6.FUNDAMENTALS OF TEXTILES AND CLOTHING

Clothing is one of the basic needs for mankind. It protects the body from heat and cold, but also brings out one's personality, enhances beauty, gives comfort and expresses the status of living. Thus the need to study about fiber, fabric and clothing in this chapter. Fundamentals of Textiles and clothing.

6.1 FIBERS

Fibers are very small visible units from which fabrics are made by one process or another. Take a yarn or thread and untwist until it comes apart, or pull a single strand from an opened cotton ball or from a bunch of wool. The small fine, individual hair-like strands are fibers. Thus, a fiber may be partly described as being a slender filament or fine strand of sufficient length, pliability and strength, to be spun into yarns and formed into cloth.

6.1.1 Fiber properties:

The fibers possess certain essential properties. These are the **primary** and **secondary** properties.

The primary properties include :

a) High length to breadth (width) ratio

b) Tenacity or Fiber strength

c) Flexibility or Pliability.

d) Cohesiveness or spinning quality of fibers, and

e) Uniformity

Secondary properties of fibers are not essential but desirable for consumer satisfaction. These include :

a) Physical shape

b) Specific gravity

c) Luster

d) Moisture regain

e) Elastic recovery

f) Elongation

g) Resilience

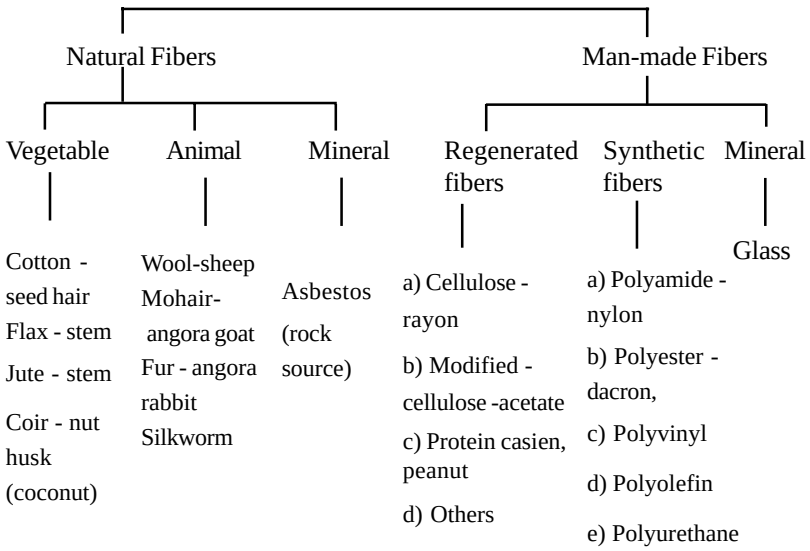
h) Thermal behavior

i) Resistance to biological organisms

j) Resistance to chemical and other environmental conditions.

6.1.2 Broad classification of fibers

Table-1



6.2 NATURAL FIBERS

These include cotton, silk and wool.

6.2.1. Cotton

Cotton referred to as the **"King of fibers"** is most important textile fibre in the world. Cotton fabrics were made by the ancient Egyptian, Chinese and of course Indian civilizations.

The cotton fiber is a long cell made up of countless cellulose molecules. Cotton is removed mechanically from the seed balls by the cotton gin. The ginned cotton is then pressed into bales and sent to the factories to be spun into yarns.

Manufacture: The main processes are bale breaking and cleaning, carding, combing, spinning, weaving, scouring, bleaching and dyeing.

Bale breaking and cleaning

The tightly pressed cotton fibers from the bales are loosened in a machine, the impurities falling out. Another machine removes more impurities until sheets of loose fiber like cotton wool emerge ready for carding.

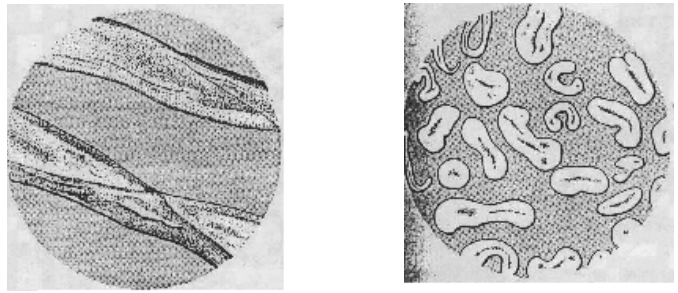
Carding: The shorter fibers are further removed in this process and the fibers are made to lie flat called **slivers.**

Combing: removes more short hairs and makes fibers more parallel.

Spinning: The combed sliver is now converted into yarn by spinning. Scouring and Bleaching is usually done after weaving to enable the cloth to be dyed easily.

Properties of cotton: Cotton fiber is a single cell and varies in length from ½ to 2½ inches. The width varies between 12 to 20 microns.

Microscopic Appearance : Cotton appears as a flat tube with spiral twists in longitudinal view, under cross section it is bean shaped with lumen.



Cross Section Longitudinal

Fig. 1 - Microscopic Appearance of Cotton

Physical properties:

1. The cotton fibers vary in colour (i.e) white to cream.
2. Cotton has low luster, elasticity & resilience.
3. It is 25% stronger when wet than dry and absorbs moisture.
4. Cotton fabrics shrink and hence they are made shrink resistant.

Thermal properties:

1. Cotton burns quickly and readily with a smell of burning paper.
2. It is a good conductor of heat.
3. It will scorch when ironed with too-high temperatures.

Chemical Properties:

1. Cotton is resistant to alkali.
2. Strong acids disintegrates cotton.
3. It is resistant to organic solvents.
4. Mercerized cotton can be dyed easily.

Biological Properties :

1. Cotton is damaged by fungi such as mildew and bacteria.
2. Silverfish lives on cellulose, so it damages cotton fibers.
3. Moths and beetles do not attack or damage cotton.

Uses of cotton:

Cotton is the most widely used fiber because it is inexpensive, easy-care, high absorbency, excellent launder ability and good colourfastness. It is not only used for apparel but also for household and industrial applications.

6.2.2 Silk

Silk has been considered as one of the most elegant and luxurious of fibers. It is popularly known as the **Queen of fabrics**. The method of raising silk worms and removing the silk filaments from the cocoons, and of using the silk in weaving for garments was discovered by **Hsi-Ling-Chi,** a little Empress of China.

Commercial silk is produced by the cultivated silkworm, Bombyx mori, a caterpillar, that feeds on mulberry leaves. The eggs laid by the moth are stored in winter and spread out on trays to hatch in a warm shed. Mulberry leaves are placed as soon as the worms appear, for them to eat.

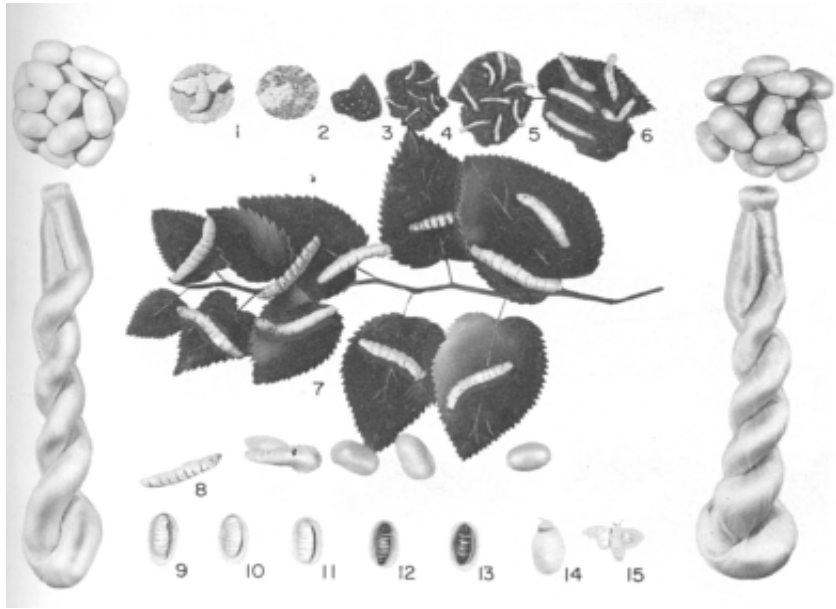


Fig. 2- The life Cycle of Silkworm

l. Laying of eggs 2.Hatching

3.First age 4.Second age

5-Third age 6.Fourth age

7.Fifth age silkworm feeding on mulberry leaves

8.Spinning cocoons

9,10,11,12-Stages of pupa 13,14,15-Stages of moth

(Courtesy International Silk Guild, Inc)

When the worm is fully grown, it starts spinning its cocoon on straw placed on the trays. The silk fluid from special glands issues from two holes, one on either side of the head, called **spinnerets.**

The fluid hardens as it comes in contact with the air and two long fibers which are stuck together with silk gum are formed. The cocoons are heated to kill the pupa inside, otherwise the moths would destroy some of the silk. Some are allowed to become moths to provide eggs.

Manufacture

The manufacturing process involves Reeling, Throwing, Degumming, Weaving, Dyeing and sometimes Weighting.

Reeling: This is a process of unwinding the silk filament from the cocoon. The cocoons are boiled in water to soften the gum so as to unwind the filaments

Throwing: Throwing is a process of combining several reeled strands to make a yarn. The number of strands are twisted together to form a strong yarn.

Degumming : The gum left on the fibers to protect them are now removed by boiling in soap and water. Sometimes degumming is left until the fabric is woven. Weaving is carried out the same way as for other fibers.

Weighting: Weighting is the process of treating silk with certain metallic salts to give weight and body to the product.

