the blanket.

2) **Printing** is done while the fabric is **stationery**. Then the **screens are lifted** and the **fabric & blanket move on**.
3) Then subjected the fabric into **dryer** and into the **steaming chambers**.
4) The **solid blanket** is **washed & dried** properly to **wash off** the adhesives while passing **down** through the machine.

Rotary screen-printing machine

It is a **continuous printing** method; the continuous rotation of the **cylindrical screen in contact with fabric** ensures continuous printing. It is also one kind of **roller printing** and is very advantageous. So, now days, it is **replacing flat screen**.

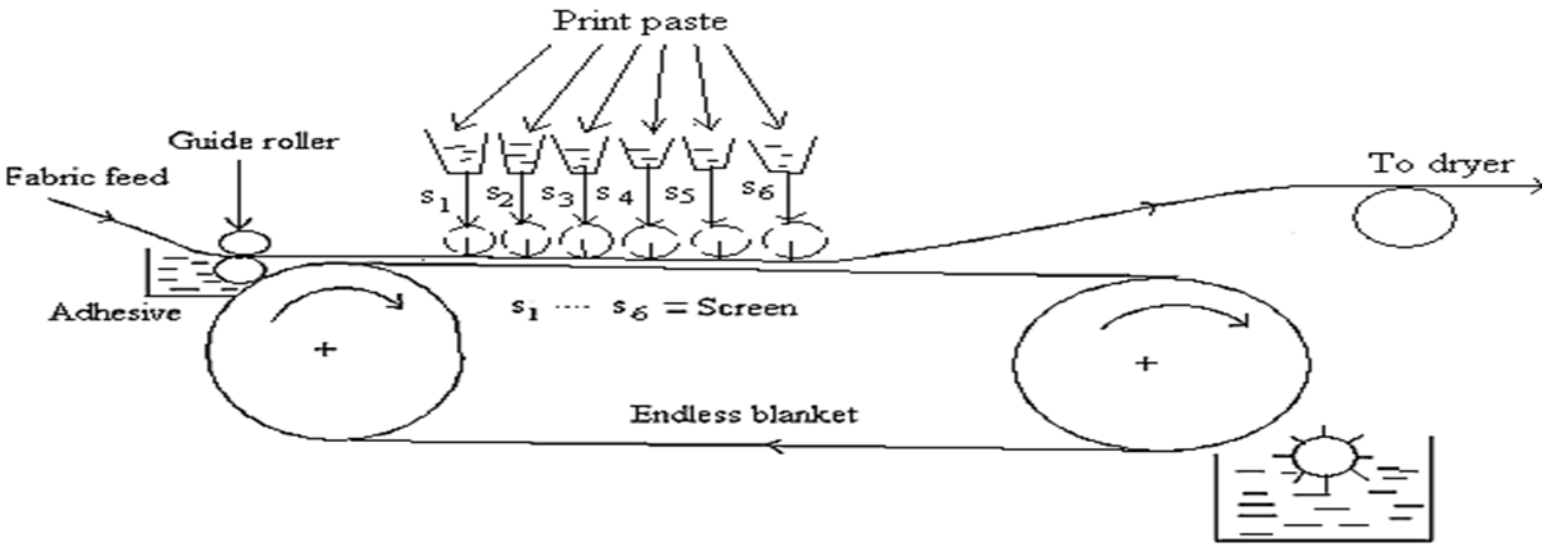


Fig: Schematic diagram of a fully automatic Rotary screen printing machine

Process description

1. **Gumming** the fabric using **water soluble adhesive** at entry zone. adhesive helps the fabric to be **firmly attached** with the blanket.

2. The **print paste** is **pumped** from a container into the **screen through a flexible pipe**. During printing, the paste is forced out through the design areas with the **aid of stationery squeegee**.
3. The adjustable rotating cylinder is used for the printing. Its **driving mechanism** is very complex as **screen, fabric and blanket- all are rotating simultaneously**. So, each must be **maintained individually**. The main controlling/maintaining points are:-

- Regulation of speed.
- Squeegee system.
- Driving mechanism.

4. The rpm of the machines should be checked time to time. The fabric speed ranges from **30 – 50 m/min**. standard international circumference of the cylindrical screen is **64 – 65 cm**.

