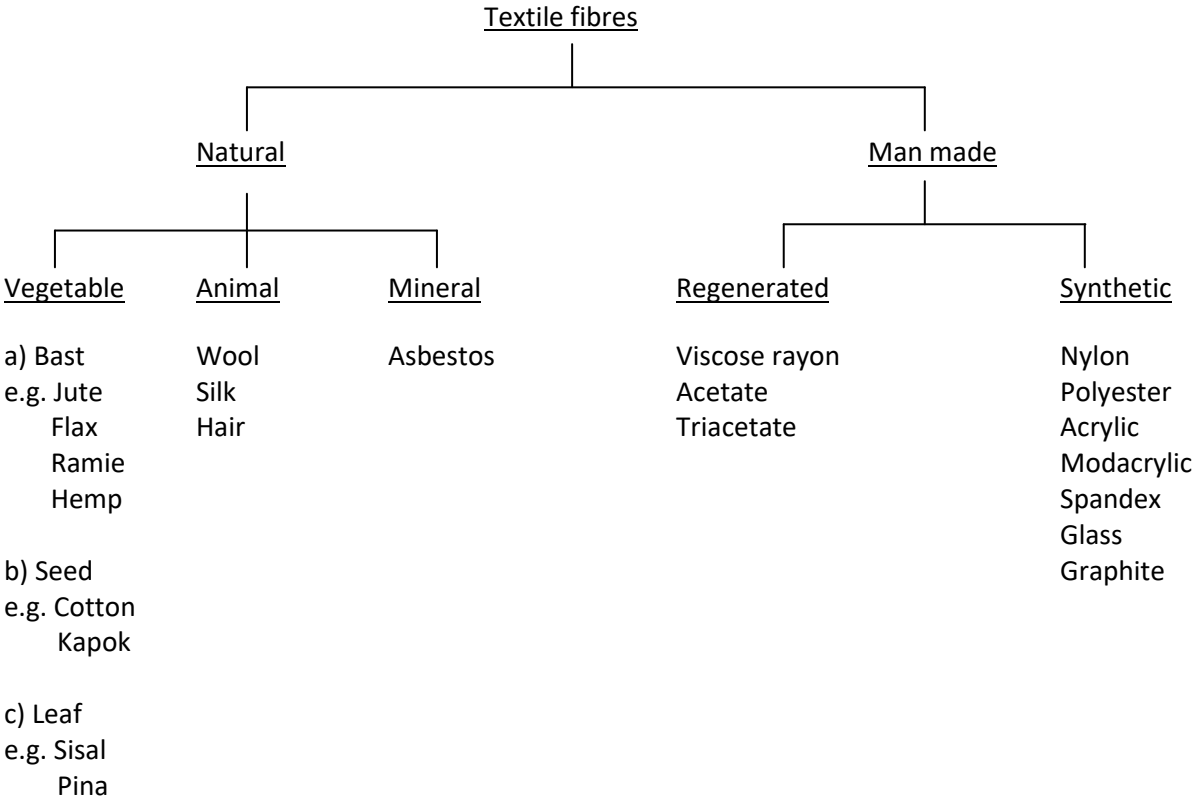
Lesson 1-5

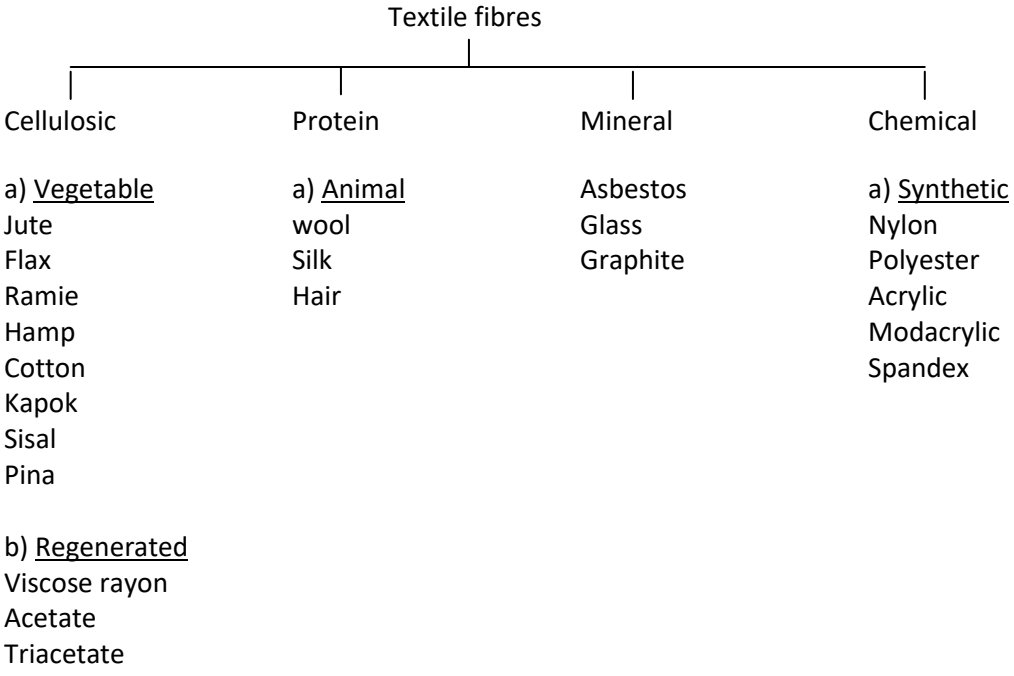
Introduction to textile fibres

Fibre: Fibre is the basic unit of textiles having a length 100 times to its diameter.

Classification of important textile fibres based on their **origin**:



Classification of important textile fibres based on their **constituents** (**composition**):



1. Natural Fibres:

The fibres which are obtained from the nature are called natural fibres. They may present in plants, animals, soil, rock etc. Examples are: cotton, jute, silk, wool, coir etc.

a) Vegetable Fibres:

These fibres are obtained from different plants. Fibres may present in different parts of the plant.
For example: Cotton is obtained from seed of the plant, jute is obtained from the stem (bast) of a plant and coir is the outer covering of coconut.
These are generally made up of *cellulose*. The two vegetable fibres mainly used for garments are cotton and flax (linen).

b) Animal Fibres:

These fibres are obtained from different animal sources. We get wool from hair of sheep and goat. Fibres can also be obtained from the hair of rabbits and camels.
Another famous animal fibre is silk. It is made by an insect called the silk worm.
The composition of animal fibres is *protein*.

2. Man-made Fibres:

Man-made fibres are manufactured by man with the help of different chemicals. Man-made fibres are generally filament fibres. Examples are nylon, polyester, viscose rayon and acrylic.

a) Synthetic fibres:

These are man-made fibres which are obtained by mixing different chemicals in different amounts. Synthetic fibres are purely made by chemicals. These are in filament form.
Majorly used synthetic fibres are nylon, polyester and acrylic.

b) Re-generated fibres

These are man-made fibres which are manufactured by chemical treatment of any natural source like cotton and wood. Materials from natural source are first dissolved in suitable chemicals and then filaments are made with this solution. Filaments can be cut in short lengths.
Examples of re-generated fibres are viscose rayon, acetate and triacetate.

Properties of fibres:

A textile fibre is important and useful only when it has certain desirable physical, chemical and microscopic properties. These properties are helpful in determining whether a fibre is suitable for a specific fabric. For example, if a soft, absorbent fabric is desired for a man's shirt, cotton would be excellent, but nylon would be undesirable.

Properties are important for any fibre. A property decides the particular use of the fibre. For example:

FIBRE	USE	PROPERTY
Cotton	Shirt for summer	Water absorbancy and soft
Wool	Sweater for winter	Prevent heat to pass
Polyester	Rain coat	Poor water absorbancy
Jute	packing	Strength and durable

Properties of fibres can be of two types:

Physical properties: The properties that are related with the physical parameters of fibres like density, diameter, length, shape etc are called as physical properties.

Chemical properties: The properties related with chemical constituents of fibres like chemical structure, chemical composition, chemical bonds, etc are called as chemical properties.

Lesson 1-5

Important properties of fibres

All fibres have certain basic characteristics. By knowing these properties we can select a suitable fibre for a specific fabric. For example, if we want a soft, absorbent fabric for a man's shirt, cotton fibre will be suitable for it, not nylon.

1. High Length to Width Ratio: Fibres must be longer than the diameter. A minimum ratio of 100 is necessary. For example if fibre diameter is 1 mm then its length should be minimum 10 cm. Fibres shorter than an inch are difficult to make in yarn.

On the basis of length, fibres are divided into two classes:

- Filament
- Staple

Filament: Filaments are natural or man-made fibres of continuous length, measurable in yards or meters. Filaments have length to width of 1000 or more. For example- polyester, nylon etc., are man-made fibres while silk is the only natural filament fibre.

Staple: Staple fibres are short in length and measurable in inches. The length varies between ¾ of an inch to 18 inches; the examples of which are cotton, wool, jute etc. Man-made fibres are of filament nature which can also be converted into short lengths from 1-1/2 to 6-1/2 inches to get staple fibres.

2. Luster: This may be defined as the light reflected from a surface. The luster of the fibre is its ability to reflect light. In natural fibres, silk has the highest sheen/shine and cotton has minimum. However, in the man-made fibres the degree of luster can be controlled.

3. Specific gravity: The specific gravity is the ratio of the mass of the fibre to an equal volume of water at 4^0 C. The specific gravity of a fibre indicates the density relative to that of water. Fabrics made of fibres such as nylon or acrylics have low density and the fabrics of cotton and rayon have high density.

4. Strength: It is the ability of a fibre to withstand the stress or tension without being pulled or torn apart. The fibres must have sufficient strength to withstand chemical or mechanical actions and to give durability to the end product.

5. Elasticity: Elasticity is the ability of the fibre to increase in length when under tension and then return to the original length when released. The fabric, which have good elasticity makes a more comfortable garment and prevent from bagginess occurring at elbows or knees. It also increases the breaking strength of the fabric. In natural fibres, wool has excellent elasticity. Fibres like spandex that elongate 100% are called as elastomeric fibres.

6. Resilience: The ability of a fibre to return to its original shape after compression, bending, creasing or similar deformation is resiliency. It is closely related with wrinkle recovery. A fabric that has good resiliency does not wrinkle easily. Wool has good resilience.

7. Abrasion resistance: It is the ability to resist wear and tear from rubbing. It increases the fabric durability. Garments made from fibres that have both high breaking strength and abrasion resistance can be worn for years.