Properties

Microscopic appearance

Longitudinally, degummed silk appears as a smooth, lustrous, translucent filament like a glass rod. In cross-section silk show triangular fibers with no markings.

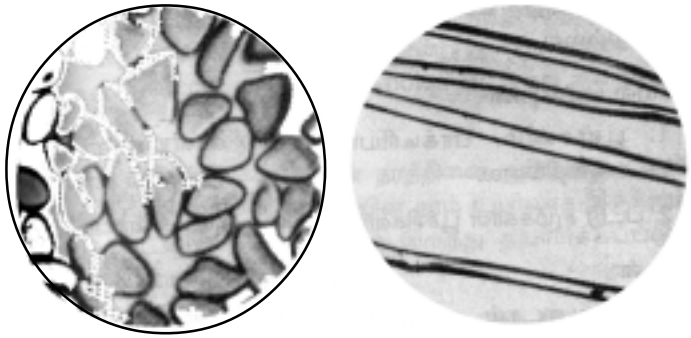


Fig.3 - Microscopic appearance of silk

Physical

1. Silk filaments are very fine and long.
2. It is one of the strongest fibers.
3. It has good elasticity and moderate elongation and resilience.
4. Silk fabrics have good resistance to stretch & shrinkage when dry-cleaned.

Thermal

1. Silk burns directly in the path of flame.
2. It extinguishes itself when removed from flame and gives an odour of burning hair.
3. Silk scorches if ironed at too high temperatures.

Chemical

1. Silk is damaged by strong acids and alkalis.
2. Silk is not affected by cleaning solvents.

Biological

1. Silk is resistant to attack by mild dew, bacteria and fungi.
2. Carpet beetles will eat it.

Use

Silk fabrics are noted for their soft, luxurious handle, rich luster, warmth, resilience, and crease resistance, strength and excellent draping quality. A wide range of fabrics are made ranging from sheer chiffon to

firmer dress and suiting material, to heavy brocades to the rich pile velvet. Silk serves best for ceremonial occasions, evening or day wear and lingerie.

6.2.3 Wool

Wool is a natural protein fiber and considered as Man's **best friend**. Sheepskin, including the hair, was probably used long before it was discovered that fibers could be spun into yarns or even felted into fabric. The earliest fragments of wool fabric have been found in Egypt but **Mesopotamia** is the birth place of wool.

Wool can be sheared from the living animal or pulled from the hide after the animal has been slaughtered for its meat. Sheared wool is called **fleece** or **clipwool** and wool taken from the hides of slaughtered animal is called **pulled wool** which is inferior in quality to fleece or clip wool.

The quality of wool is expressed by numbers. The higher the numbers, the finer the wool and better the quality. The finest wool is from young sheep. Very fine wool of excellent quality is shorn from lambs when eight months old .

Manufacture

Once the raw wool reaches the mills, it has to pass through many processes before it finally emerges as woolen cloth. Sorting, Scouring, Carbonizing, Carding, Spinning, Bleaching, Dyeing, Weaving, Knitting and Finishing.

Sorting : When the bales are opened, the fleece is graded. It may be separated into sections such as shoulders, sides etc.

Scouring : The raw wool is washed in successive troughs of soapy alkaline water of decreasing strength to remove dirt and grease.

Carbonizing : Straw, burrs and other vegetable matter are removed by treatment with acid, heat and pressure of rollers.

Carding: The wool is passed through machine rollers with sharp steel wires which separate the fibers and mix them thoroughly.

Spinning: The mass of carded wool is drawn out and twisted or spun into woolen yarn which is soft and fluffy thread.

Properties

Microscopic Appearance

Wool appears in longitudinal as solid rod with its surface covered with horny scales. The cross- section reveals the cellular internal structure with spindle like ceils in the cortex, which are smaller than those in the medulla

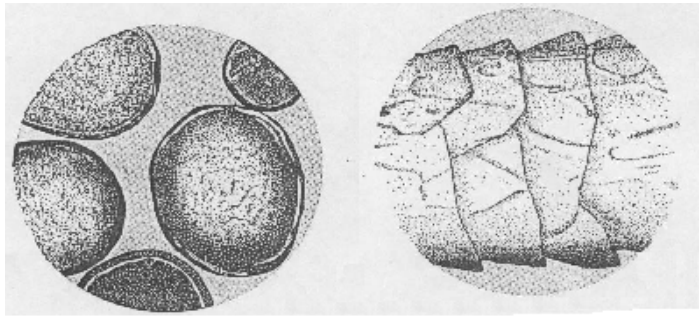


Fig. 4 - Microscopic Appearance of wool

Physical

1. Wool fibers varies in length from 1½ -15 inches
2. Wool after scouring is yellowish - white or ivory in colour. Other wool may be grey, black, tan or brown.
3. Fine & medium wool have more luster than coarse wool.
4. Wool has a natural crimp. The crimp increases the elasticity and elongation properties of the fiber.
5. Wool is weak but has exceptionally good resilience and moisture absorption.

Thermal

1. Wool bums slowly with a slight sputtering and is self extinguishing.

2. A crisp, black, bead-shaped residue is formed and gives a burning hair smell when removed from flame.
3. Wool scorches easily.

Chemical

1. Wool is susceptible to damage by alkaline solution. Even 5% of NaOH will dissolve wool.
2. It is resistant to mild acid but strong concentrated sulphuric acid decomposes wool fibers.
3. Solvents have no damaging effect on wool fibers.

Biological

1. Wool is resistant to bacteria and mildew but if moisture is present both may destroy wool fiber.
2. Wool being protein fiber is a good food source for carpet beetle and the larvae of clothes moth.

Uses

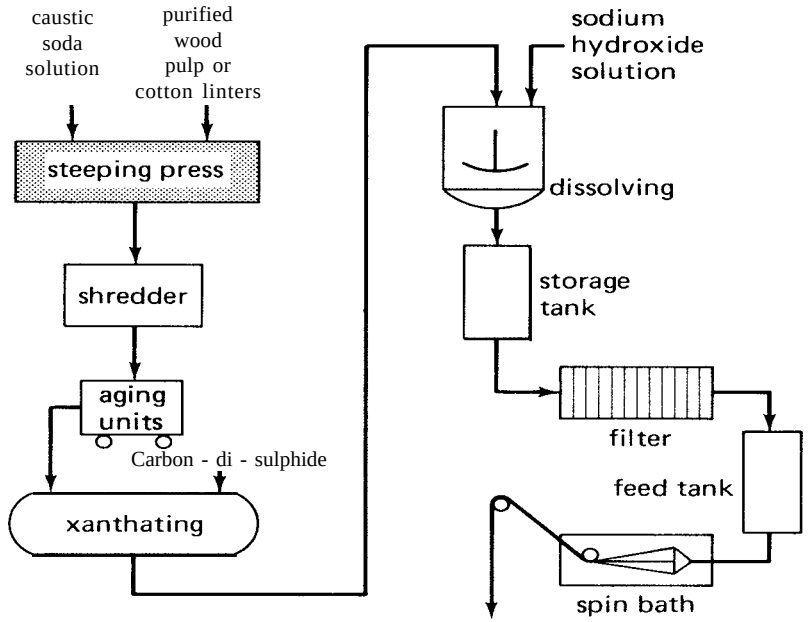
Woolen and worsted fabrics are used throughout the world. They are crease resistant, flexible, elastic, absorbent, warm and comfortable. A major problem with wool fabric is the tendency to shrink. Crimp decreases when wet and increases when dry. Wool can be dry-cleaned but laundering is difficult. Wool can be dyed and has good colourfastness property.

6.3 MAN-MADE FIBERS

These include viscose rayon, polyester and nylon.

6.3.1. Viscose Rayon

Viscose Rayon - The Versatile Fiber is the result of the work of Cross, Bevan and Beadle of England, who in 1892 made the first viscose solution.



to desulfurizing, bleaching, washing, drying, twisting, skeining and combing.

Fig. 5 -Flow Diagram Showing Processes in Viscose Rayon Manufacture

Manufacture

There are three main steps in making rayons. They are,

1. To obtain pure cellulose from the raw material.
2. To form a thick, thread - like liquid from the cellulose.
3. To spin the liquid into hardened filaments of regenerated cellulose.

For viscose, **spruce wood** or **cotton linters**, which yield the cellulose, are used as raw materials. They are treated with caustic soda and carbon bi sulphide to form a thick liquid.

Spinning: The liquid is forced through a spinneret into an acid bath to harden the long filaments, which are stretched and twisted to form the yarn. This is called **wet stretch spinning.** The stretching makes the fibers stronger and the acid and other chemicals in the bath cause the cellulose to re-form or to be regenerated.

Delustering : The filaments have metallic luster, if not treated. They are delustered by putting a white pigment in powder form into the spinning solution.

Dyeing may be carried out after the yarn is spun or pigments may be added to the spinning solution.

Properties:

Microscopic Appearance

The longitudinal appearance of regular viscose rayon exhibits uniform diameter and interior parallel lines called striations.

In cross section viscose fiber shows highly irregular or serrated edges. The presence of delusterants is indicated by spotted effect.