Difference between Rotary Screen Printing and Flat Screen Printing

Rotary screen printing	Flat screen printing
1. It is truly a continuous process.	1. It is not a true continuous process because the printing is done when the fabric is stationary.
2. Rod, blade and air flow squeegee systems are used.	2. Double blade and magnetic rod squeeze systems are used.
3. The repeat area is subjected to limitation i.e. 64 cm.	3. Repeat area can be higher than that of rotary screen.
4. Production is high.	4. Production is low.
5. Not very economical for small runs because the preparation of screen is more costly.	5. Economical for shorter runs as the screen preparation is relatively cheap.
6. Rotary screen gives rotation.	6. Flat screen does not give rotation.
7. Higher speed.	7. Lower speed.
8. Less pressure is needed.	8. More pressure is needed.

Roller printing

Roller printing machine is the most **economical** and **fastest** way of printing. The output of this M/C cannot be surpassed by **any other method** of printing. Designs with up to **16 colors** present no problem in Roller printing.

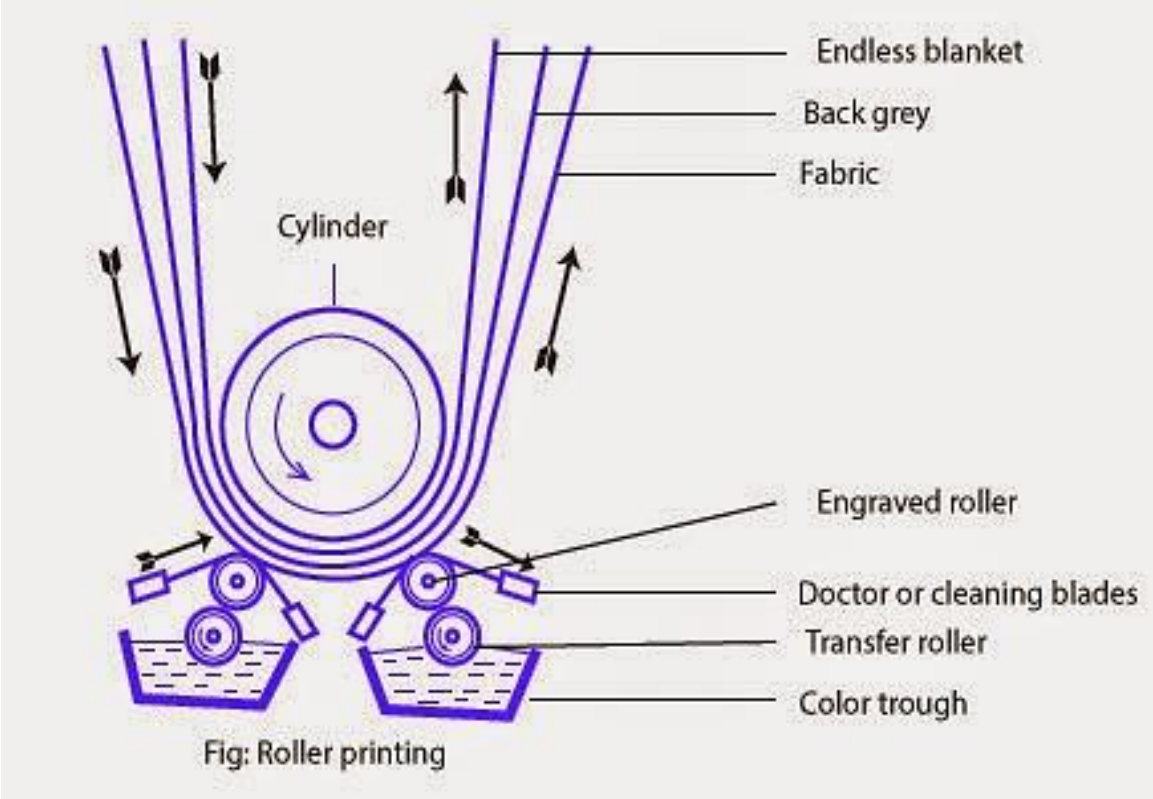


Fig: Roller printing

Working procedure:

Engraving design pattern on the **copper roller**

↓

Alignment of the rollers

↓

Engraved rollers come in contact with the **transfer roller**

↓

Doctor blade fixes the **excess dye** from the surface of the roller

↓

Fabric passes between the **engraved rollers and cylinder rollers**

↓

The dye from the shallow areas is pressed on the fabric

↓

Back grey absorbs the excess print paste

↓

The printed cloth is immediately passed into a **drying chamber**

↓

The printed cloth is passed into a **steam chamber**

Advantages:

- Suitable for large scale production.
- High speed M/C and hence more production.
- Can be used for fine printing.
- Can be made/prepared high quality design due to not joint mark.
- Possible to print in complex weave design.