8. Absorbency: Absorbency is the ability to take-in moisture. Some fibres are capable of absorbing the water quickly and these fibres are called as hydrophilic fibres. All natural fibres and some man-made fibres like viscose rayon and acetate are hydrophilic fibres. Those fibres, which do not absorb water, are called as hydrophobic fibres. Man-made fibres other than rayon and acetate are hydrophobic.

9. Drapability: The ability of a fabric to hang easily and fall into graceful shape and folds indicates its drapability. The characteristic depends upon the kind of fibre, yarn, and construction of the fabric as well as the finish given to it.

10. Heat Conductivity: Heat conductivity means the ability of the fibre to pass the heat through the fabric structure. Cotton has a high degree of heat conductivity, so it is good for summer. Wool has poor heat conductivity and keeps the body warm in winter.

11. Effect of Heat: It is the ability of a fibre to withstand or bear heat.

12. Affinity for Dyes: This is the ability of the fabrics to take up the dye solutions. Different fibres have different affinity to dye classes because of their constituents. Like cotton can be easily dyed with direct dyes but polyester has affinity to disperse dyes.

Lesson 6-7

COTTON

Cotton is called “The King of Fibres”.

Cotton is a natural fibre made up of cellulose. It is a seed type vegetable fibre.

Cotton is composed of cellulose (90-94% of its weight).

Main producers of cotton are USA, Russia, Brazil, Egypt, India, Pakistan, and China. Egypt grows the best quality cotton.

End Uses of Cotton:

- Apparel - Wide range of wearing apparel: tops, shirts, dresses, childrenwear, active wear, suits, jackets, skirts, pants, sweaters, hosiery, neckwear.
- Home Fashion - curtains, draperies, bedspreads, sheets, towels, table cloths, table mats, napkins

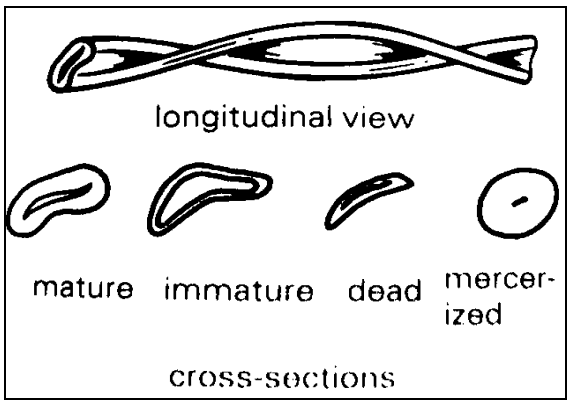
Characteristics:

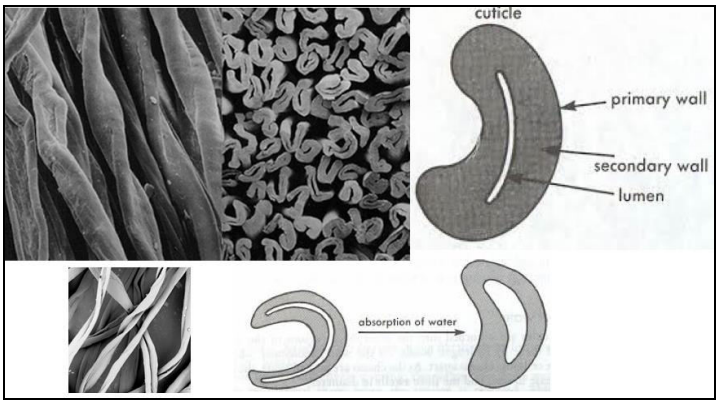
- Soft and comfortable
- Good absorbency
- Good strength
- Good drape
- Machine washable
- Dry-cleanable
- Good Color retention
- Prints well
- Easy to handle and sew

Shape and structure (Microscopic view):

The longitudinal view of fibre is flat, twisted and ribbon like. The natural twist of the cotton fibre is called convolutions’. One fibre can have 150 to 300 convolutions.

The cross-sections of cotton fibre are bean shaped. The cross-sectional shape can change from v-shape to circular depending upon the maturity.





Physical properties:

Color: Cream white, white, light grey.

Lustre: Cotton has minimum or no lustre.

Length: Cotton is divided into two categories of length:

Long cotton fibre (long staple), length more than 28 mms (1.2 – 2.5 inch)

Short cotton fibre (short staple), length less than 25 mms (0.5 – 1 inch)

Usually, the longer fibres are of good quality. They are finer and stronger. Hence the longer staple are more expensive.

Strength: Cotton is a strong fibre with a tenacity value of 3 - 5 gpd (gram per denier). The strength of cotton fibre increases by 25% on wetting. Means wet strength of cotton is higher than dry strength.

Absorbency: Cotton has excellent absorbency. The reasons for its high absorbency are:

- 90 – 94% cellulose
- Air filled lumen (water fills-in the space of air)

Due to good absorbency, cotton does not show the problem of static charge.

Elasticity: Cotton has little or no elasticity. So the fabrics made from cotton wrinkles easily.

Heat Conductivity: Cotton has a high degree of heat conductivity. The fabrics made of this fibre are excellent for the summer wear because body heat can be easily passed by the cotton fabric. It is generally known as a cool fibre.

Chemical properties:

Effect of heat: Cotton can bear medium heat. The safe iron temp is 218°C. At high temp the cotton will damage and loss its strength. It is good to use steam iron for cotton.

Effect of micro-organisms: Cotton is made of cellulose so it is damaged by bacteria and mildew in hot and moist conditions. So cotton material should be stored in a dry condition.

Effect of acids: Cotton is destroyed by hot inorganic acid (such as Hydrochloric acid (HCL), Sulfuric acid (H_2SO_4) and Nitric acid (HNO_3). It is not damaged by organic acids like acetic acid (vinegar).

Effect of alkalis: Cotton is not damaged by alkalis. Strong soap and detergents can be used for washing cotton, because they are alkaline in nature.

Affinity for Dyes: Cotton fibres have a good affinity for dyes due to its good absorbency and the cellulosic composition. Cotton can be easily dyed by direct dye, reactive dye, vat dye, sulfur dyes etc.

Lesson 8-9

WOOL

Wool is an animal fibre. It is the natural hair grown on sheep or goat.

Wool is made of **keratin** type protein.

Producers: Australia, India, China, Spain, Wales and New Zealand.

Note- Australia produces the finest wool. Marino is the finest wool in the world.

End uses: Apparels- sweaters, cardigan, muffler, gloves, socks, shawls, suits, dresses, tweeds
Home furnishing- Carpets, floor coverings, felts

Characteristics:

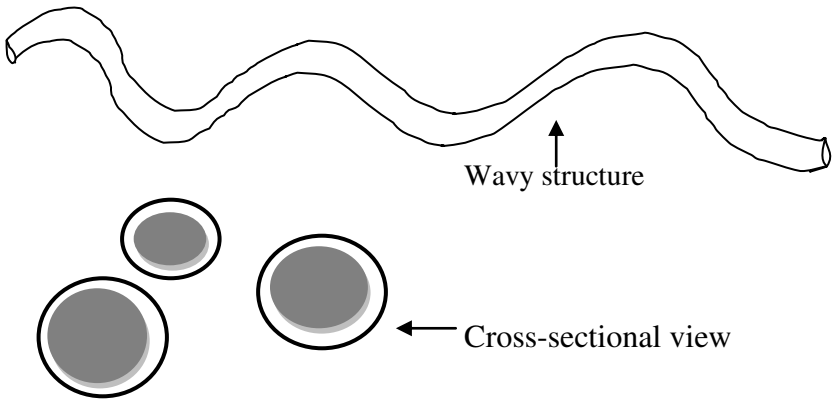
· Good insulator of heat.
· Excellent absorbency.
· Good elasticity and resiliency.
· Loss of strength on wetting.
· Good drape

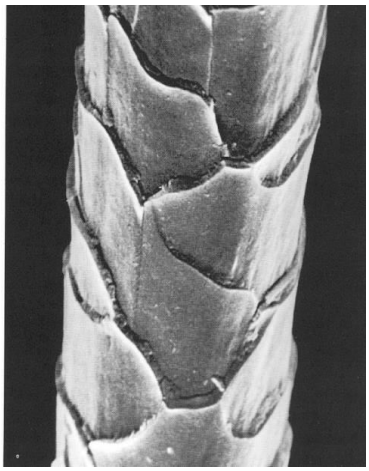
Shape and structure (Microscopic view):

Wool has a wavy or spiral structure.

The longitudinal view of wool fibre is spiral like. The surface of wool fibre is rough due to the presence of scales.

The cross-sections of wool fibres are circular and oval in shape.





Scales on the surface of wool

Importance of scales of wool fibre (Relation of scales with the wool quality and properties)-

- The scales of wool are important for fibre identification.
- Scales increase the heat insulation of wool.
- If the scales of the fibre are smoother and more in number, then the fibre will be finer, softer and warmer.

Scales	Properties	Quality
More in number, smooth	Fine, soft, warm	High
Less in number, rough	Thick, coarse, less-warm	Low

- Scales help in making felt (a non-woven fabric).
- Marino wool has more crimp (waves) and the maximum number of scales (3000 per inch)

Physical properties:

Color: Cream, yellow, grey-yellow.

Luster: Wool has some luster due to scales on the surface.

Length: The length of wool fibres can be from 1" to 8".

Strength: Wool has poor strength. But, the crimp (waves or spirals) increases the breaking strength of the fibre. The wool has tenacity value of 1 - 2 gpd (gram per denier). The strength of wool fibre decreases by 25% on wetting.

Elasticity: Wool has excellent elasticity. The reason is its wavy structure and sliding of its scales over one another on pulling. Wool can be stretched to about 30% of its original length before breaking.

Absorbency: Wool fibres absorb moisture quickly. It can absorb up to 20% of its weight in water without feeling damp and 50% without dripping. Wool also dries slowly.

Heat Conductivity: Wool has a poor heat conductivity and good heat insulation. So the fabrics made of this fibre are excellent for the winter wear. The reasons of good heat insulation are-

a) Scales on surface and crimp that provide air pockets for insulation.
b) Protein which is non- conductor of heat.

Cleanliness and wash ability: The dust and dirt particles get trapped in scales of wool, so it requires frequent washing or dry-cleaning. Wool fabrics can shrink on washing. Wool loses 25% of its strength on wetting, so wet wool fabric should not be pulled, rubbed and wrung.

Chemical properties:

Effect of heat: Wool is sensitive to heat. It becomes harsh at 100°C.

Effect of micro-organisms: Wool has good resistance to mildew, but if left in damp conditions, mildew develops. Wool is damaged by cloth moth and beetles. Special care and protection is needed during storage.

Effect of acids: Dilute acids do not damage wool, but concentrated acids destroy it. The detergents (like genteel, easy) used for washing wool contain dilute acids.