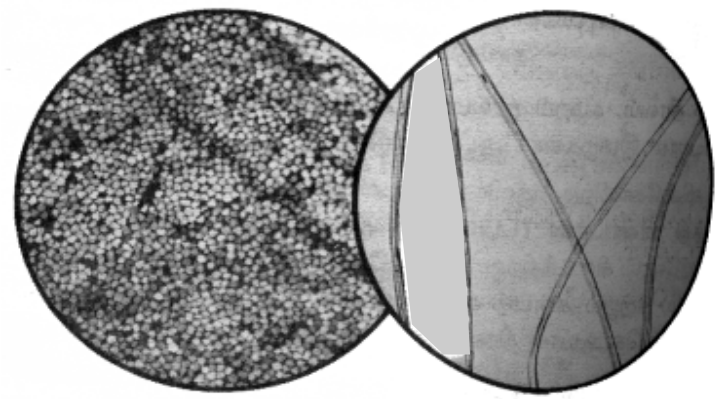


Fig. 6 - Microscopic Appearance of Viscose Rayon

Physical

1. Viscose rayon though resembles silk in appearance, its physical and chemical properties are quite different. However, some properties are like those of cotton.
2. Viscose is absorbent, a burn rapidly, is not elastic, it has low dry strength, much reduced strength when wet and greater stretch.

Thermal

1. Rayon fibers burn rapidly with a yellow flame and give a light grey residue.
2. Afterglow results after extinguishing the flame.
3. Very high temperatures disintegrate the fibers.

Chemical

1. Rayon fibers disintegrate in acids.
2. Strong alkali solution causes rayon to swell and produce a loss of strength.

Biological

1. Mildew and bacteria damage the fibers.
2. Silverfish also destroys rayon fibers.

Uses

Rayon fibers are used extensively in apparel and home furnishing fabrics. It is also used in automobile tyres and various industrial applications. Simple, complex and textured yarns can be made from rayon fibers.

6.3.2 Polyester

During the early stages of fundamental research for Du Pont was done by the Carothers team on polyester fibers. In 1941, J.R. Whinfield and J.T. Dickson of Calico Printers Association introduced a successful

polyester fiber. Dacron polyester has become one of the most used of all synthesized fibers.

Manufacture

Polyester are the product of the reaction between a **dihydric alcohol** and **dicarboxylic acid**. Ethylene glycol and terephthalic acid polymerize by condensation reaction to form the polyester polymer. Dimethyl terephthalate is more frequently used than terephthalic acid because it is easily obtained in pure form. The resultant molten polymer is forced through spinneret and then cooled where it solidifies. It is later cut into small chips, dried and stored until needed for filament formation. The fibers can be used for weaving or knitting.

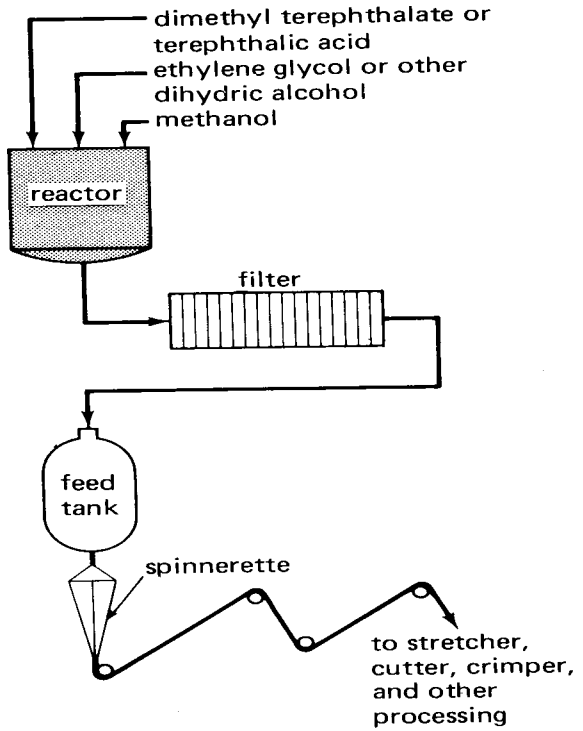


Fig. 7- Flow diagram Showing Processes in Polyester manufacture

Properties

Microscopic Appearance

The longitudinal view of polyester exhibits uniform diameter, smooth surface and a rod-like appearance. The cross-section of regular polyester is round.

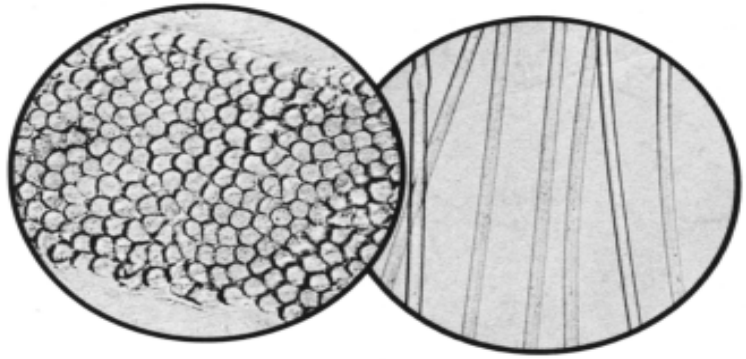


Fig. 8 - Microscopic appearance of polyester

Physical

1. Polyester is transparent and white or off - white in colour. The fiber strength varies due to differences in the formulation of the polymer.
2. There is no loss of strength when the fiber is wet.
3. Polyester has good elasticity, resilience and wrinkle resistance.
4. The fibers are heat-set to prevent shrink and stretch during use.
5. Polyester like cotton and linen has high degree of wickability. This wicking property carries exterior moisture through to the inside, or body perspiration through to the outside.

Thermal

1. Polyester will burn and produce a dark smoke and an aromatic odour.

2. It forms a grey colored bead.
3. Heat setting is essential if polyester fabrics are to possess the easy-care, wrinkle free properties.

Chemical

1. Polyester has good resistance to weak than strong alkalis.
2. It is not affected by acids, but prolonged exposure to strong acids at high temperature may destroy the fiber.
3. It is resistant to organic solvents.
4. Polyester exhibits good resistance to sunlight when behind glass, but prolonged exposure to sunlight weakens the fiber.

Biological

1. Beetles and other insects cut their way through the fabric.
2. Microorganisms will attack fabrics that have been applied with finishes.

Uses

Polyester fibers have immediate consumer acceptance because of their easy-care and wrinkle-free properties. They require no-ironing, easy to launder and quick to dry. Polyesters are not only used as apparel but also in industrial use items such as laundry bags, calendar sheeting, press covers, conveyor belts, fire hoses, fish netting, ropes and protective clothing. An important use of polyester is for surgical implants.

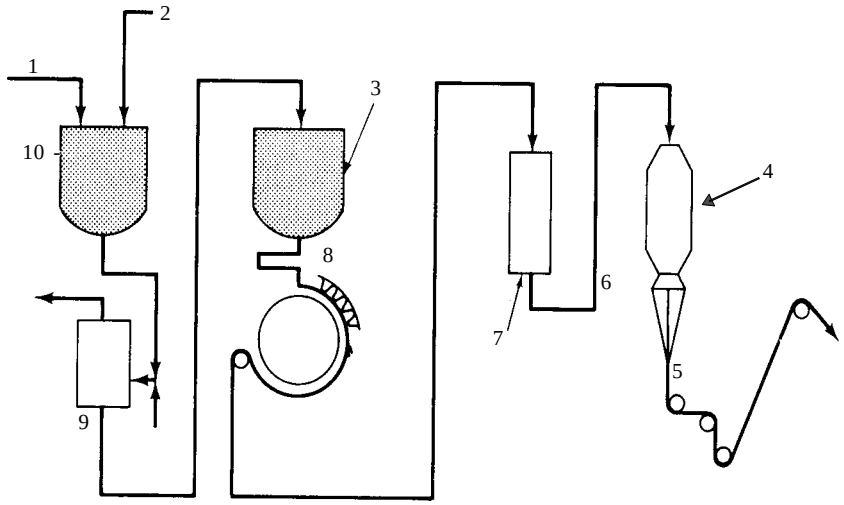
6.3.3 Nylon

Nylon is a man-made fiber developed by Du-Pont company in 1927-29. It was discovered that when a glass rod came in contact with some viscous material in a beaker was pulled away slowly, the substance adhered to the rod and a fine filament was formed which hardened when exposed to cool air. It had excellent stretchability producing a flexible and strong fiber.

Manufacture:

Nylon 6,6 means it has six carbon atoms per individual molecule. Nylon is made by **linear condensation polymerization** process of

the two chemicals, **hexamethylene diamine** and **adipic acid.** After polymerization it is extruded in a ribbon form and chipped into small flakes or pellets. The polymer is melted and extruded through a spinnerette into cool air. Thus the nylon filaments are formed which are stretched to give strength and fineness.



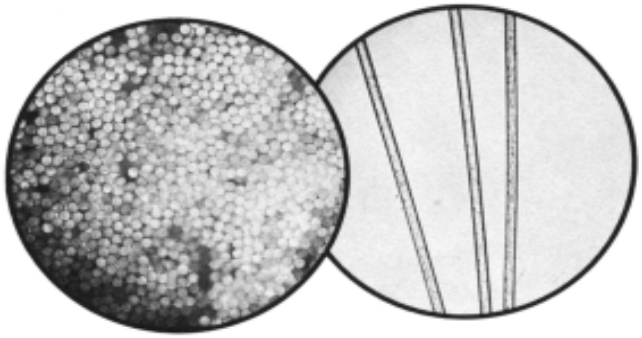
1. Adipic acid
2. Hexamethylene diamine
3. Autoclave
4. Pressure chamber
5. Spinneret
6. Air
7. Chipper
8. Water
9. Water
10. Reactor

Fig. 9 - Flow diagram showing process in nylon manufacture

Properties

Microscopic Appearance

Longitudinal appearance of nylon are transparent fibers of uniform diameter. Cross-sectional view of nylon fibers is perfectly round.



Cross Section Longitudinal

Fig. 10. Microscopic appearance of nylon

Physical

1. Nylon is transparent and can be made bright or dull.
2. It is the strongest of man-made fibers.
3. It has good elasticity, good recovery from creasing and wrinkling.
4. It has low moisture absorbency and resistance to perspiration.

