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# 11. PRINTING AND FINISHING OF TEXTILES

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# 11. PRINTING AND FINISHING OF TEXTILES

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Having dealt with the preparatory processes and dyeing in the previous lesson, we now move to the other two important value addition processes viz. printing and finishing of textiles which are covered in this lesson. The next lesson, which is the final lesson of this unit, will be devoted to a consideration of the tests for colour fastness on washing and rubbing.

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## 11.0 Objectives

After going through this lesson, you will be able to gain an understanding of:

- The history of textile printing
- The major textile printing processes
- A method used for applying textile finishes
- The various types of textile finishes applied

## 11.1 Introduction

Printing and finishing of textiles are two very important processes which add value to the fabric. This lesson will deal with various aspects of these two processes.

A vast majority of fabrics are printed. Unlike dyeing in which the fabric is coloured throughout or in large areas (as in tie and dye) by immersing it in a dyebath, printing is localized application of a dye or pigment to a fabric to generate a pattern or a design. As opposed to normal dyeing which uses a dye solution to apply the dye, in printing a thick dye paste is used. To understand why this is necessary, a very simple experiment may be done. If a drop of colour solution is placed on the surface of a fabric, it is seen to quickly spread into an irregular shape due to capillary effect. To hold the colours in position, thick dye paste is used. This requires the use of thickening agents, which prevent colour migration. The paste holds the dyestuff until it is fixed after printing (say by steaming) and then the unwanted paste ingredients are removed.

Compared to printing, finishing of textiles has a much wider connotation, as one could say that anything which makes a textile attractive is finishing. In this context, bleaching and dyeing (which were covered in the previous lesson) also come within this all-inclusive definition as bleaching makes the fabric white resulting in value addition and dyeing also adds to the value of the fabric by transforming it into an attractively coloured product. Mercerization, which was considered as a preparatory process in the previous lesson, may have a strong claim to be classified as a finishing process as it renders the fabric lustrous and attractive. In this lesson the term 'finishing' would be used in its more restricted sense in which the finish may be applied to get improved handle, easy care, flame resistant, water repellent or wash proof effect, anti-static effect, anti shrink effect, moth and insect resistant, more lustrous fabrics, etc.

In this lesson, we will first describe the printing process and then consider some of the more important finishing processes.

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## Self-check Questions

1. What is meant by printing of fabrics?
  2. What is meant by finishing of textiles?
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## 11.2 The Printing Process

We will begin our discussion of printing with a historical perspective and then consider the various methods used for textile printing.

### 11.2.1 Historical perspective

Hand painting and block printing on textiles are reported to have been practised in India for thousands of years.

Hand painting involves directly drawing an image using colour. Alternately, patterns are created on fabrics with the help of the resist technique in which the pattern is drawn on the fabric with clay, starch, gum, or wax, which forms a barrier to dye penetration. Dyeing the fabric then reveals this pattern.

The block printing method was practised in Sind (now in Pakistan) region in the 8<sup>th</sup> century from where it came to India. A design was carved on the smooth surface of a wooden block and the raised surface of the block was smeared with the dye paste. The design was then stamped on to the fabric and repetition of this equidistantly all over the fabric gives rise to an attractively printed fabric.

Stencil printing was also practised in India during the Gupta period (6<sup>th</sup> to 8<sup>th</sup> century). The stencil is placed on a fabric and the colour is then brushed or sprayed in the cut out portions, giving beautiful designs.

Machine roller printing came in the latter part of the 18<sup>th</sup> century and its development could be traced to the block printing process. This eventually transformed the slow and costly block printing process into cheap mass production which revolutionized the cotton print industry.

The stencil printing process led to the development of screen printing which works on the resist principle described earlier. In the early days, fine silk meshes were used as the screen. Towards the end of the 19<sup>th</sup> century, this process was well developed in Japan. Flat screen and rotary screen machines had by that time made this process very popular for printing.

### 11.2.2 Methods Used For Printing

In this lesson we will give only brief descriptions of some important methods.