Disadvantages:

- Changing time high. So, not suitable in small scale production.
- Engraving the printing roller is an expensive operation.
- May be light printing shade.
- Crush effect produce.

Difference between Rotary Screen and Roller Printing:

Rotary Screen Printing	Roller Printing
1. Printing is done by specially made perforated cylindrical or spherical screen.	1. Printing is done by specially engraved roller.
2. Paste is pumped to the screen and distributed lengthwise by pumps.	2. Paste is transferred to the engraved roller by color furnishing roller.
3. Up to 24 colors can be printed but, 8-10 are printed easily.	3. Even 16 engraved rollers can be used for different colors of pattern.
4. Can be printed woven and knitted fabric.	4. Can be printed woven and tricot fabric.
5. The main equipment of printing is rotary screen.	5. The main equipment of printing is Engraved roller.

Thickener

Definition: 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.

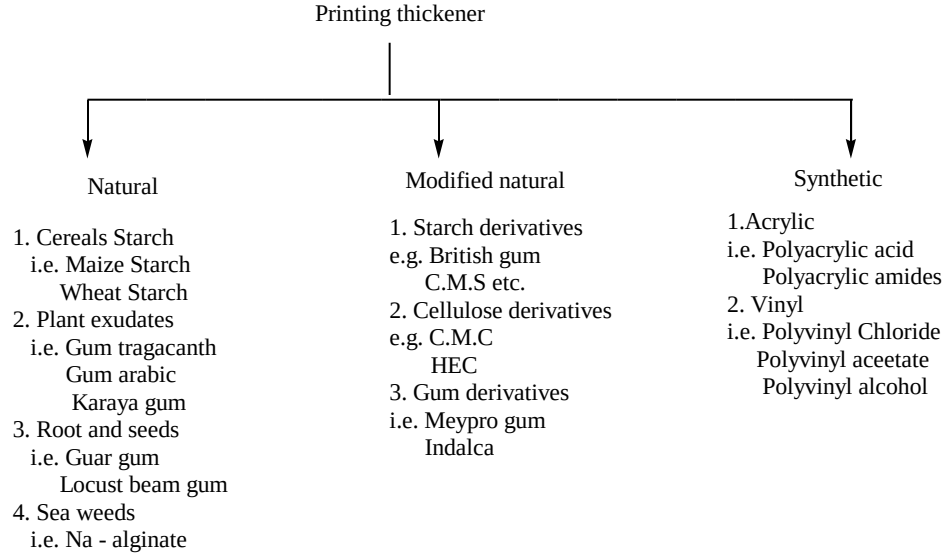
Function or Object or Purpose of Thickener:

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

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

- Type and quality of material to be printed.
- Compatibility with dyes and chemicals.
- Print paste stability.
- Styles and methods of printing.
- Properties of the dried thickener film.
- Effect on color yield, such as-diffusion, fixation.
- Preparation and removal of the thickener.
- Cost.
- Biological oxygen demand.

Classification of Thickener:



C.M.S – Carboxy Methyl Starch

C.M.C – Carboxy Methyl Cellulose

H.E.C – Hydroxy Ethyl Cellulose

Essential Quality of Thickener:

- Stability to keeping (physical-cheical stability) should be good.
- It should have certain physical and chemical properties such as viscosity, flow property, ability to adhere and wet to the internal surface of etchings of the engraved roller.
- It must be compatible with the other ingredients of the printing paste.
- The thickener film should dry properly on the fabric to prevent spreading of the color by capillary action.
- Proper extraction of water from steam during steaming should be ensured to provide free space for the dye molecules to move towards the fabric.
- The thickener should not have affinity for the dye and should not keep the dye from the fabric.
- The thickener molecule should have a control over the free water pick up and not carry the dye beyond the boundaries of the impression.
- The thickener should be cheap and available in abundance.
- After perform printing, the useable media i.e. Block, Roller, Screen should be easily cleanable.