Effect of alkalis: Wool is quickly damaged by strong alkalis.

Affinity for Dyes: Wool absorbs many different dyes because of their high affinity for dyes. Wool fabrics dye well and evenly. Best types of dye classes for wool are acid dyes and basic dyes.

Lesson 10-11

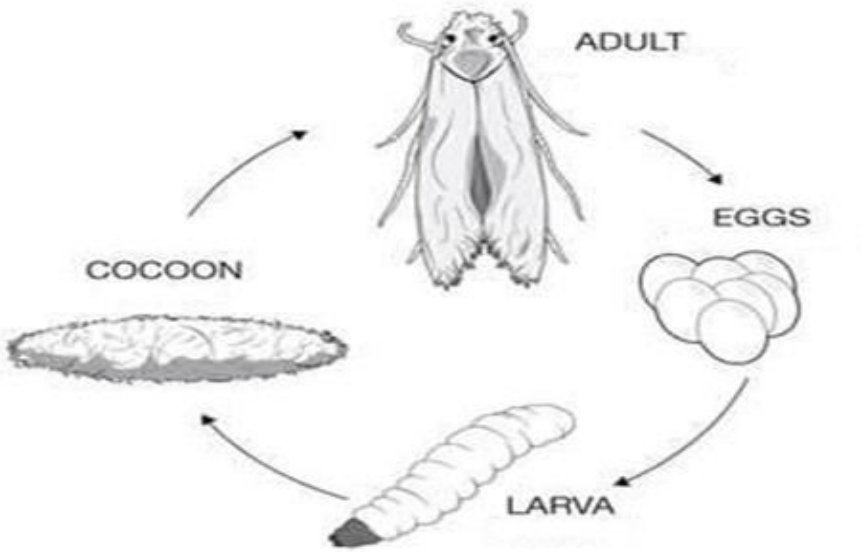
SILK

Silk is called “the queen of the fibres.” Silk is an animal fibre and is obtained from the cocoon of the silkworm.

Silk is made of **fibroin** type protein.

Producers: Japan, China, India, Italy, Spain, France.

Life cycle of silkworm:



Characteristics:

· Excellent strength.

· Excellent luster.

· Good elasticity.

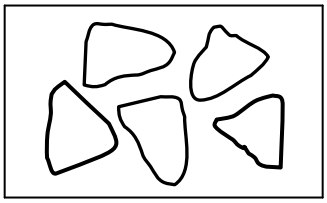
· Good insulator of heat.

· Lightweight.

· Expensive (costly).

Shape and structure (Microscopic view):

The longitudinal view of silk is fine, transparent rod like. The surface of silk fibre is smooth and shiny.



The cross-sections shape of silk is triangular.

Physical properties:

Color: Cream, yellow.

Luster: Silk has excellent luster due to smooth surface and triangular cross-section.

Length: Silk is the only natural fibre that found in continuous filament form. The length of silk filament can be in meters.

Strength: Silk is the strongest natural fibre. The strength of silk yarn is due to continuous length of the filament in yarn. The silk has tenacity value of 4-5 gpd (gram per denier).

Elasticity: Silk has good elasticity. It is the second most elastic natural fibre after wool.

Absorbency: Silk has good absorbency. It can generally absorb 10-20% of its weight in water.

Heat Conductivity: Like wool, silk is a protein fibre. So it is a poor heat conductor. It may be used for winter clothing. But silk is also used in summers because of its lightness, fineness and absorbency.

Cleanliness and wash ability: Silk has smooth surface so it does not attract dust and dirt particles. Silk fabrics can be washed with mild soaps or dry-cleaned.

Chemical properties:

Effect of heat: Silk is sensitive to heat. It destroys at 165°C.

Effect of light: Silk loses its strength when kept in sunlight for long times. It is destroyed by sunlight more quickly than cotton and wool. The color of silk product fades when kept in light for long time.

Effect of micro-organisms: Silk has good resistance to mildew, but care must be taken while storing the silk. Silk may be attacked by the cloth moths or beetles.

Effect of acids: Dilute acids do not damage silk, but concentrated acids dissolve it faster than wool. The silk can be washed with acidic detergents (like genteel, easy).

Effect of alkalis: Silk is damaged by concentrated and hot alkalis.

Affinity for Dyes: Silk has good absorbency and so it has good affinity for dyes. Best types of dye classes for silk are acid dyes and basic dyes.

End uses:

Silk is used for making shirts, sarees, dresses, kurtas, neck tie, scarfs etc.

Lesson 13-14

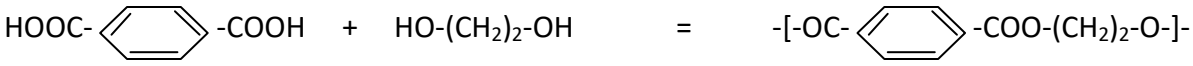
POLYESTER

The scientific name of polyester is *Polyethylene tere-phthalate* or PET

It is the most used synthetic fibre. It was discovered in 1941, but commercially produced in 1951.

Polyester is a man-made fibre and made by *melt* spinning through polymerization process.

Polymerization of polyester-

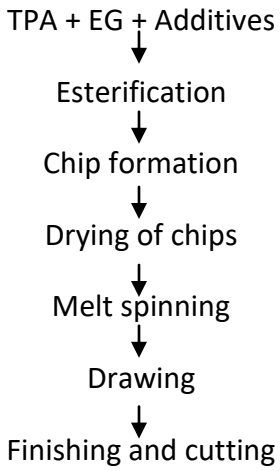


Terephthalic acid (TPA) Ethylene glycol (EG) Polyethylene tere-phthalate (PET)

Note- Two monomers of polyester are *Terephthalic acid* (TPA) and *Ethylene glycol* (EG). During polymerization, the monomers are linked by **ester** linkage (-COO-).

Manufacturing process of polyester-

The production flow-chart of polyester staple fibres is shown below:



Polyester fibres are produced in both filament and staple form.

Characteristics:

- Good strength
- Poor water absorbency
- Good oil absorbency
- Do not wrinkle easily
- Do not stretch
- Quick drying
- Good color retention
- Pilling problem
- Static charge problem

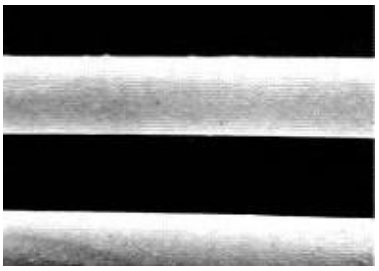
Lesson 13-14

End use: Suiting, shirting, carpets, curtains, pillows, mattress, belts, tyre construction, umbrella, raincoats, automobile covers.

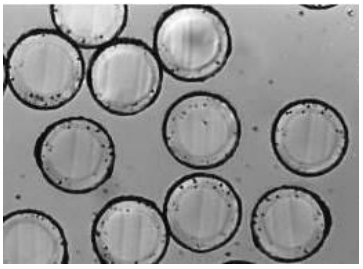
Shape and structure (Microscopic view):

The polyester fibres are uniform in diameter, having smooth surface and are transparent. The longitudinal view is smooth and rod like.

Polyester fibres can be manufactured with different cross-sectional shape according to the use.



Longitudinal view



Cross-sectional view

Physical properties:

Color: white or any color.

Lustre: Polyester has good lustre. Lustre can be controlled during production.

Strength: Polyester is a strong fibre. Its strength is 2.5 to 6 gpd. Polyester does not loose strength on wetting.

Elasticity: Polyester fabrics have low elasticity.

Absorbency: Polyester has very poor absorbency for water.

The two main advantages of low absorbency are:

- Polyester fabrics dry quickly.
- Polyester fabrics can be used for water repellent products like umbrella, rain coat etc.

The two main disadvantages of low absorbency are:

- Polyester fabrics are not comfortable for summers. They do not absorb sweat.
- The problem of static charge generation.

Polyester has good absorbency for oil. So oil stains are difficult to remove from polyester fabrics.

Chemical properties:

Effect of heat: Polyester become sticky at 227°C and it will melt at 250°C. Polyester should be ironed at lower temperature.

Effect of light: Polyester fabrics have very good sunlight resistance. These are more suitable for curtains.

Effect of micro-organisms: Polyester is not damaged by bacteria, mildew and other insects.

Effect of acids: Polyester fabrics have good resistance to acids. But hot and concentrated mineral acid, like sulfuric acid can destroy polyester.

Effect of alkalis: The polyester fabrics have good resistance to weak alkalis and fair resistance to strong alkalis. At boiling temperatures, strong alkalis can dissolve polyester.

Acrylic

The scientific name of acrylic is *Poly-acrylonitrle*. Acrylic is now used as artificial wool.

'DuPont' company first made acrylic fibers in 1944 and began commercial production in 1950.

It is made by either dry spinning or wet spinning.

Acrylic filaments are smooth and straight. A process called 'texturizing' is done on acrylic filaments to make them wavy like wool. Due to texturing, acrylic fibers become bulky and warm wool-like.

Characteristics:

- Soft and warm
- Wool-like
- Retains shape
- Good abrasion resistance
- Light weight
- Quick-drying
- Resistant to moths, sunlight, acids and chemicals
- Problem of static charge which also attracts dirt and dust

End Uses:

- Apparel: Dresses, infant wear, knitted garments, ski wear, socks, sportswear, sweaters.
- Home Furnishings: Blankets, carpets, draperies, upholstery.
- Other: Auto tops, hand-knitting and craft yarns, industrial and geotextile fabrics.

Physical properties

Strength**:** Acrylic fabrics have fair to strong tenacity. The acrylic fibre loses the strength on wetting. It is weaker than cotton but stronger than wool. It has good abrasion resistance.

Elasticity**:** Acrylic fabrics have low elasticity. Acrylic fabrics do not wrinkle easily and recover from creases quickly which makes it very suitable for apparel purposes.

Heat Conductivity**:** Acrylic fibres have poor heat conductivity. The advantage of acrylic fabrics over wool is its warmth with light weight. This makes acrylic suitable for blankets.

Absorbency**:** Acrylic fabrics have poor water absorbency. These fabrics dry quickly.

Cleanliness and Washability: It is easy to keep Acrylic fabrics clean, and they may be dry-cleaned easily. Acrylic fabrics should be washed with a mild soap or detergent.

Acrylics should not be washed at boiling temperatures because the fabrics will shrink when washed at high temperatures.

Chemical Properties:

Effect of Heat: Acrylic fabrics cannot be heat set. They tend to discolour and decompose when heated.

Effect of Light**:** Acrylics have excellent resistance to sun light.