- Block printing method:

Wooden blocks are made by slicing logs of wood horizontally and the required designs are chiseled on to the hard, smooth block surface. The carved out design on the block is smeared with thick dye paste and then stamped on to the fabric transferring the design as cut in the block. Each separate colour will require a separate block. The process

is repeated till the design covers the fabric. Hand block printing is carried out as a cottage or small scale industry in India. It is slow and expensive but is ideal for exclusive designs on limited quantities of fabrics.

- **Stencil method**

A design shape is cut out of a piece of thin, hard non-absorbent material and when this is placed on a fabric and the colour brushed or sprayed in the cut out portions, the design is traced on the fabric. An ordinary stencil is shown in Fig.11.1.



Fig.11.1 A stencil

- **Machine roller printing**

Modern roller machine printing is a development of the engraved block method. The principle of the method is shown in fig.11.2. The design is engraved onto a set of copper-surfaced rollers, the number depending on the number of colours in the design. The rollers are situated in sequence round the circumference of a large pressure cylinder whose surface is padded and is protected from staining by dyestuff being pressed through the printed fabric.

- **Screen printing method**

Printing of textile materials using a screen is either done manually or with the help of machines. In the latter category, the automatic flat bed method or the rotary screen printing method are used. In view of its wide use, this method will now be described in greater detail.

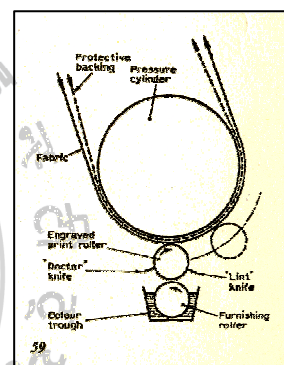


Fig.11.2 Roller Printing Machine  
(Taken from Ref.1)

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## Self-check Questions

3. Which two printing methods were practised in India during the Gupta period?
  4. Which well-known printing technologies developed from the two printing methods of the Gupta period?
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## 11.3 Screen Printing

### 11.3.1 Manual screen printing



**Fig. 11.3 Screen frame**

In manual screen printing the fabric to be printed is laid on a long table. A screen (Fig.11.3) with length slightly greater than the fabric width is fitted in a wooden frame. The design to be printed is transferred to the screen (for each colour, there is a separate screen) and the space in the screen not covered by the design is covered with an impermeable membrane so that the colouring material can only pass through that part of the design which is to be in one colour. (Fig. 11.4)

A thick paste containing the colour (dye or pigment) prevents migration of the colour and the paste holds the colour till it is fixed after printing and then the unwanted paste ingredients can be removed. For this appropriate thickening agents are used which increase the viscosity of the paste.



**Fig. 11.4 Manual screen printing process**



**Fig. 11.5 A Squeegee**

The printing paste is pressed through the screen with the help of a device having a rubber blade called squeegee (Fig.11.5). The screen is moved one repeat and the process repeated. The different colour screens follow and thus the whole length of the fabric is printed.

### 11.3.2 Semi-automated process

The manual process has been semi-automated by mounting the screen on a carriage and driving the squeegee mechanically across the screen. In both hand and semi-automatic flat screen printing the colours are printed one after another with time for drying between one colour and the next. The dried fabric is removed from the table and stored for a while before fixing by dry heat in the case of pigment printing and steaming or dry heat in case of reactive dye printing.

### 11.3.3 Automated Screen Printing

- **Automatic flat bed screen printing**

In order to increase the speed of flat screen printing, it was imperative to devise a method of printing all the colours simultaneously. This entails each colour application position being fixed while the substrate moves. The colour is applied through the screens while the frame is stationary.

Flat bed screen printing machines where the fabric remains stationary and the screen moves on a carriage have also been developed for the printing of silk. The entire operation is controlled pneumatically. One such machine is shown in Fig.11.6.