- Once the dye is transferred from the thickener film (desizing steaming) the removal of the exhausted thickener film without fetching water soluble dye should be easy.

Printing Ingredients:

1. Dyestuffs or Pigments.
2. Wetting agents.
3. Thickener.
4. Solvent, dispersing agents.
5. Defoaming agents.
6. Oxidizing and Reducing agents.
7. Catalyst and Oxygen Carrier.
8. Acids and alkalis.
9. Carrier and Swelling agents.
10. Miscellaneous agents.

Function:

1. **Dyes/Pigments:**

- Attraction of dye stuff to the fiber due to presence of auxochrome.
- To achieve color effect on the fabric
- To produce required shade.

E.g.Vat, Azoic, Reactive, direct etc.

2. **Wetting agents:**

- To wet the fabric as well as dyestuff.
- To reduce surface tension of water allowing the dyestuff for easy penetration into fiber.
- To obtain smooth paste.
- To dissolve the dyestuff in the paste

e.g.: Olive oil, T.R oil, caster oil.

Lissapol N. Animal oil, Glycerine

3. **Solvents/dispersing agents/solution acids:**
   - To get bright design.
   - To assist dye penetration
   - To spread dye moles evenly in the past.
   - Assist dye fixation.
   - To prevent aggregation of dye molecules in the highly concentrated of the dye.
   - To prevent precipitation.
   - To increase solubility of the dyes.
   - To make proper printing shade

e.g.: Urea, Glycerine, desirable, Alcohol, Acetone, Diethylene glycol, Thio diethy lene glycol

4. **Thickener:**
   - To give required viscosity to the printing paste.
   - To prevent premature reactions bet^{n} the chemicals contained in the print paste.
   - To hold the ingredients of the print paste on the fabric

Ex: Na-alginate, fine gum, British gum, CMC

5. **Defoaming agents:**

- To prevent the foam generation during printing.

E.g. Silicone, defoamers, sulphated oil, perminol KB, Emulsified pine oil.

6. **Oxidising and reducing agent:**

Oxidising agent:

- To develop the final color during steaming or in the subsequent after treatment.
- Assists to dye fixation.

e.g.: Sodium chlorate, Potasium chlorate, Sodium nitrate, Resist Salf Ammonium chloride, Ludigol, Na or K dichromate

Reducing agent:

- Used for reduction of different dyes.
- Used for mainly in discharge printing.
- To destroy color from the ground of fabric.
- To make the insoluble dyes to soluble

e.g. Sodium hydrosulphite, Stanus chloride etc. Rongolite-C

7. **Catalyst and oxygen carrier:**

- To prevent fiber damage during steaming.
- Accelerate the final color development by oxidation.
- Reduce the risk of oxidisation.

E.g. copper sulphide, Amimonium vanadate, Potassium ferrocyanide.

8. **Acids/Alkalis:**

- To maintain P^H
- To develop the color or printed fabric.
- To fix dye on the fabric permanently.

E.g. Organic acid Alkali KOH, NaOH, Na_2CO_3, pottasium carbonate, sodium bicarbonate, Sodium acetate.

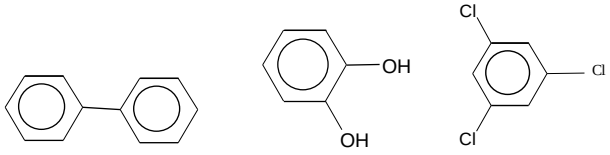
9. **Carrier and swelling agent: Swelling agent:**

- To create the big size holes of the fibers.
- Helps to swell the fiber structure.
- To reduce crystallinity.
- Help the easy penetration of dye molecule inside the fiber polymer.

E.g. Polyethylene Glycol, Phenols, DEGDA (di-ethylene glycol. diacetate)

Carrier:

Used for fixing disperse dyes on polyester or polyster wool blends at temp below 105^{o}C.



e.g. Diphenol, Ortho-phenol, Tri-chloro benzene, Para phenyl phenol

10. **Miscellaneous agent:** Hygroscopic agent:

- Assist fixation of dyes.

- Absorb moisture from air.
- Facilitates subsequent washing off.
- e.g. Urea, glycerine etc.

Mild oxidising agent:

During steaming of ago color, the partial color can be destroyed by the effect of Reducing. To secure of this condition, Mild agent used.

Ex: Ludigol, Resist Salt.