Reaction to Alkalis: Acrylic fabrics are resistant to weak alkalis and have medium resistance to the strong and cold alkalis. Its resistance decreases as the strength of the alkali, the temperature and the time increases.

Reaction to Acids: Acrylic fabrics have excellent resistance to the dilute acids.

Affinity for Dyes: They can be dyed with disperse or cationic dyes in a wide range of colour.

In addition, most of the synthetic filaments are solution dyed. This means that the dyes are added to the polymer melt before spinning. Solution dyed fabrics have excellent colour fastness as the dye molecules become the fixed part of the filament structure.

The properties of the warmth, bulkiness without weight and the resistance to insects make acrylics advantageous over wool.

Viscose Rayon

Viscose rayon is a re-generated cellulose fiber.

It is made by chemical treatment of wood pulp or waste cotton.

It is made by wet spinning.

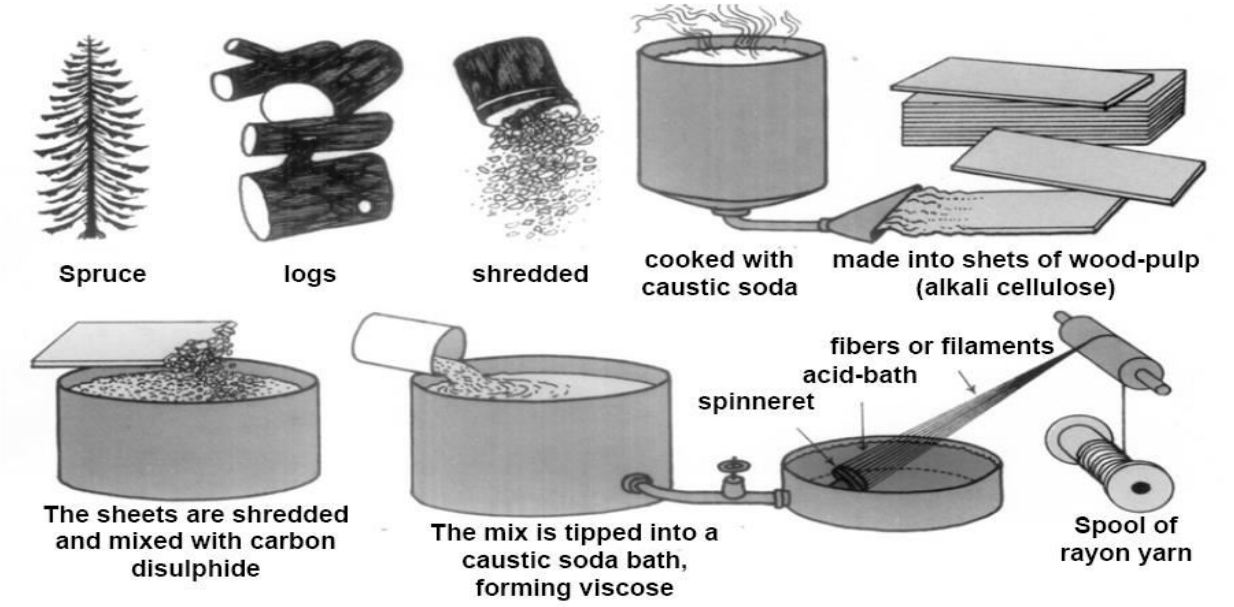
Characteristics:

- High absorbency
- Soft and comfortable
- Shrinks more than cotton
- Poor abrasion resistance
- Loses strength on wetting
- Dyes easily
- Fairly expensive

End Uses:

- Apparel: Tops, coats, dresses, jackets, undergarments, linings, slacks, sports shirts, sportswear, suits, ties, work clothes.
- Home Furnishings: Bedspreads, carpets, curtains, draperies, sheets, tablecloths, upholstery.

Manufacturing Process:



Manufacturing process of rayon

Physical properties

Luster: Rayon has good luster.

Strength**:** Regular rayon is stronger than wool but is weaker than cotton and the strength is reduced from 40-70% when wet. Rayon has tenacity value of 2-3 gpd.

Elasticity**:** Rayon has greater elasticity than cotton but less than wool or silk. Rayon wrinkles easily

Heat Conductivity**:** Rayon is a good conductor of heat because it is a regenerated cellulose fibre. It is used for summer apparels.

Absorbency**:** Rayon fabric has excellent absorbency. But its absorbency is less than wool and silk.

Chemical Properties:

Effect of Heat: Rayon has burning properties similar to cotton fabric. Rayon fabric loses strength above 149° C. It decomposes at 177 to 204°C. Rayon fabrics do not melt or stick.

Effect of Micro-organisms: Resistance of rayon fabrics to mildew is similar to cotton. Rayon is damaged by mildew and silverfish when stored in damp condition for long time.

Reaction to Alkalis: Alkalis does not attack the rayon fabrics. However, concentrated solutions of alkalis damage rayon.

Reaction to Acids: Similar to cotton, rayon is attacked by acids.

Affinity for Dyes: Rayon fabric is absorbent in nature, so absorbs dyes evenly. Colored rayon has good color fastness but color fade with long exposure to sunlight. To overcome this, solution-dyed rayon was developed.

MAN-MADE FIBRES

Man-made fibres are manufactured by the use of different chemicals or manufactured from any of the natural source treated with different types of chemicals.

The man-made fibres are of two types:

a) Regenerated fibres
b) Synthetic fibres

Regenerated fibres are manufactured by chemical modification of natural material. The natural material like waste cotton and wood pulp are treated with different chemicals and converted into fibre form.

Examples of regenerated fibres are Viscose Rayon, acetate, Triacetate.

Synthetic fibres are made by the chemicals. The chemicals are mixed and converted into fibre form.

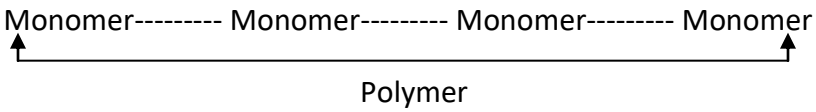
Examples of synthetic fibres are nylon, polyester, acrylic, spandex etc.

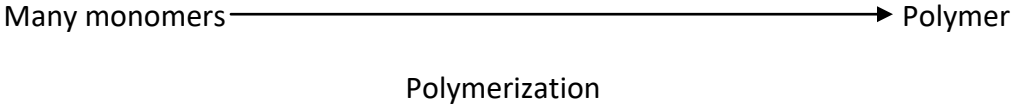
Man-made fibres are manufactured by polymerization process.

Polymerization –

Textile fibres, like any other material, are made up of molecules. Fibre molecules are called polymers. The "unit" of polymer is monomer.

Monomers are chemically reactive. They react with each other and join end-to-end to form a polymer. This process of formation of long polymers is called polymerization.





Man Made Fibre Production (Chemical Spinning)

Spinning is the making yarn or filaments from fibres, filaments or solution.

Fibres/Filaments ⟶ Yarns

Solution ⟶ Filaments ⟶ Yarns

Types of Chemical Spinning:

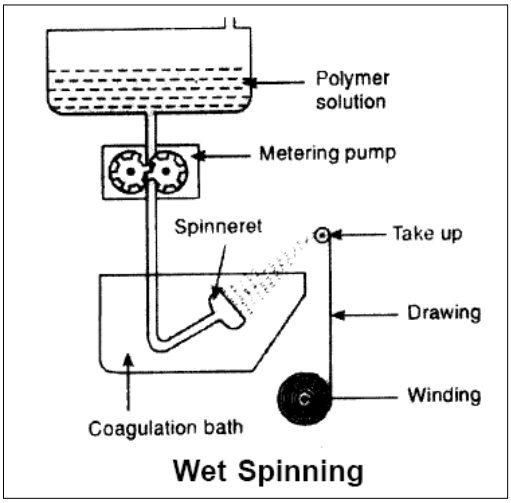
Chemical spinning is of three types:

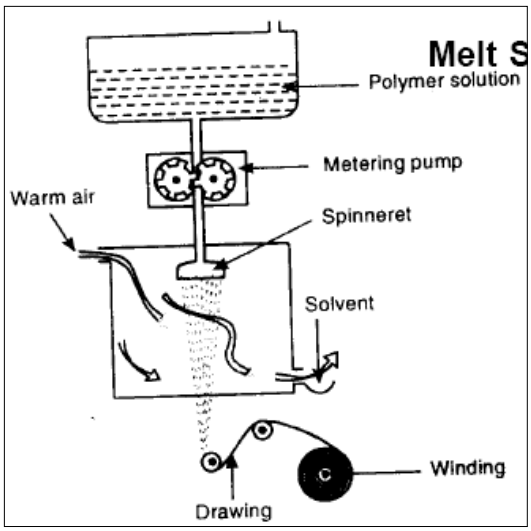
a) Wet Spinning b) Dry Spinning c) Melt Spinning

Wet Spinning:

In this process, the polymer solution or spinning solution is pumped through the spinneret into a chemical bath. This chemical solidifies the solution into filament form. These filaments are drawn, washed, dried and then wound onto packages.

Example- manufacturing of Viscose Rayon, Acrylic, and Spandex.





Dry Spinning:

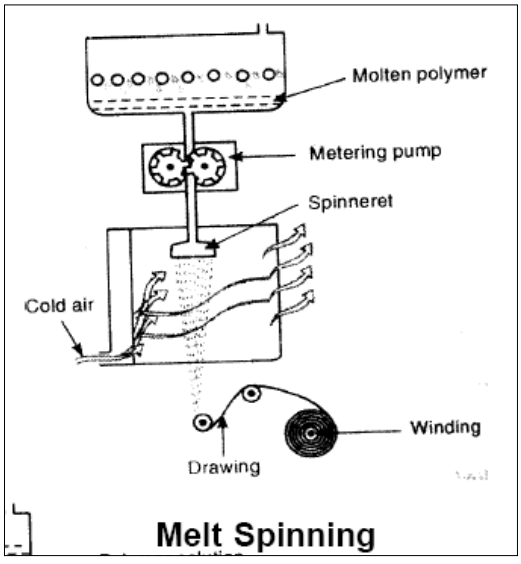
In this process, the polymer solution or spinning solution is pumped through the spinneret into an air chamber. This air solidifies the solution into filament form. These filaments are drawn, twisted and then wound onto packages.

Example- manufacturing of Acetate, Triacetate, Acrylic, and Spandex.

Melt Spinning:

In this process, the polymer chips are melted and then pumped through a spinneret into an air chamber. The air solidifies the filaments. These filaments are then drawn and wound onto the package.

Example- Polyester, Nylon



Spinning of cotton yarn (Mechanical Spinning)

Spinning is the process of converting fibres or filaments into yarn.