Thermal

1. Nylon melts away from flame and forms a gummy grey residue that hardens as it cools.
2. Nylon is heat set but very high temperatures discolour the fabric.

Chemical

1. Nylon is unaffected by alkalis.
2. Acids disintegrate nylon fibers.
3. Except phenol all other solvents are harmless.
4. Prolonged exposure to sunlight has a destructive effect on nylon and weakens the fabric.

Biological

1. Ants, crickets, and cockroaches will eat nylon fabrics if trapped in creases or folds.
2. Mildew has no effect on the fiber.

Uses

Nylon is widely used for apparel, home furnishing and industry. It is a leading fiber in the manufacture of hosiery and lingerie for it wears well, has good elastic recovery, dimensional stability, shape retention and abrasion resistance. lt is also used as carpeting materials and upholstery fabrics.

To weave or knit a fabric, it is necessary to have yarns. Thus now we move on to the manufacture of yarns from these fibres.

6.4 FABRIC CONSTRUCTION

The quality of cloth, its suitability for different purposes, and its performance in wear and cleaning cannot be assumed entirely from a knowledge of its fibers. The method by which the fibers have been combined to form yarns, and the ways in which the yarns have been interlaced to form the material are very important.

Yarns are composed of textile fibers. Yarns play an important role in determining the characteristics of the great variety of fabrics. Much of the beauty, variety and texture of fabrics is due to yarn differences.

Yarn as defined by ASTM (American Society of Testing Materials) is "**A generic term for continuous strand of textile fibers or filaments in a form suitable for knitting, weaving or otherwise interwining to form a textile fabric".**

Yarns are of two types

1) Short staple fibers are derived from natural fibers that are short in length or they may be composed of man-made fibers or silk fibers that have been cut short.

2) Long filament fibers obtained by extruding the chemical liquid through fine jets in the spinnerette.

6.4.1 Classification of yarns

Yarns are classified as simple, complex and textured yarns.

- A simple yarn is composed of two or more simple single yarns plied or twisted together. A ply yarn consists of two or more singles twisted together and a cord yarn consists of two or more ply yarns twisted together.

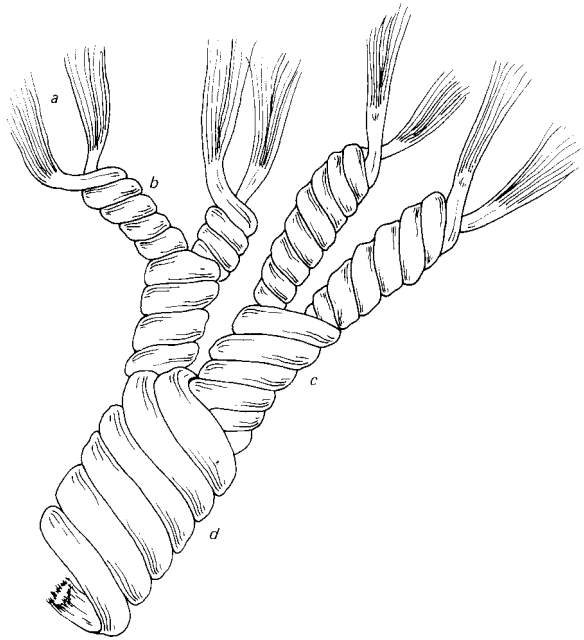


Fig 11 - Yarn Structure

a) fibres b) singles c) ply yarn(s) d) cord yarn(s)

- Complex or Novelty yarns are different from simple yarns in structure, size, twist and effect. Complex yarn may be composed of single or ply. Complex ply yarns are composed of a base or

core, an effect and tie or binder yarn. The base yarn controls the length and stability of the end product. The effect yarn forms the design and the tie or binder yarn holds the effect yarn so that it will remain in position.

- Textured yarns have greater apparent volume than other yarns of similar fiber count and linear density. The yarns have a relatively low elastic stretch and the greater volume is achieved by physical, chemical or heat treatment.

6.4.2. Processing of yarns

Yarns are made from fibers by two processes - General which is common to many yarns and texturizing to obtain special textured effects such as extra bulk, stretch or a combination of these properties in the fabrics made from them.

The **General** processes include opening, picking, cleaning, blending, degumming, scouring, carbonizing, carding, combing, drawing, spinning, throwing, slashing, rewinding as discussed in the earlier chapters in the manufacture of natural fibers. No fiber goes through all these processess. Texturing process are primarily applicable to man-made fibers and particularly to thermoplastic fibers.

Texturizing imparts a permanent **curl, loop or crimp** to the individual filaments, so that when they are recombind, the yarns are more or less fuzzy - appearing and have stretch, bulk or both. Textured yarns do not have free fiber ends to pull out, roll up, or pill. They are more opaque, have a different appearance, feel, warmth and more absorbent.

Yarns thus formed are now used in the manufacture of fabrics. Woven fabrics consists of sets of yarns interlaced at right angles in established sequences. One of the process of fabric manufacture is **weaving**.

6.4.3 Weaving of Fabrics

Weaving is the process most used for the manufacture of textile fabrics (John Hoye, 1942) In weaving two or more set of yarns are

interlaced at right angles to each other. The warp yarns run in the lengthwise direction in a woven fabric also called as **ends.** The filling yarns run in the crosswise direction also called as **picks.** Extra warps yarns at each side form a selvedge which is parallel to the warp yarns.

The machine for weaving is a **loom**. Loom are of different types varying in their complexity from the most primitive to the most modern, operate on the same principles. A diagram of a simple loom is shown in figure-12.

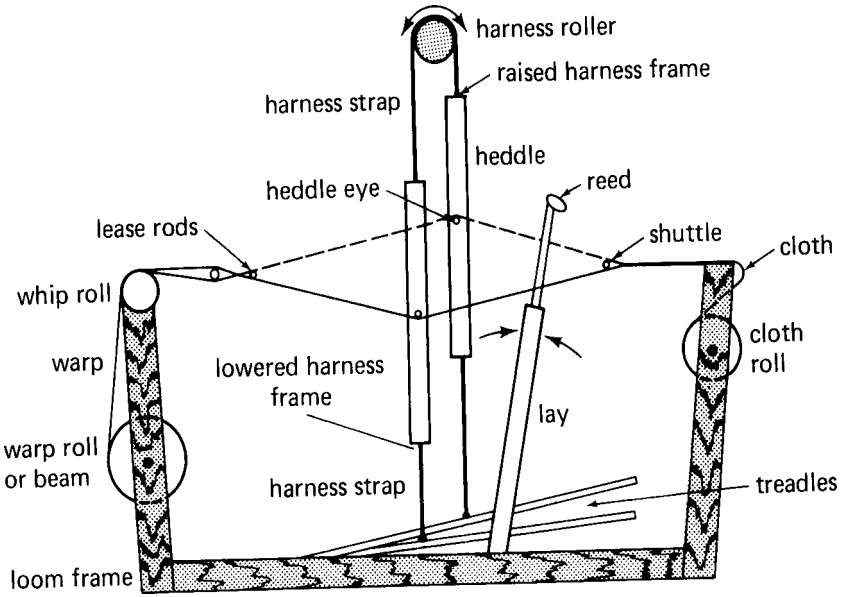


Fig.l2-Simple loom

The essential parts of the loom are - the warp beam which holds the lengthwise yarns is located at the back of the loom and release yarns as needed. The harness is the frame which holds the heddles in position. The heddles are the wire or metal strips with an eye at the centre through which individual yarns are threaded. The harness can be raised or lowered to produce the shed. The reed is a comb-like device which determines the cloth width and acts as a beater bar. The filling

yarns are carried by shuttles or bobbins across from side to side. The cloth beam is present at the front of the loom which rolls the fabric as it is woven.

The basic weaving operation includes :

Shedding : The harness can be raised or lowered which has the warp yarns by means of heddles to form the shed. The filling yarns pass from one side of the loom to the other through the openings of the warp yarns.

Picking : The filling yarns are carried by the shuttle across the shed, laying the filling in position.

Battening or Beating consists of evenly packing the filling yams into position in the fabric with the reed.

Taking up involves the taking up of the newly made fabric on the cloth beam and **Letting off** involves releasing thread from the warp beam for the weaving operation.

6.4.4. Different types of Weaves

Weaves are classified according to the interlacing of warp and weft yarns and the number of warp and weft yarn used. Variety can be achieved by using the basic weaves plain twill and sateen by varying the number of warp and weft yarns used.

The different types of weaves are :

Plain Weave

This is a simplest form of weaving. The weft yarn passes over one warp yarn and under the next alternately across the entire width of the fabric. Plain weave has no wrong side unless coloured finish is applied to differentiate right or wrong side. Attractive fabrics can be obtained by varying the number of warp yarns and filling yarns. Most fabrics are made using plain weave. It produces strong and durable fabrics.

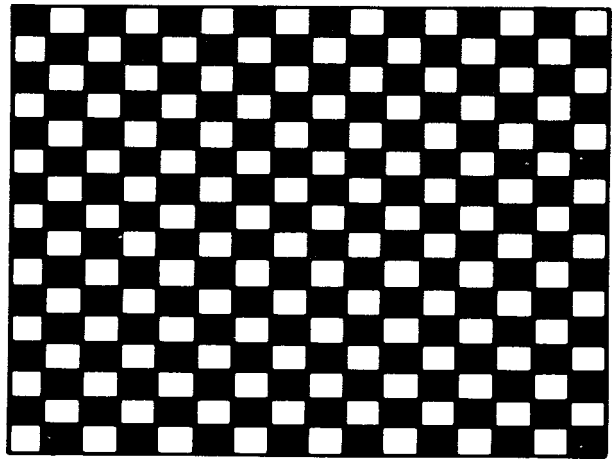


Fig.l3-Plain weave

Rib Weave:

The rib appearance is produced by using heavy yarns in the warp or filling direction, by grouping yarns in specific areas, or by having more number of yarns in warp than filling. Examples are poplin, broadcloth and grosgrain.