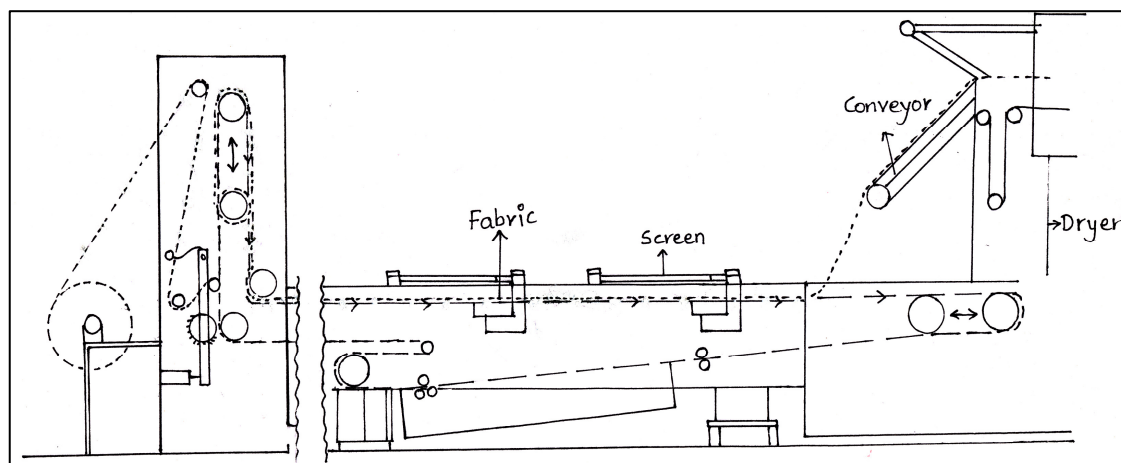


Fig.11.6 Fully automated flat screen printing machine

- **Rotary screen printing**

Unlike flat bed machines, in which the printing action is intermittent, continuous movement of the fabric has been achieved in rotary screen printing machines (Fig.11.7). This is by moving the screens along with the fabric while printing. The screens are cylindrical (Fig.11.8) and the fabric also moves on a cylinder. However, these machines are quite expensive.

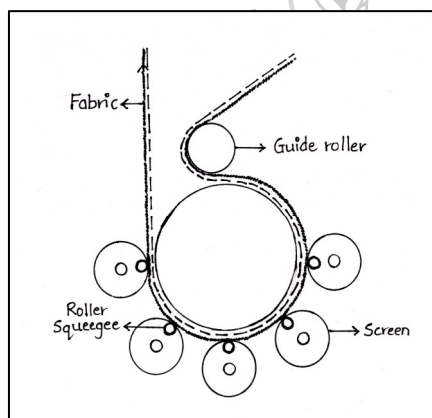


Fig.11.7 Rotary screen printing set-up

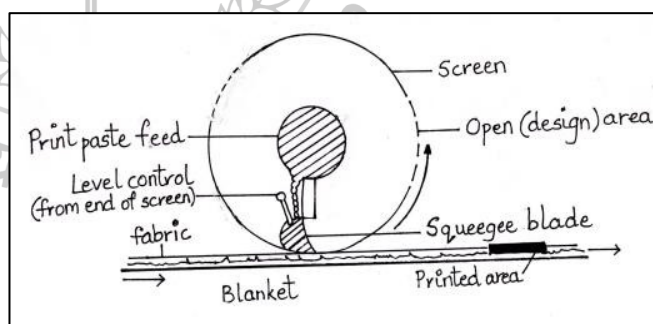


Fig.11.8 Rotary screen printing section

## Activity

1. Prepare a 8"x8" design for screen printing process.

## Self-check Questions



5. Fill in the blanks:

- i) \_\_\_\_\_ and \_\_\_\_\_ processes add value to the fabric.
- ii) Block printing was internally practiced in \_\_\_\_\_ region during the 8<sup>th</sup> century.
- iii) \_\_\_\_\_ agents are added to increase the viscosity of the printing paste.
- iv) In earlier days \_\_\_\_\_ meshes were used as screens.
- v) The printing paste is pressed through the screen with the help of a \_\_\_\_\_.

6. Why is a dye solution not used for printing?

7. Why is a thick paste used for printing?

## 11.4 Finishing Processes

Following Wynne (Ref. 2), the available finishing processes can be divided into chemical processes and mechanical processes. In addition to these, heat setting of textiles and surface coating may also be considered as finishing processes. We will consider the chemical process first and then make a brief reference to the others.

### 11.4.1 Chemical Finishing Processes

Chemical Finishing Processes are those processes which involve the application of chemicals to the fabric and these can lead to modification of handle or make the fabric water repellent, oil and soil repellent, moth and insect proof, anti microbial, flame-retardant, anti static, etc.