Fibres/filaments $\xrightarrow{\text{(Spinning)}}$ Yarn

Cotton yarns are spun by mechanical spinning. This is also called conventional ring spinning.

The cotton is a staple fibre, so cotton yarn made is called **staple yarn**.

Flow chart for ring spinning of cotton yarn:

BLOWROOM	BLOWROOM OPERATIONS (Opening and Blending)
↓	↓
CARD	CARDING
↓	↓
COMBER	COMBING
↓	↓
DRAW FRAME	DRAWING
↓	↓
SPEED FRAME	SIMPLEX
↓	↓
RING FRAME	SPINNING
Machine flowchart	Operation flowchart

Blow room operations:

Blow room is the first operation in a spinning mill. Here the cotton bales are opened and fibres are cleaned. The different verities of cotton are mixed or blended together to get a yarn of uniform quality.

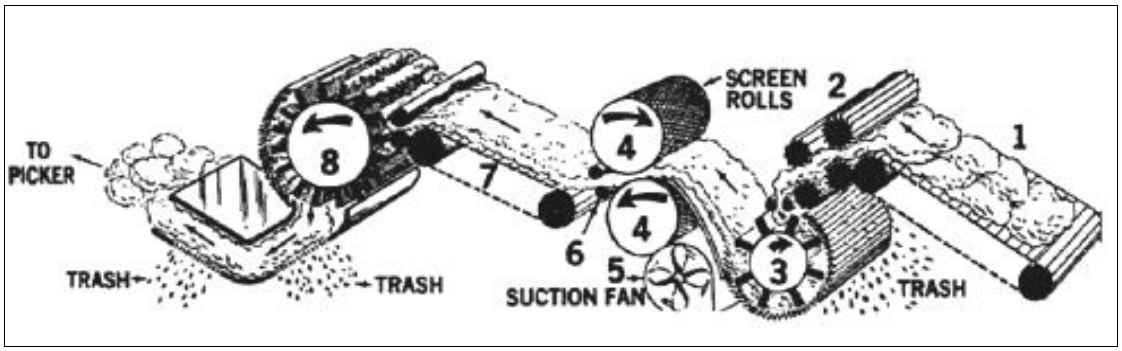


Figure: Opening Operation

1. Opener 2. Feeder rollers 3. Beater cylinder 4. Screen rolls 5. Fans 6. Small rolls 7. Conveyor belt 8. Beater cylinder

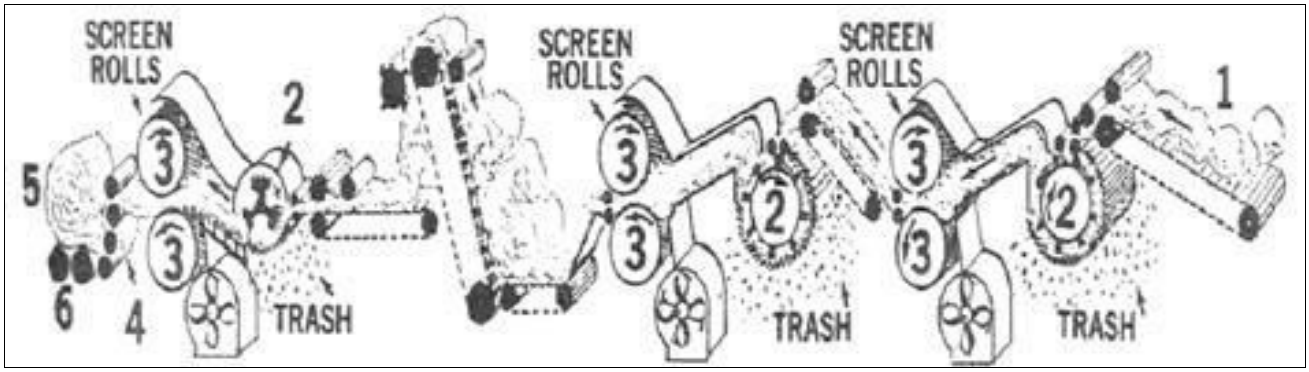


Figure: Picking Operation

1. Conveyor belt 2. Beater 3. Screen rolls 4. Cotton in the form of lap

5. Lap roll 6. Winding rolls

Objectives of blow room-

-bale opening

-mixing of different bales for good quality

-fibre cleaning (Removing trash)

-lap formation

Carding:

The process of arranging the fibres parallel is known as carding. The straightening and entangling process is necessary for all staple fibres to produce fine yarns from the bale of fibres.

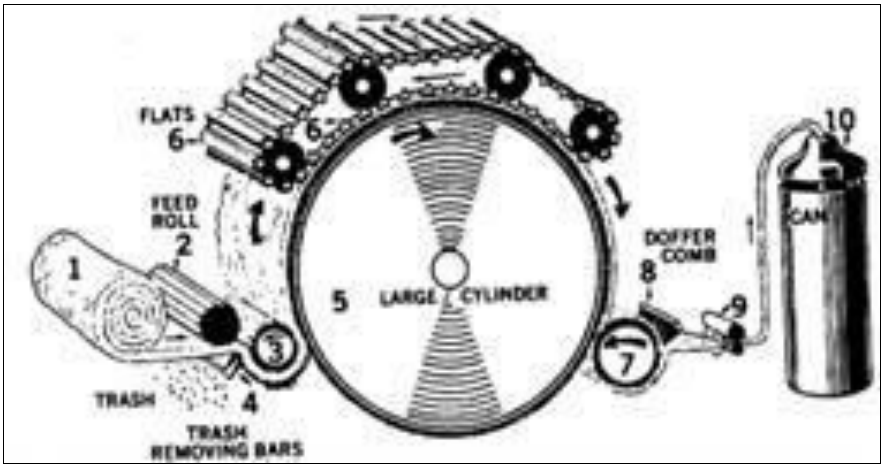


Figure: Carding Operation

1. Cotton lap 2. Feed roll 3. Licker-in roll 4. Cleaner bars 5. Large cylinder 6. Flats 7. Doffer cylinder 8. Doffer comb 9. Condenser rolls 10. Coiler head

Objectives of carding-

-removal of remaining trash

-disentangling the fibers

- arranging the fibres parallel

-sliver formation

Combing:

Combing is an optional process. It is used for longer fibres to make finer yarns.

Objectives of combing-

-to make fibres more straight and parallel

-removal of short fibers

Drawing:

Several slivers are combined in the drawing process to eliminate the irregularities of slivers. In draw frame, several pairs of rollers pull the slivers lengthwise and finally produce a sliver.

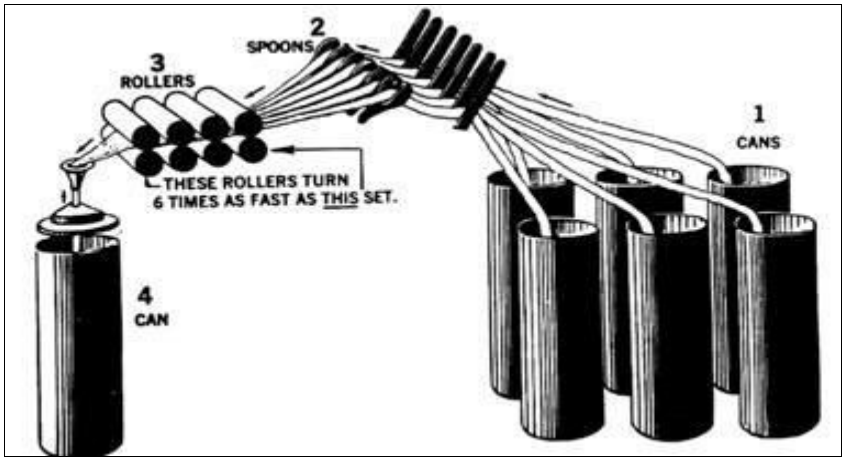


Figure: Drawing Operation

1. Cans 2. Spoons 3. Rollers 4. Can

Objectives of drawing-

-to remove irregularities from the slivers

-to make the slivers ready for speed frame

Speed Frame:

In this process the slivers from the drawing frame are further drawn out and twisted. The thickness of the sliver is reduced and roving of pencil lead size is formed.

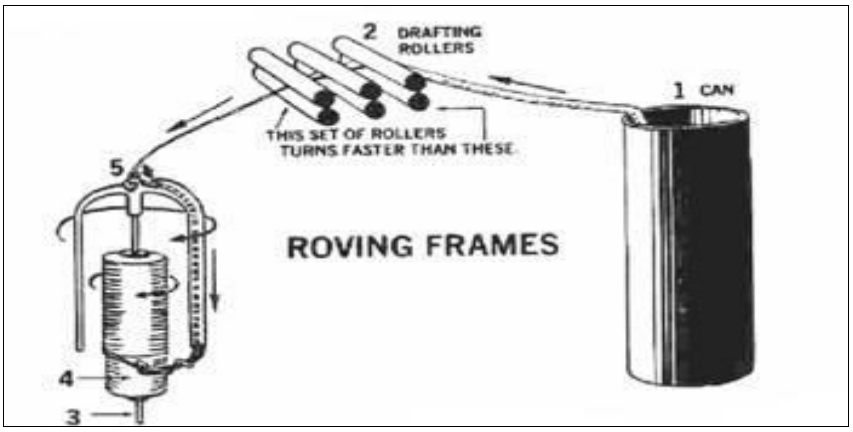


Figure: Simplex operation

1. Sliver can 2. Drafting rollers 3. Spindle 4. Bobbin 5. Flyer

Objectives of speed frame-

-drawing and twisting of sliver to make roving

-to wound roving on a bobbin

Ring Frame:

The roving of bobbins is placed in the spinning frame where it passes through several sets of rollers running at successively higher rates of speed and is finally drawn out to yarn of the size desired.