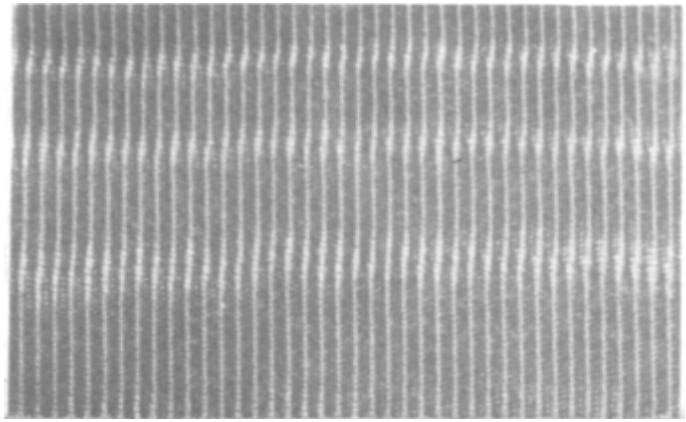


Fig. l4 - Rib weave

Basket Weave

Two or more weft yarns pass alternately over and under two or more warp yarns. In this construction the fabrics are not durable, but are more decorative. Examples are coat and suit fabrics, hopsock.

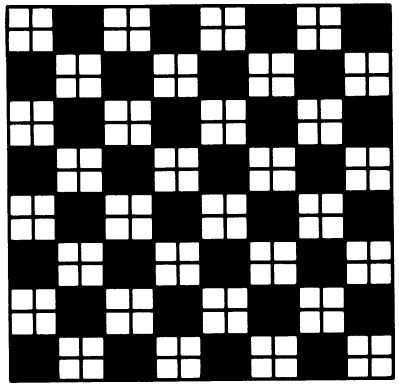


Fig. l5 -Basket weave

Twill weave

The second basic weave pattern is the twill weave. A twill weave always shows diagonal ridges across the fabric. The twill or diagonal weave may run from left to right, or from right to left, both on the face and back of the cloth. The simplest twill weave uses three warp yarns and three weft. Twill weave has increased strength and warmth but more easily worn by abrasion. Examples are denim, drill, jean, some flannel and suitings.

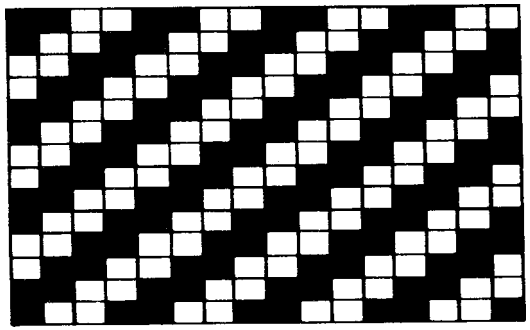


Fig. 16 - Twill weave

Satin Weave

This weave makes use of low-twist floating warp yarns of lustrous man-made or silk filaments. The warp yarns pass over a number of weft yarns and under one alternately, so that the warp floats are on the surface along the length of the fabric. The weft yarns are hardly noticeable. A variation of the satin weave in which the filling yarns float on the surface of the fabric is **satin** weave. Example damask, sateen, ticking and Venetian

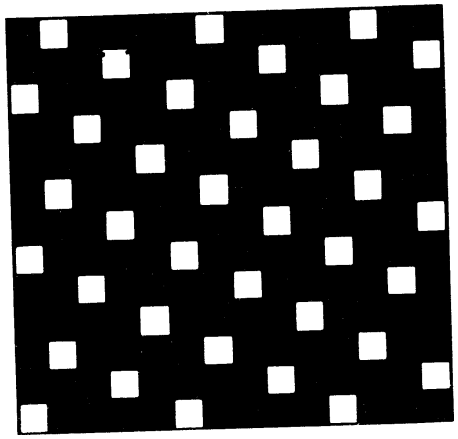


Fig. l7 -Satin weave

6.4.5 Novelty Weaves

Novelty Weaves are also called as decorative, fancy, figure and design weaves. They are formed by predetermined changes in the interlacing of warp and filling yarns. The different weaves include dobby, jacquard, leno, pile and double cloth.

Dobby Weave

Dobby designs have small figures such as dots, geometric designs and floral patterns woven into the fabric. The design is produced by a combination of two or more basic weaves and the loom may have upto thirty two harnesses. Examples of dobby weave are shirting madras, pique, huck towelling.

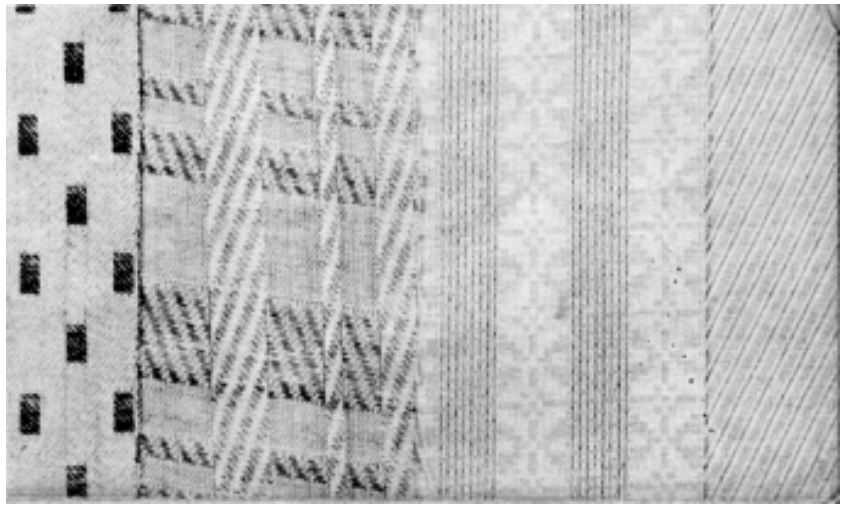


Fig. l8 - Dobby weave

Jacquard designs

Fabrics with elaborate designs are woven using the Jacquard loom attachment. It was introduced by Joseph Marie Jacquard in 1801. The Jacquard mechanism has the ability to control every warp yarn instead of a series as in regular harness looms. The machine is very big and very expensive. The pattern for the Jacquard loom is transferred to a series of perforated cards, one for each filling pick in the pattern.

The card is punched so as to permit the needles on the machine to be raised to pass through the card. The shed is formed and the pick passes through each card stops on the cylinder for its particular pick, moves on, and new card takes its place. This process continues until all the cards are used. Thus when pattern is over the cards start for the next till the entire cloth is woven. Thus extremely complicated and decorative woven designs are produced using jacquard loom attachment. Examples include brocade, damask, tapestry, terry-cloth towels.

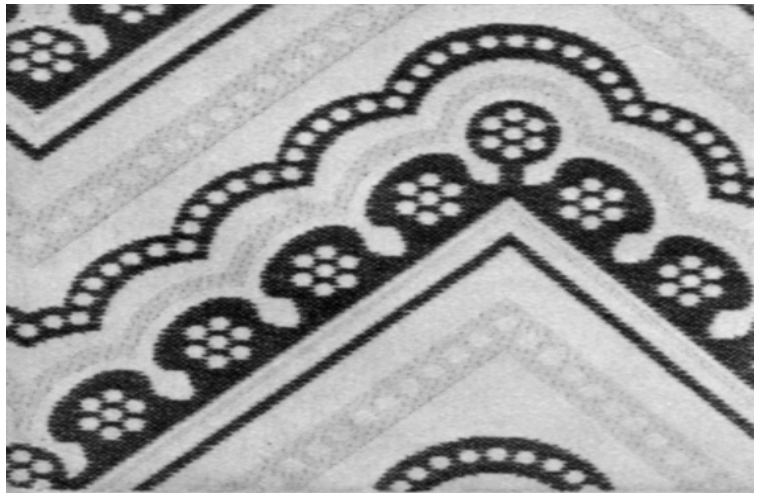


Fig. l9 - Jacquard weave

Leno Weave

The leno weave produces an open-textured fabric that may be sheer or heavy. It is produced by the doup attachment to the basic loom. The doup attachment controls the warp threads horizontally as well as vertically and the unusual warp interlacing prevents slippage of the filling and reduces shrinkage. Examples include mosquito nets, household bags and curtains.

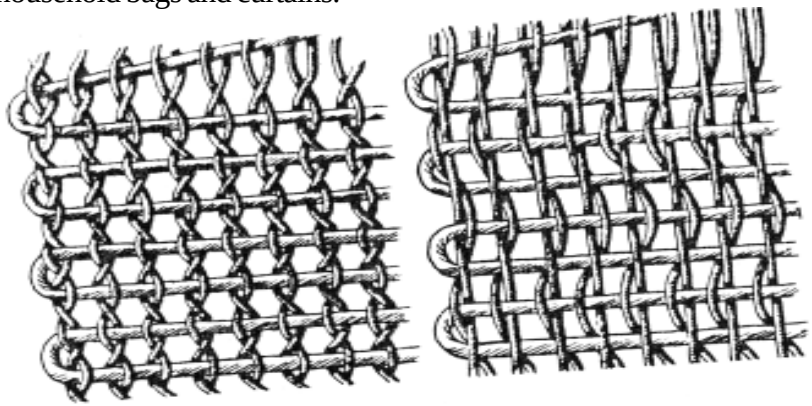


Fig. 20. Leno weave

6.4.6 Surface Figure Weaves

Extra warp or filling yarns can be interlaced on the basic weaves to produce different designs. These include

Lappet Weave

In lappet weave an extra warp yarn is introduced in a manner so as to create design on the base, fabric. Patterns are woven in the fabric by an attachment to the loom. Long floats formed on the back of the fabric are cut away, if floats are small they are usually left. Example: fancy sarees.