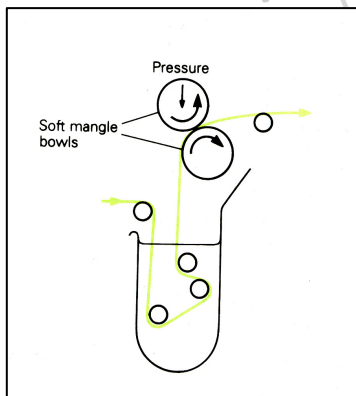


Fig.11.9 A padding mangle  
(Taken from Ref. 2)

Chemical finishes are normally applied in the form of an aqueous solution or emulsion and can be applied, for example, with the help of a pad mangle (Fig.11.9). The fabric passes through a trough of chemical finish. It is then squeezed by a pair of nip rolls to ensure the even application of a fixed amount of the finish on to the fabric. After padding, the fabric is dried to remove the water and the finish can then be fixed by subjecting the fabric to a relatively high temperature for a short period. This enables the applied chemicals to form a durable finish on the fabric.

Some of the chemical finish treatments will now be described:

- **Handle modification**

When a dilute solution of boiled starch is applied to a woven piece of cotton and the fabric dried, the dried starch film will stick the warp and weft threads firmly together to give a stiff product. A crisp, smooth finish for cotton goods results from use of modified starches.

The most common handle modifier used today is the softener which lubricates the warp and weft of woven fabrics allowing the fabric to bend more easily and this gives it a soft feel. Anionic compounds such as sulphated oils and sulphated alcohols are used as softeners. Other softening agents are oil fat and wax emulsions soaps and synthetic detergents and silicon compounds.

- **Water repellent and water proof finishes**

Waterproof finishes are those that coat or seal a fabric so water does not pass through the fabric. Water repellent finishes result in a fabric that resists wetting.

In the earlier days, the method for waterproofing a fabric was to coat it with rubber. This did the job but the coated fabric was heavy, bulky and uncomfortable. Silicon compounds have been found to be the most suitable.

- **Oil, stain and soil-resistant finish**

Silicones and fluoro chemical finishes are very effective. A drop of oil placed on an untreated fabric spreads rapidly and stains it. A fabric treated with fluoro chemical finish does not allow these to penetrate the fabric.

Any treatments that encourage the wetting of the textile surface will act as soil release agents. Polymers containing hydrophilic groups (say acrylic acid groups) would be readily wetted by water and the wet surface will act as soil release agent.

Materials such as carboxy methyl cellulose (CMC) aid in preventing re-deposition of soil during laundering and are frequently included in detergents.

- **Moth and insect damage proofing finishes**

The older method of producing a mothproof finish by treating wool with an insecticide was popular. Environmental concerns have led to the use of more acceptable materials like the synthetic pyrethroids which have low animal toxicity.

- **Microbiocidal finishes**

These are becoming important for textile finishing. Bacteriostatic is a chemical which inhibits the growth of bacteria. Similarly Fungistatic is a chemical which inhibits the growth of fungi. Fabrics impregnated with these chemicals will be safe and guard against infection.

- **Flame retardant finishes for cotton**

A phosphorous containing material is reacted with urea. The reaction product is padded on to cotton fabric and dried. The fabric is then reacted with ammonia and finally oxidized with hydrogen peroxide. This renders the fabric flame retardant.

- **Anti-static finishes**

An antistatic finish dissipates an electrical charge and does not allow it to accumulate on a fabric. An interesting development in the field of anti-static treatments



has been the development of the Permolose finishes by ICI which consists of block copolymers of ethylene oxide and polyester. When polyester fibers are treated with this, the polyester portion of the copolymers is adsorbed by the polyester fiber but, the polyethylene oxide portion is incompatible with the polyester fibre and so remains on the surface, where it attracts water and forms a conductive surface on the polyester fibre.

### 11.4.2 Heat-setting

To heat-set a fabric, it is subjected to selected temperatures (above the glass transition temperature and close to the maximum use temperature) for a specified length of time. Fabrics may be heat-set into a flat surface or they may be heat-set into a pre-determined shape such as nylon hosiery. Heat-setting causes molecular rearrangement and relieves internal stresses. It makes the fabric dimensionally stable.