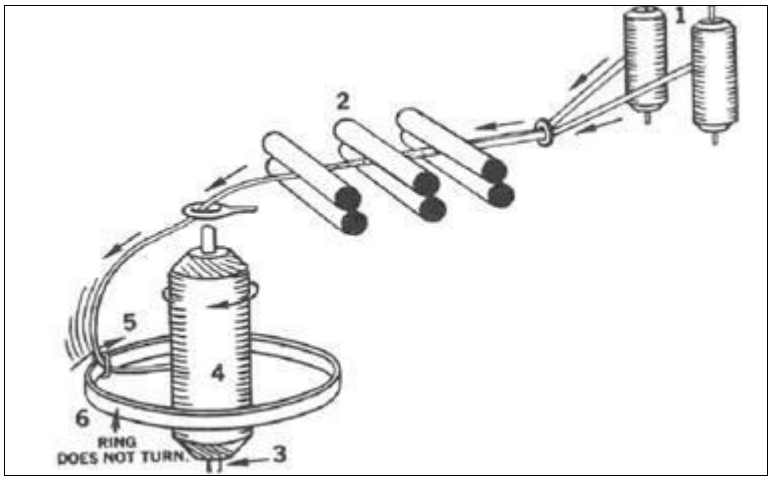


Figure: Ring spinning operation

1. Roving bobbins 2. Drafting rolls 3. Spindle 4. Bobbin 5. Traveler 6. Ring

Objectives of ring frame-

- drawing and twisting of roving to make yarn

-to wound yarn on a spindle

Types of yarn

A yarn is a continuous strand made up of many fibres which are twisted together. Fibres are thin and small and cannot be made into a fabric directly. So they are first converted into yarns which are longer, thicker and stronger. These yarns are used to make fabrics.

There are different types of yarns according to the construction and the manufacturing process. The yarns are generally classified into three types, namely:

- Simple yarns
- Novelty or Fancy yarns
- Texture yarns

1. Simple yarns:

-The simple yarns are the yarns, which are twisted around each other.

-These yarns are simple in appearance and give greater amount of strength to the fabrics.

-These yarns do not produce any novel effect.

The different types of simple yarns are:

a) Single yarns
b) Ply yarns
c) Cable or Cord yarns

a) Single yarns –

-Single yarns are single strands of staple fibres or of filaments held together by twist.

-These can be spun yarns (made of staple fibres) or filament yarns (made of one or many filaments).

-The strength of these yarns depends upon

(a) the amount of twist given to the yarns and

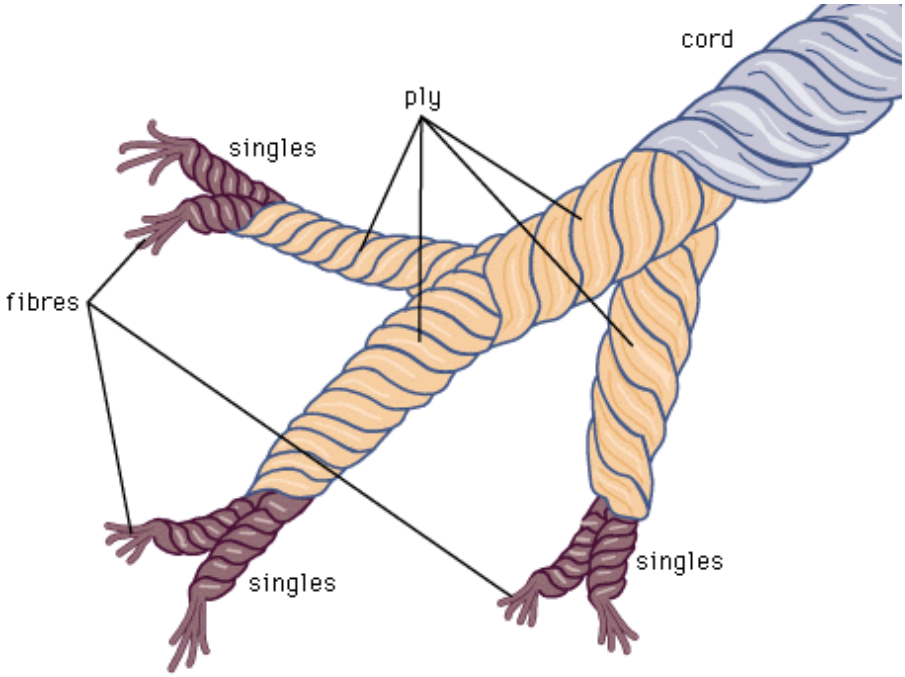
(b) the type of fibre and filament used.

b) Ply yarns-

-Ply or plied yarns are made of two or more single yarns twisted together.

-Singles yarns are plied together to form the 2-ply, 3-ply and 4-ply yarns. For example, Two-ply yarn is made of two single strands; three-ply yarn is composed of three single strands.

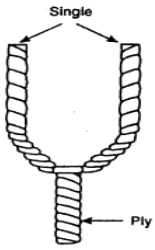
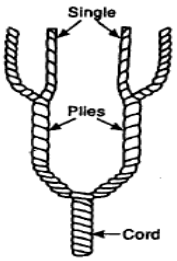
-In making ply yarns, each single yarn is twisted in one direction and then combined and twisted in the opposite direction.



c) Cable yarns –

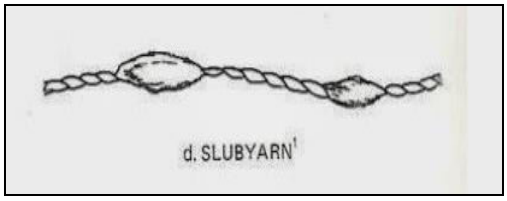
Two or more plied yarns are twisted together to form a cabled yarn. The twist is given in opposite direction to the ply yarn. Because of this opposite twist direction the plies grip each other and make the yarn hard and strong.

S/Z/S or Z/S/Z.

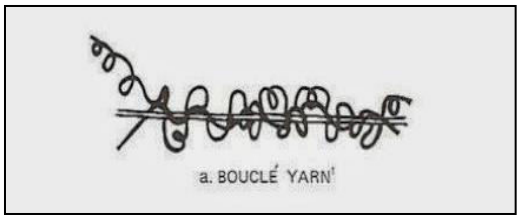
Single Yarn	Ply Yarn	Cord Yarn
A single yarn is made directly from fibers.	A ply yarn is made by second twisting operation which combines two or more singles. Each part of the yarn called a ply. The twist is inserted by a machine called "twister. The ply yarn is also known as folded yarn.	Cord yarns are composed of two or more ply yarns combined for is simple cord yarns, the singles used to make the ply yarns and the ply yarns used to make the cord are simple yarns.
		

Novelty Yarns –

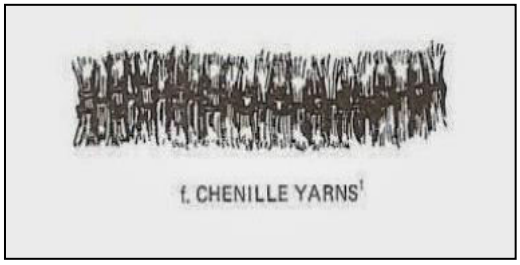
Novelty yarns are produced for special appearance; usually uneven in size or colour. These are produced by variations in the spinning process. Novelty Yarns differ significantly from the normal appearance of a single or plied yarn due to the presence of irregularities, deliberately produced during its formation. A novelty or fancy yarn generally has three basic parts such as the core yarn, the effect or fancy yarn and the binder yarn. The different types of novelty or fancy yarns are as follows:


d. SLUBYARN[1]

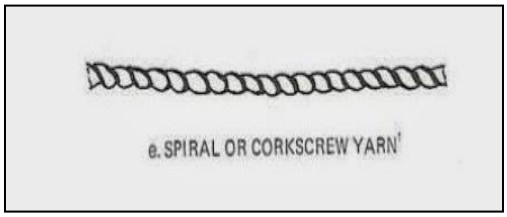
Slub Yarn - It is a type of novelty yarn having soft, untwisted areas at intervals along the length. In slub yarns, some portions are left untwisted. This results in appearance of thick, soft, untwisted areas at frequent intervals throughout the length of the yarn. The effect is produced by twisting the thicker part of the yarn to a lesser extent and the thinner part of the yarn to a greater extent. These yarns are generally used as wefts in woven and knitting yarns for sweaters, drapery etc.


a. BOUCLÉ YARN[1]

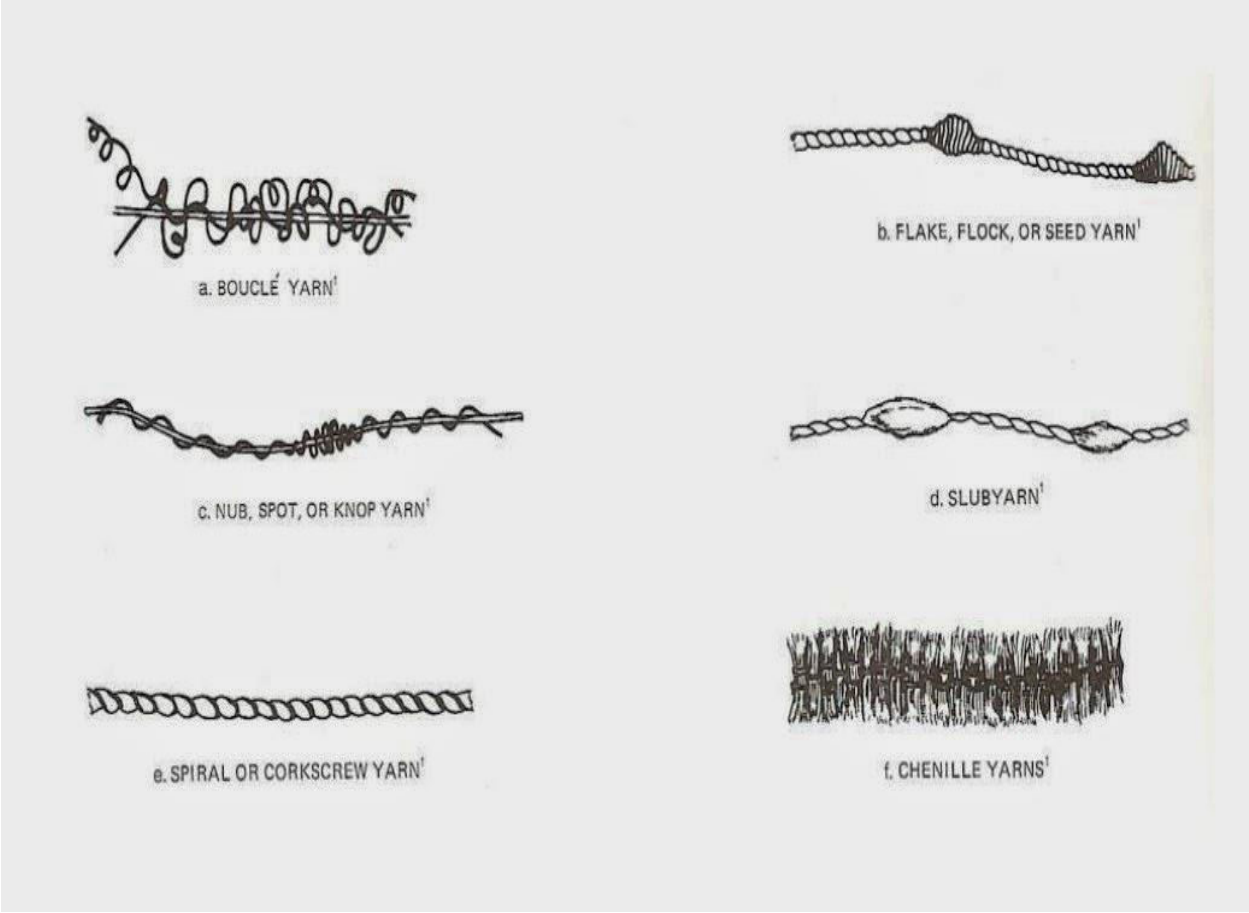
Boucle Yarn - Boucle yarn is a specialized type of yarn that is usually made of three plies. Among the three plies, one thread is looser than the others. The looser thread results in the loop formation along the length of the yarn. These yarns have a rough feeling and a bulky look.


f. CHENILLE YARNS[1]

Chenille Yarn - Chenille is the French word for caterpillar. This yarn is so called because of fur appearance of yarn surface similar to caterpillar. These yarns have soft, fuzzy and bulky surface. The construction of the yarn consists of two yarns plied together which holds short untwisted fibres between the twists along the core length. These are used for sweaters, outerwear fabrics, upholstery and curtain fabrics, blankets, and area rugs.


e. SPIRAL OR CORKSCREW YARN[1]

Corkscrew Yarn - A two ply yarn in which a soft, less-twisted thick thread is wound spirally round a thin, hard-twisted yarn.