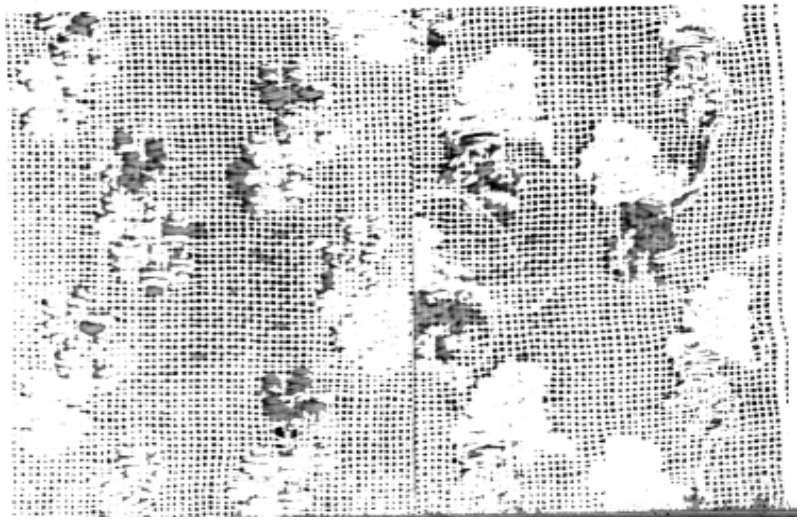


Fig.21 -Lappet weave

Swivel Weave

The Swivel weave differs from lappet in that designs are produced by extra filling yarns. Separate shuttles are placed at each point where the design has to be made. The shed is formed by the pattern, where the shuttle carries the yarn through the shed, the distance of the pattern. The extra filling floats on the back of the fabric, the long floats is cut away after weaving is completed. Example : silk sarees.

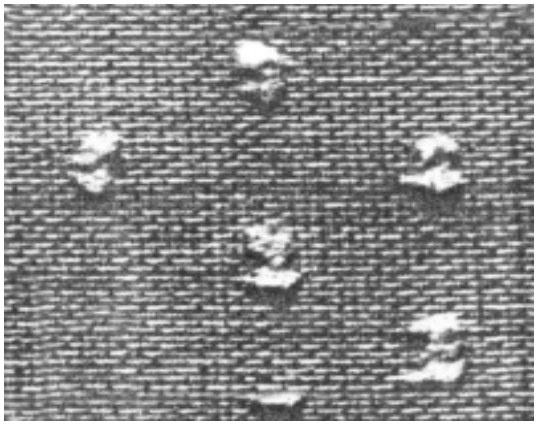


Fig. 22-Swivel weave

Spot Weave

Spot designs are formed by extra warp or filling yarns. The yarns are inserted the entire length or width of the fabric, spots or dot designs are formed. The long floats on the back side are cut away, leaving the dots. The threads can be pulled easily. Filling threads are easy to cut but warp floats are difficult. Example : dotted swiss.

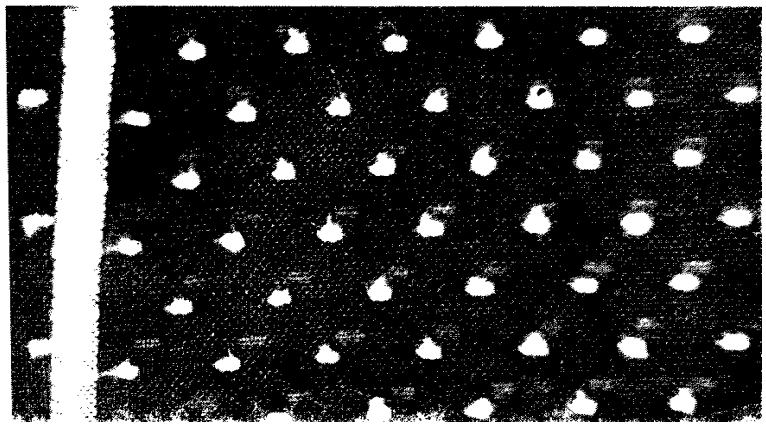


Fig. 23-Spot weave

6.4.7. Pile Weave

Pile fabrics are formed by having the basic plain or twill weave as a backing and a third yarn is woven to yield a surface pile. The pile may be warp pile or weft pile. For making ground fabric, plain or twill weave is used, the extra set of filling yarn floats over three or more warp yarns. The floats are cut and brushed up to form pile. This is called filling pile. Examples are velveteen and corduroy fabrics.

If an extra warp yarn floats over the filling yarn, it is called warp pile. Examples are velvet, velour and rug velvet.

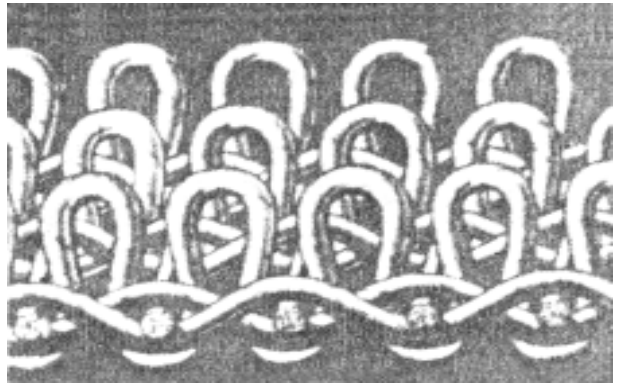


Fig. 24 - Pile weave

6.4.8. Double weave

Double weave fabrics are obtained by using five or more set of yarns. The most common types of double cloth have two set of warp and two set of weft yarns with an extra yarn interlacing both the cloth. The double cloth has additional bulk, strength and warmth. Examples are coatings, blankets, double brocade and brocatelle.

6.5.FINISH AND COLOUR APPLICATION

Fabrics which reach the consumer are finished by one treatment or other. Except for the white fabrics, colour is applied to all the fabrics. **“A Finish is any treatment given to a fabric to change its appearance’.** The fabric can be finished so as to be smooth, shrink

resistant, easy care, flame resistant, etc. Finishes can be divided into two types, general and functional.

General finishes or routine finishes are identified as mechanical, chemical or combination of the two. Durability or performance of the finish is considered, and fibres and fabrics usually receiving the treatment are identified, if there are special problems or types involved. In other words it is a basic procedure in preparing fabrics for consumer use. Example: Bleaching, Heatsetting, Mercerization.

Functional finishes are those which alter, improve or change the behavior or service characteristics of the fabric and produce certain properties. Example: A durable press fabric, A waterproof fabric.

Scouring : Fabrics can be scoured by immersing them in 2- 4 percent of caustic soda (NaoH) with addition of wetting agents and emulsifiers under heat to remove waxes, foreign matter and discolouration.

Bleaching : Bleaching is done to fibers, yarns and fabrics to make them white or prepare them for dyeing and printing. It is a chemical finish where sodium chloride or hydrogen per oxide bleach is used to bleach the fabrics. The chemical for bleaching depends on the textile fiber. Cellulose fabrics such as cotton can be bleached with sodium hypochlorite whereas silk and wool respond well to hydrogen peroxide.

Calendering (Pressing) : Calendaring is also called pressing done on cotton, wool, silk as well as rayons. It is a mechanical process where the fabric is fed between flat, heated plates and pressed under heat and pressure. As for wool the fabric is fed between needle boards, which help retain the pile finish. Calendering must be renewed after each laundering or cleaning.

Heat Setting : Mostly thermoplastic fibers are given heat-setting finish to produce fabrics which are wrinkle resistant, good elastic recovery, and give relative permanent design details such as pleats, planned creases and surface embossing. The fibers are exposed to a certain temperature called the glass transition temperature

(Tg temperature) where they are shaped. If at any later period the fabric is exposed to temperature higher than Tg temperature the fabric may take a new shape. So fabrics should be laundered or dried under the Tg temperature.

Mercerization : Mercerization is a chemical finish mostly done on cotton fabrics. The fabric is immersed in 16-27 percent of sodium hydroxide and fed between rollers for a specific period of time. Then it is passed on a tentering frame to have specified dimensions. At last it is washed and dried. This process causes the fabric to have increased luster, improves dying characteristic and strength.

Sizing : Sizing is a process of stiffening materials to yarns or fabrics. Sizes is composed of starch or resin. Starch is applied mostly to cellulose fabrics to improve its luster and to add strength. Resin when applied reacts with the fiber molecules and chemical change occurs in the fiber. Starch is applied to the fabric which then passes between rollers that pad the starch into the fabric and remove excess solution. Thus a fabric with additional stiffness and improved luster is obtained.

Tentering : Tentering is a mechanical finish where the fabric is held horizontally by each selvedge between pins. There is a tenter frame which moves with a speed slightly higher than the speed with which the chains holding the fabric are moving. This process straightens the fabric which involves many finishing processes like mercerizing, resin finishing and drying.

Weighting : Weighting is a process applied to silk fabrics. After removal of gum (i.e) degumming, the silk fabric, becomes very soft. To make the silk fabric heavy and stiff, the Federal Trade Commission ruled out that silk fabric can be given stiffness by addition of 10% stannous chloride a metallic salt. If this 10% exceeds very high the silk fabric tends to crack and split. Weighted silk has body and density but they are not durable and can be damaged by sunlight, air and perspiration.