### 11.4.3 Mechanical finishes

By passing the fabric between heated rotating rollers, the surface of the fabrics is rendered smooth, flattening slubs, increasing the fabric luster, improving the fabric handle by making it softer.

There are many finishing operations that have not been covered. These are included in the books cited in the References and Suggested Further Reading sections.

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### Activity

2. Prepare a list of different finishing treatments and respective chemical reagents used for them.

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### Self-check Questions

8. Fill in the blanks: ★
  - i) The finishing processes can be divided into \_\_\_\_\_ & \_\_\_\_\_ processes.
  - ii) Chemical finishes are applied with the help of \_\_\_\_\_ mangles.
  - iii) Heat setting makes the fabric \_\_\_\_\_.
  - iv) Materials such as \_\_\_\_\_ prevent redeposition of soils on to the fabric.
  - v) Polymer containing \_\_\_\_\_ groups are readily wetted with water.
9. How is stiff handle given to a woven cotton fabric?
10. Which chemicals are used to make a fabric water proof?
11. What does an anti-static finish do?

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## 11.5 Assignments

### 11.5.1 Class assignments

- i) Print six cushion covers using the screen printing process.

### 11.5.2 Home assignments

- i) Collect different fabric samples with textile stamps which refer to different fabric finishes such as pre-shrunk, mercerization etc.

## 11.6 Summing Up

The printing and finishing processes for textiles have been described in this lesson. In the area of textile printing, the processes of block printing, stencil printing, roller printing and screen printing-manual, automatic flat bed and rotary- have been briefly discussed. A whole variety of finishing processes have also been described.

## 11.7 Possible Answers to Self-check Questions

1. Printing is localized application of a dye or pigment to a fabric to generate a pattern or design.
2. Anything that makes a textile attractive is finishing.
3. The Stencil Printing Method and the Block Printing Method.
4. Screen printing developed from stencil printing while roller printing grew from block printing.
5. Fill in the blanks:
  - i) Printing, Finishing
  - ii) Sind
  - iii) Thickening agent
  - iv) silk meshes
  - v) Squeeze
6. A dye solution spreads into an irregular shape (when put on the fabric) due to capillary effect.
7. The thick paste holds the dyestuff without irregular spreading until it is fixed after printing.
8. Fill in the blanks:
  - i) Chemical & mechanical
  - ii) Padding
  - iii) Dimensionally stable
  - iv) CMC
  - v) hydrophilic

9. By applying a dilute solution of boiled starch.
10. Silicon compounds.
11. An anti-static finish dissipates an electrical charge and does not allow it to accumulate it on the fabric.

## 11.8 Terminal Questions

1. Describe briefly the automated screen printing method.
2. Describe how chemical finishes are usually applied?

## 11.9 References

1. Gulrajani, M.L. (Ed). 1993. Methods of Printing in Chemical Processing of Silk by Chopra, S. Textile Department, IIT, Delhi.
2. Joseph M.L. 1966. Introductory Textile Science. Holt Rinehart and Winston Inc., Chicago.
3. Miller, E. 1978. Textile Properties and Behaviour. B.T. Batford Ltd., London.
4. Wynne, A. 1997. Textiles. Macmillan Education Ltd., London.

## 11.10 Suggested Further Reading

1. Gohl, E.P. and Vilensky, L.D. 2005. Textile Science. CBS Publishers & Distributors, New Delhi.

## 11.10 Glossary

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|------------------|--|
| 1. Localized     | To limit or confine to a particular location       |
| 2. Connotation   | Meaning  |
| 3. All-inclusive | Taking everything into account                     |
| 4. Slicing       | Cutting into a thin broad piece                    |
| 5. Smearred      | To apply something greasy by rubbing               |
| 6. Equidistant   | Equally distant                                    |
| 7. Impermeable   | Not permitting passage, especially to fluids       |
| 8. Pneumatically | Worked by compressed air                           |
| 9. Intermittent  | Stopping and starting again at intervals, periodic |

10. Glass transition temperature      Softening temperature