12.3 Fancy Yarns

· Slub Yarns

· Flake Yarns

· Spiral Yarns

· Ratine Yarns

· Nub Yarns

· Chenille Yarns

1. Slub yarns – In slub yarns, some portions are left untwisted to vary the diameter for ornamental effects. These yarns consist of irregularities and varying thicknesses of soft, untwisted areas at frequent intervals throughout the length of the yarn. The effect is produced by twisting the thicker part of the yarn to a lesser extent and the thinner part of the yarn to a greater extent. These yarns are generally used as hand knitting yarns for sweaters, drapery etc.

2. Flake yarns – Flake yarns are the variations of the slub yarns with the soft and untwisted areas at intervals. The slub effect is made by inserting the soft, thick, elongated tufts of fibre into the yarn at regular intervals. The flake construction uses three sets of yarns- binder, effect and core yarn. The elongated tufts of fibre (effect) are inserted at regular intervals on the core yarn and are held is position with another set of yarn called binder yarn.

3. Spiral yarns – These yarns are obtained by winding the yarns around each other rather than being twisted. These are plied yarns where one yarn wraps around the other. The appearance of a coarse yarn is that of a coarse yarn wound around a fine yarn. This winding operation gives the effect of spiral. The fine yarn in this construction is the core yarn around which the coarse yarn (effect yarn) is wound. The thicker yarn is given a slack twist whereas the fine yarn is given a hard twist.

4. Ratiné yarns – Ratiné yarns are the variation of spiral yarns. The effect yarn is twisted around the core yarn in spiral form, but at intervals the effect yarn is thrown out as a longer loop, which kinks back on itself. This structure of core yarn and effect yarn are held in place with the binder yarn.

5. Knot or nub yarns – The knot yarn consists of bumps or nubs spaced at intervals along the length of the yarn. The yarns are produced by twisting the effect yarn around the core yarn many times within a very short space causing bumps at the intervals. Different coloured yarns can be used to obtain variations.

12.4 Textured Yarns

Textured yarns as defined by ASTM are a filament or spun yarns that have been given notably greater apparent volume than a conventional yarn of similar fibre count. The textured yarns are more opaque, have improved appearance and texture, and have increased warmth and absorbency. Texturizing processes was originally applied to man-made fibres to reduce such characteristics as transparency, slipperiness, and the possibility of pilling (formation of small fibre tangles on a fabric surface). There are two different types of textured yarns which include;

· Stretch yarns

· Bulk yarns

Yarn Properties

Yarn Twist

Twist is the spiral arrangement of the fibres around the axis of the yarn.

-The twist binds the fibres together.

-The twist increases the strength of the yarn.

-The amount of twist affects the appearance of the yarn.

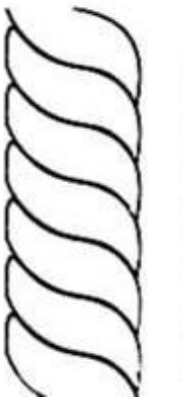
-The amount of twists is measured as number of turns per inch.

Twist direction:

The direction of the twist is indicated by the use of letters S or Z.

A single yarn has S twist if, when it is held in the vertical position, the fibres are in the direction of the slope of the letter S.

Similarly the yarn has Z twist if the fibres are in the direction of the slope of the letter Z.



S Twist

Z Twist

Importance of twist:

The amount of twist is an important factor in finished consumer goods.

-It determines the appearance and the durability of a fabric.

-Fine yarns require more twist than coarser yarns.

-Warp yarns are given more twist than weft yarns in a woven fabric.

-The amount of twist also depends upon the type of the fabric to be woven:

a. Yarns for soft surfaced fabric are given low twist.
b. Yarns for smooth surfaced fabrics are given medium twists.
c. Yarns for crepe fabrics are given maximum amount of twists.

Note: the sewing threads have Z twist.

Yarn Numbering Systems

Yarn numbering systems are used to express a relationship between a unit length and weight of yarns.

In the spinning process, there is always a fixed relation between the weight of the amount of fiber and the length of the yarn produced from this amount of fibre. This relation indicates the thickness of the yarn.

---------- Student's assignment ----------

For example: - amount of fibre= 1 kg

In one case (a), 1 meter yarn is made from 1 kg fibre

In second case (b), 5 meter yarn is made from 1 kg fibre

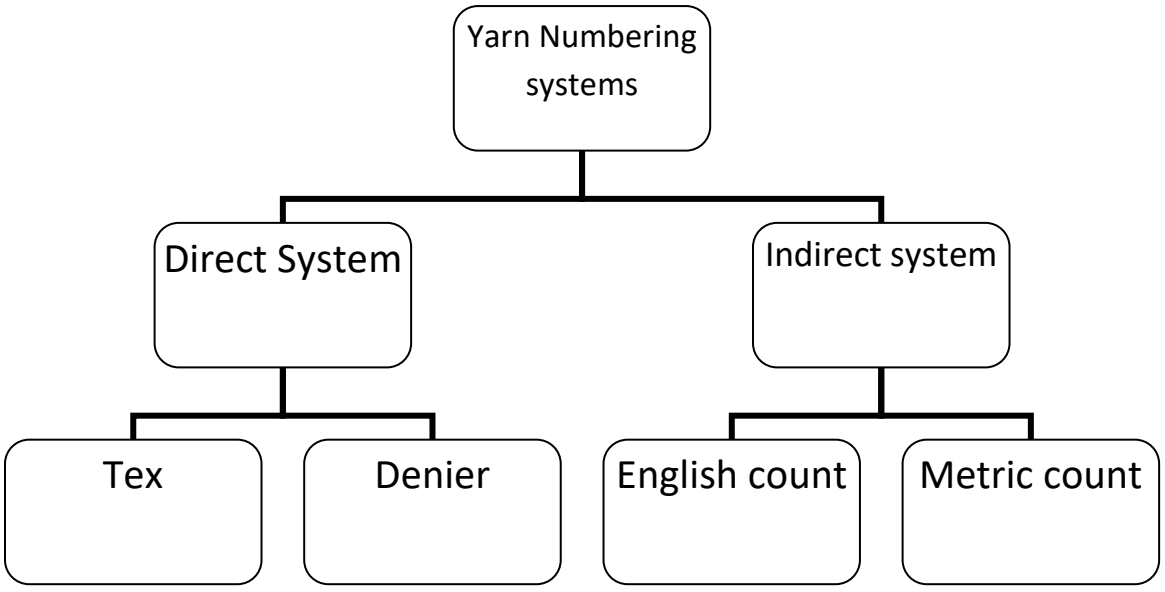
In which case, thickness of the yarn will be more?

----------x---x---x----------

This thickness of the yarn may be expressed according to the yarn numbering system.

The two yarn numbering systems are:

a) Direct system
b) Indirect system



Direct system measures the weight per unit length of the yarn.

The two units of direct numbering system are:

Tex: weight in grams of 1000 meters of yarn.

Denier: weight in grams of 9000 meters of yarn.

1 Denier = 9 Tex

In direct system- finer the yarn, lower is the yarn number. This numbering system is used for silk thread, synthetic filament thread (polyester thread, nylon thread, etc.)

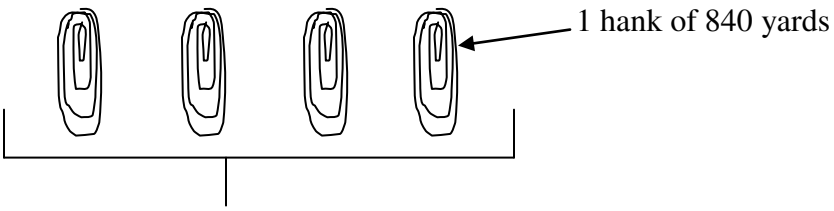
For example: 8 tex, 20 tex, 40 tex

8 tex yarn will be finer than 40 tex yarn.

Indirect system is based on the length per unit weight of a yarn.

The main unit of indirect numbering system is: count

Count: number of hanks of 840 yards in 1 pound.



The count is expressed as 20^S, 30^S, 120^S

For example: in the above diagram the yarn number is 4^S

In direct system- finer the yarn, higher is the yarn number. This numbering is used for cotton thread, silk spinning and staple fiber.

For example: 20^S count yarn will be thicker than 40^S count yarn.

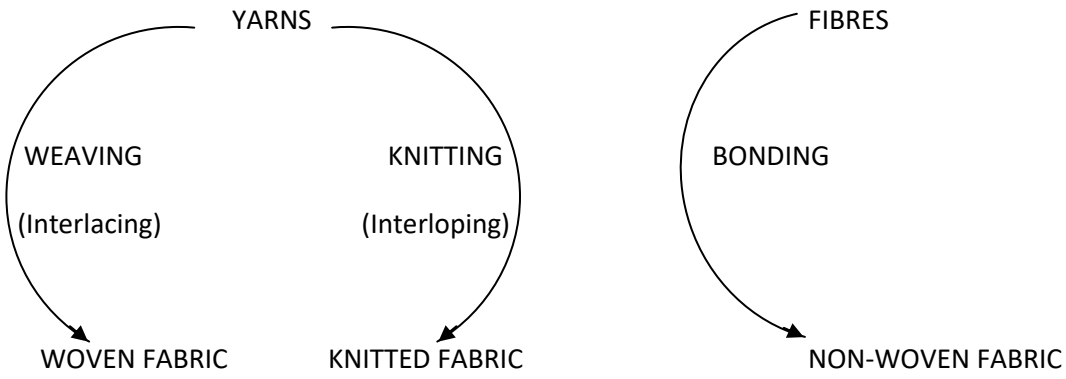
Note-The yarns of 40^S to 60^S count are used for making shirt and yarns of 100^S to 120^S count are used for making fine voile (duppta).