Water proofing : Water proof finishes are those that prevent water entering the fabrics. These fabrics do not allow air also to enter and thus not suitable for wearing apparel. Earlier, **rubber, oxidized oil or varnish** were used to waterproof fabrics. Modern fabrics are coated with **synthetic** polymers.

6.5.1 Dyeing and Printing

Dyeing and printing are the methods of applying colour to white fabrics. **Dye is a substance which is fixed more or less permanently on the fabric which evokes colour.**

Types of Dyes

Dyes are classified according to hue produced, chemical class, method of application and the types of fibers to which they are applied. Some of the different dyes include :

1. **Direct Dyes :** Direct dyes are water soluble and are applied mostly to cellulosic fibers. These dyes are dissolved in water and salt is added to control the absorption rate of the dye by the fiber. Then the cloth which is to be dyed is immersed. Direct dyestuffs have relatively excellent light fastness and good colourfastness to sunlight.
2. **Acid Dyes :** Acid dyes are used on protein, acrylic and nylon fibers. They have no affinity for cellulosic fibers and are not suitable for fibers which are sensitive to weak acid solutions. They have excellent lightfastness and some have good colourfastness to dry cleaning and perspiration.
3. **Basic Dyes :** Basic or cationic dyes are excellent for colouring acrylic fibers. They are mostly used as "topping" colours to give brilliant colour effects on fabrics. Because of the variety of colour effects produced, it is successfully used on modified nylon and modified polyester.
4. **Vat Dyes :** Vat dyes have excellent colourfastness property and is suitable on all cellulosic fibers and man-made fibers. It is not suitable on protein fibers because of the alkaline bath which will

damage the fibers. There is a wide choice of colours in vat dyes and they withstand hard wear and are fast colours.

5. **Reactive Dyes:** Reactive dyes are suitable for mostly all fibers-cellulosic, wool, nylon, silk, acrylics, as well as blends. Bright colours with excellent wash fasteness & colourfasteness are obtained. Colour fasteness to crocking, perspiration and fume fading are excellent.

6.5.2. Application of Dyestuffs

There are four stages of manufacture in which colour may be applied to textile materials.

a) **Solution :** Pigments or dyestuffs are dispersed in the spinning solution where the fibers are manufactured. There are some difficulties in this process of obtaining colour on fabric.

b) **Fiber Dyeing :** Fibers are dyed in their loose state where the fibers are less tangled and dyed thoroughly. Fiber dyeing is expensive to produce. There is better penetration of the dye into the fiber which produces a higher degree of colourfasteness on fabrics. Direct, sulphur, vat and developed dyes are used on cellulose fibers.

c) **Yarn Dyeing :** Yarns are dyed by three methods namely, skein dyeing, package dyeing and beam dyeing. Yarn dyeing is best adapted to large- quantity dyeing. Gingham, chambrays, denims and madras are dyed by this method. Vat dyes are mostly used as well as limited amount of other dyes.

d) **Fabric Dyeing :** Fabric dyeing consists of either piece dyeing the fabric or printing followed by an after treatment to fix the dye. Piece dyeing is nothing but most solid color fabrics are dyed after the fabric has been completed. Fabrics made of cellulosic fibers, cotton; rayon and flax are most frequently piece dyed.

6.5.3. Printing

Designs are applied on fabrics by means of printing. Printed fabrics are defined as those that have been decorated by a motif, pattern or

design applied to the fabric after it has already been constructed (Marjory-Joseph, 1977) Printing can be done by two basic methods - Resist printing and Direct printing.

Resist Printing : Resist printing is done by preventing the dye to enter some specific portions of the fabric by some methods.

1. **Tie and Dye :** Fabrics are made into tiny puffs with some object inside and tied with a waxed thread wherever the dye has to be prevented. The fabric is immersed in the dye solution. If two or more colours are desired the thread is removed and the fabric retied. After drying the object is removed. Other methods of tie and dye include folding the fabric and stitching it and pulling the threads to draw the fabric to resist the dye from penetrating into the fabric, called as **tritik**.. Tie & dye fabrics are quite popular in apparel and home furnishings.

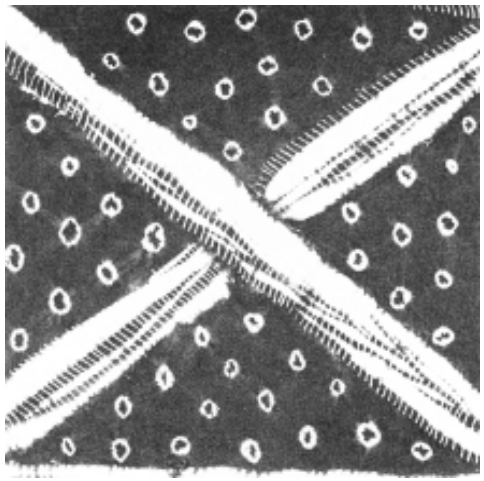


Fig.25-Tie and dye

2. **Batik :** A resist method developed by the Javanese involves wax as the resist substance. A copper cup called tjanting is attached to a reed handle. The wax is taken in this tjanting and applied in the design areas, wherever necessary to resist the dye. The fabric is

immersed in dye solution. The wax resists the dye from entering the fabric. In some places it forms cracks and forms fine lines in the design. The fabric is later washed in boiling water to remove the wax.

Fig. 26 - Batik

3. Screen Printing

A screen resist is made by covering a frame with bolting cloth of silk, metal or nylon filament yarns. The fabric is covered with a film and the design areas are cut out of the film. Some areas of the mesh are left open to allow the dyestuff to pass through and print the fabric.

The frame is laid on the fabric, and the dye is placed at one end of the frame. A rubber knife moves the dye across the screen and forces the dye through the open mesh of the fabric, One screen is prepared for each colour. Screen printing is considered by many textile authorities to be newest method of decorating fabrics.

Fig. 27-Screen printing

4. Discharge printing :

Discharge printing is used to print designs on fabrics which has been previously dyed. A reducing bleach is used which removes the base dye and leaves a white pattern on a coloured ground. Dark fabrics with white designs such as polka dots are examples of discharge printing.

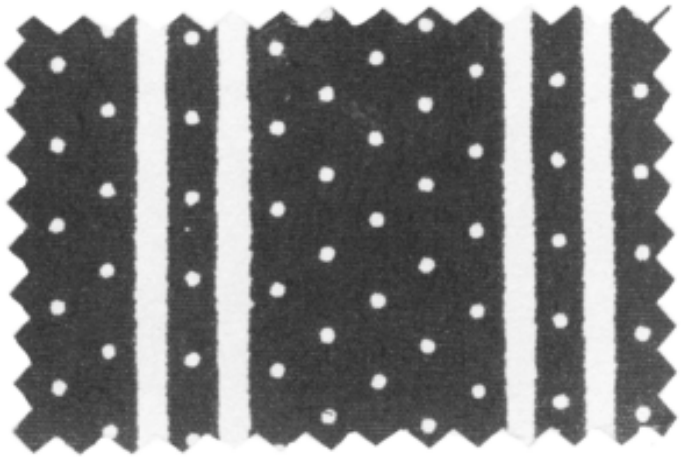


Fig.28 -Discharge printing

Stencil printing : Stencil printing was developed by the Japanese. Designs are cut in stencil paper which is coated with wax. The stencil designs are placed on fabric and colour is applied by sponge, air brush or by spray gun. This method is done on minimum fabrics like scarves and similar products.

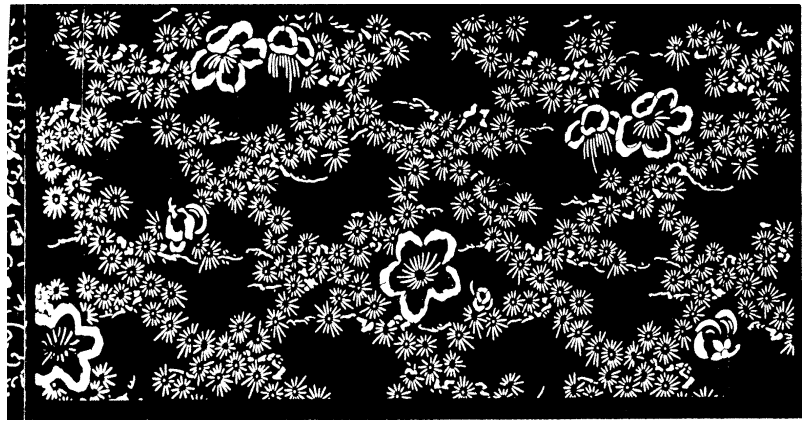


Fig.29-Stencil printing

Direct Printing

Direct printing is the method of applying colour directly on to the fabrics by one of the following methods.

1. Roller Printing: Designs are engraved in metal rolls and arranged around a main cylinder and locked into place. Many rolls can be used. A trough containing the dye solution along with a doctor blade which scrapes of the excess dye is placed for each roll. The large cylinder is covered by a padded blanket and a grey cloth is used on top of the printing blanket.

The cloth to be printed is on the outer surface. The layers move together, the rolls take up the dye from the trough print on the cloth as it comes and goes to the drying oven which sets the colour on the fabric. Roller printing is steadily increased during the past decades for its quality prints and unusual patterns produced.

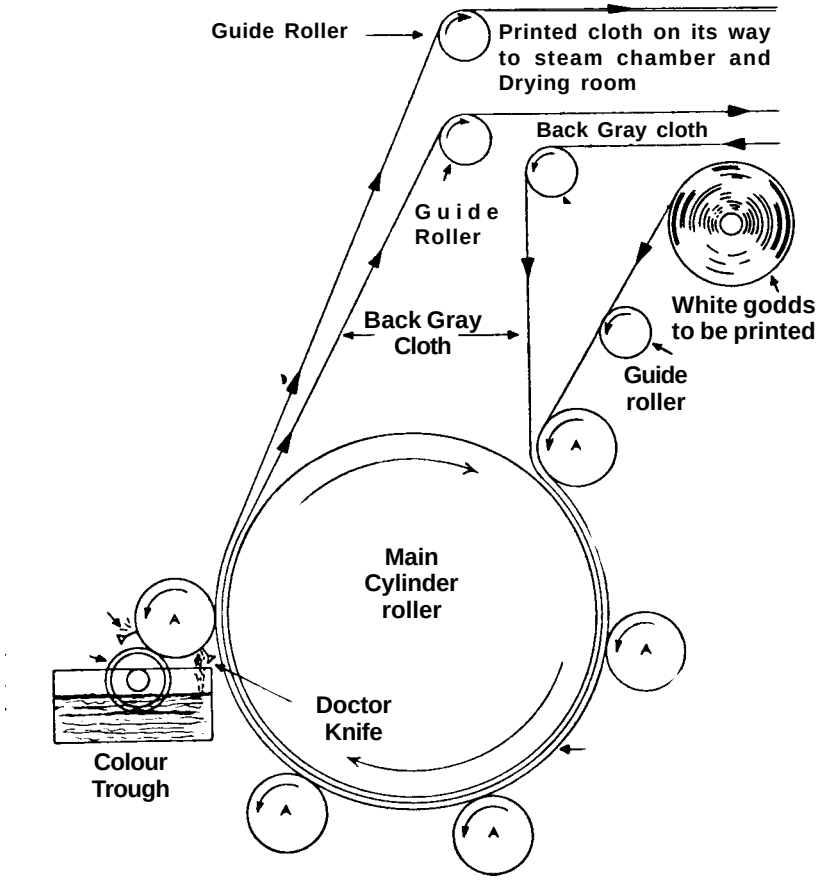


Fig. 30 - Roller Printing

2. Block printing :

Block made of wood or metal are engraved with designs. Each block prints only one colour. The blocks are dipped in dye solution. Only the raised portion in the blocks picks up the dye and is then pressed on the fabric, forcing the dye to be printed on the surface.

Fig. 3l -Block printing

3. Duplex prints

Duplex prints are produced by modified direct roller print equipment. The design is made by a machine, which is set up to print on both the face and back of the fabric.

4. Photographic prints

Photographic prints are made similar to that used in making photograph. A negative is placed on the fabric and light is transmitted to it and the design is developed. The fabric is washed and the design is as permanent as a photo.

5. Transfer printing

Transfer printing involves heat and pressure. The dye in the desired design, is first printed onto a special paper. The paper is laid on the fabric and the design is transferred by-sublimation. The dye is changed from solid state on, the paper to vapour and again changes to solid and fixes on the fabric. The heat sets the colour on the fabric. Transfer printing is suitable for nylon and some acrylic fabrics.

Practical

1. Collect samples of fabric and study the characteristic for identification.
2. Carry out burning test for different fibres in small samples of fabric, colourfastness test-to laundering, dry cleaning, sunlight rubbing, crocking and ironing.
3. Collect samples of fabrics and identify the different weaves.
4. Dyeing - plain, tie and dye, painting a small fabric using fabric paints and vegetables, stenciling. Make your own fabric samples.

Procedure for practical

Tests for fibre identification

The Burning Test

The burning test is a good preliminary test. Although it does not identify fibres specifically, it provides valuable data regarding appropriate care. The procedure is as follows:

1. Select one or two yarns from the warp of the fabric.
2. Untwist so that the fibres are in a loose mass.
3. Hold yarns in forceps; move them towards the flame from the side.
4. Observe the reaction as they approach the flame.
5. Move them into the flame, and then pull them out of the flame and observe the reaction.
6. Notice any odour given off by the fibre.
7. Observe ash or residue formed.
8. Repeat for the filling yarns of the woven fabrics.

Home tests for colourfastness of fabrics

Dry cleaning

Take a sample fabric, approximately 2 by 4 inches, and immerse in cleaning solution for 10 to 20 minutes. Observe to determine whether any colour has bled into the cleaning solution, then dry and compare the sample with an original piece to determine colour change.

Laundering

A small fabric sample can be taken from seam allowance or hem of a fabric. Take one cup of water and one teaspoon of soap or synthetic detergent in a jar. Add the fabric sample. Shake the jar frequently and allow the fabric to remain in solution for 10 minutes. Observe the colour of the wash water. Rinse the sample in warm water atleast twice and observe any loss of colour into the rinse water. Dry the sample and compare it with the original fabric to determine whether any colour change has occurred.

Sunlight

Textile fabric that is exposed to sunlight for many hours each day such as curtains and draperies should be colourfast to sunlight or sunfast. Expose the fabric to sunlight between 10.00 am and 4.00 pm, standard time, the period between may and September, Keep a record of the number of hours of exposure. Compare the sample with an original at frequent intervals.

Ironing

Colour may be altered by ironing or pressing with either dry or wet heat. When dry heat is used, the fabric will usually return to its normal colour after cooling. Press the: sample fabric with iron set at the temperature recommended for the fibre. Observe any colour change. If colour does change, observe the fabric as it cools to determine whether it returns to its original shade.

Rubbing and Crocking

Place small square of white cotton fabric preferably muslin or percale over the forefinger. With even pressure rub the white fabric atleast ten times over a coloured one. Observe to see whether the colour rubs off onto the white square of fabric. Repeat with the white square of fabric that has been moistened thoroughly. Either by test, using home methods or laboratory equipment, or label information a consumer has the ability to determine, to some degree atleast, the care a product will require.

CHART OF BURNING CHARACTERISTICS OF FIBRES

Fibres	Cotton	Silk	Wool	Rayon	Polyester	Nylon
Approaching flame	Ignites upon contact, does not shrink away.	Gurls away from flame	Curls away from flame	Ignites upon contact, does not shrink away	Fuses, melts and shrink away from flame	Melts way from flame, shrink and fuses
Inflame	Burns quickly	Burns slowly and sputters	Burns slowly	Burns quickly	Burns slowly and continuous to melt	Burns slowly with melting
Removed from flame	Continues burning, after glow	Usually self extinguish	Self extinguishes	Continuous burning, after glow	Self extinguishing	Self extinguishing
Odour	Similar to burning paper	Similar to burning hair	Similar to burning hair	Similar to burning paper	Chemical odour	Celery
Residue	Light, feathery ash grey in colour	Crushable bead, black in colour	Brittle, small black bead	Light, fluffy residue, very small amount	Hard, tough, black or brown bead	Hard, tough, grey tan bead

QUESTIONS

Section -A

I. Fill in the blanks

1. _____ are the smallest visible units from which fabrics are made.
2. Cotton has low _____.
3. _____ is a mineral fibre.
4. Cotton is referred as _____.
5. Silk is known as _____.
6. _____ is the process of treating silk with metallic salts to give weight and body to the product.
7. _____ is from young sheep.
8. Viscose rayon is called as the _____ fibre.
9. Polyester burns with an _____ odour.
10. Yarns are made from _____.
11. _____ is the process most used for making fabrics.
12. _____ printing is a direct printing method.

II. One Word Question

1. Name a protein fibre.
2. What is the name of the silkworm?
3. What type of fibre is wool?
4. How is colour applied on fabric?
5. Which is the strongest man-made fibre.

6. Name a decorative weave.
7. What are the two methods of printing?

III. Match The Following

1. Cotton	Synthetic Fibre
2. Dyes	Short fibres
3. Nylon	Vegetable fibre
4. Protein Fibre	Lustre
5. Stape yarn	Wool
6. Sizing	Direct Printing
7. Mercerization	Produces colour
8. Roller Printing	Starch
9. Duplex Printing	Resist Printing
10. Tie and Dye	Modified Roller Print

Section -B

1. Give the uses of cotton fibre?
2. Give the physical properties of silk fibre.
3. Give the microscopic appearance of wool fibre.
4. List the thermal properties of polyester.
5. What are the three types of yarns?
6. What is a Novelty weave?
7. What is a Lappet Weave? Give example.
8. Discuss scouring.
9. Define dyes. Give two examples of dyes.
10. What are Vat dyes?
11. What is Piece dyeing?
12. What is Block printing?
13. How is Batik done on fabrics?

Section - C

1. Describe the physical, chemical and thermal properties of cotton fibers.
2. Describe the manufacture of silk fibers.
3. Describe the physical and thermal properties of silk fibers.
4. Discuss the properties of viscose rayon fibers.
5. Give the classification of yarns.
6. Discuss the parts of a loom?
7. Define finish. Discuss general and functional finishes with example.
8. Discuss the types of dyes.
9. Discuss the different types of direct printing methods.
10. Describe the various novelty weaves with examples.

Section-D

1. Describe the manufacture of Viscose rayon and discuss its properties.
2. Describe the manufacture, properties and uses of cotton fibres.
3. Give the classification of yarns and how are yarns processed?
4. Discuss Weaving mechanism and its operation?
5. What are the different types of Weaves? Explain Plain, Twill and Satin Weaves with examples.
6. Explain the various finishing methods used on fabrics
7. Write notes on

   a) Tie & Dye b) Batik c) Roller Printing

   d) Photographic Prints e) Transfer Printing with examples.