FABRIC

Fabric is a flexible 2 dimensional structure made from the combination of yarns or fibres.

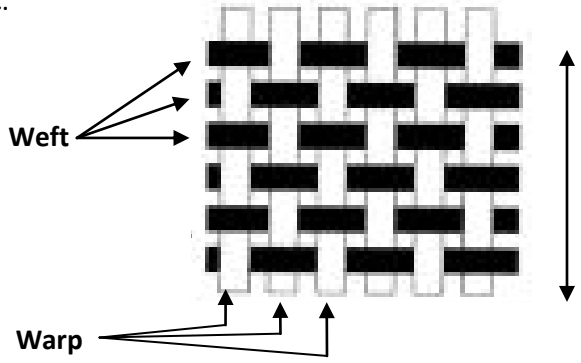
Different techniques of fabric manufacture:

1. Weaving
2. Knitting
3. Non-woven



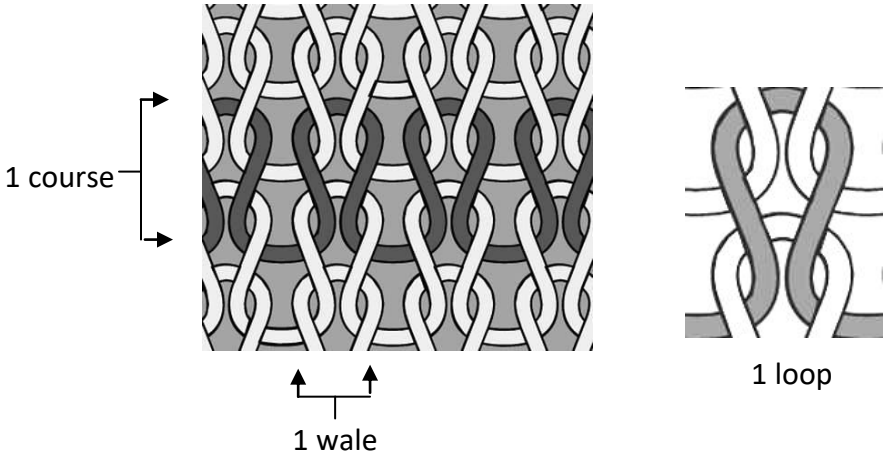
Weaving:

- Weaving is a process of interlacing two sets of yarns perpendicular to each other.
- The two sets of yarn are called **warp** and **weft**.
- Warp: The yarns along the length of the fabric are called warps.
- Weft: The yarns along the width of the fabric are called wefts.
- Weaving machine is called loom.
- The fabric made by weaving technique is called woven fabric.
- Woven fabrics are used as saris, shirts, pants, coats, shawls, bed sheets, table cover, curtains, towels, hand bags, bandages, etc.



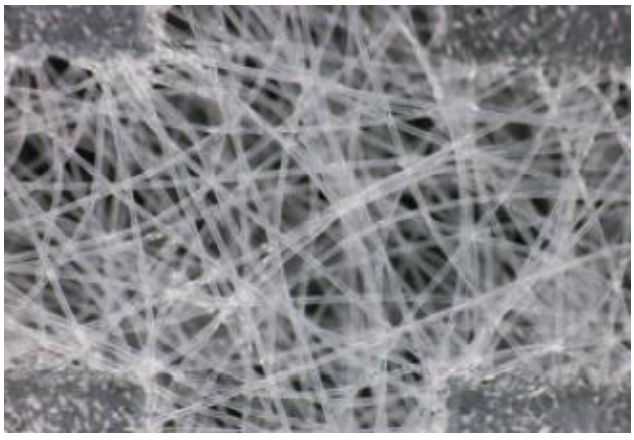
Knitting:

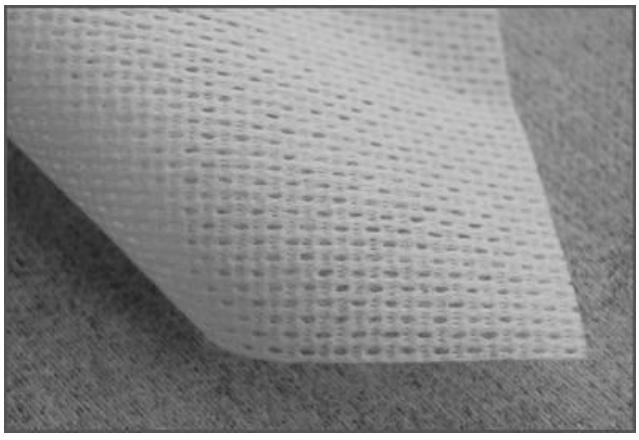
- Knitting is a process of intermeshing of loops of one or many yarns.
- In knitting, loops of one or more yarns are intermeshed to make the fabric.
- The vertical row of loops is called wale and horizontal row of loops is called course.
- Knitting is done on knitting machine.
- The fabric made by knitting technique is called knitted fabric.
- Knitted fabrics are used as t-shirts, socks, sweaters, mufflers, gloves, undergarments, nets, curtains, body fitted garments



Non-woven:

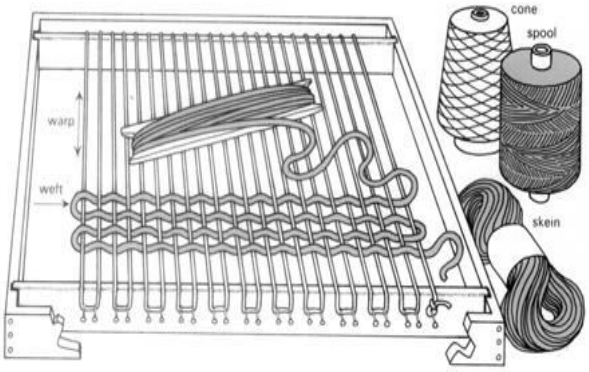
- Non-woven technique makes fabric directly from fibres.
- The fabric made is called non-woven fabric.
- Non-woven fabrics are made by bonding or intermeshing of fibres.
- Now-a-days, non-woven fabrics are very popular. These are mainly used in industries.





Weaving

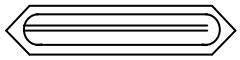
Weaving is a process of interlacing two sets of yarns perpendicular to each other. Weaving machine is called loom.

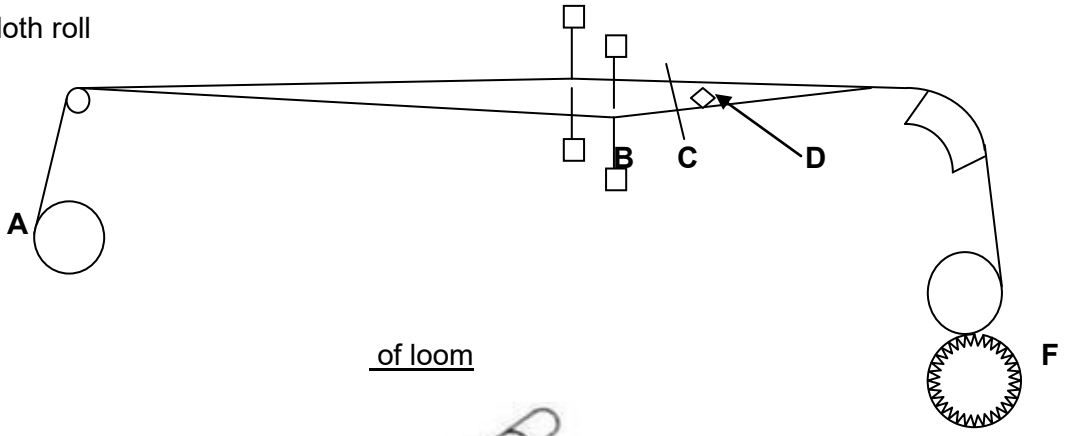


Working of loom:

The loom is a machine made up of many parts, mechanisms and motions which are operate at a particular time and in a proper sequence.

Parts of loom are:

A. Warp beam
B. Heald shaft
C. Reed
D. Shuttle 
E. Pirn
F. Cloth roll



of loom

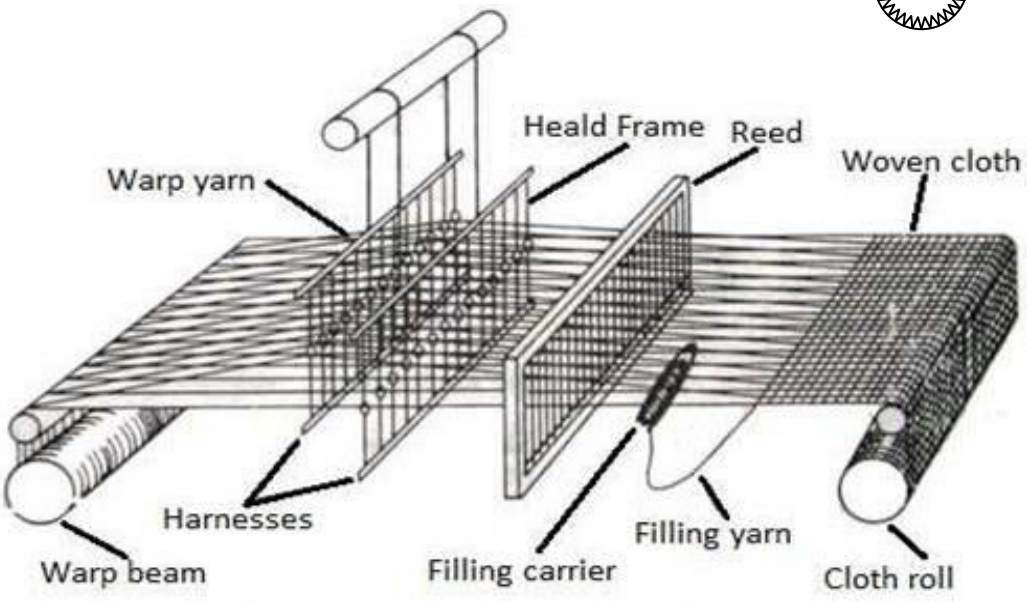
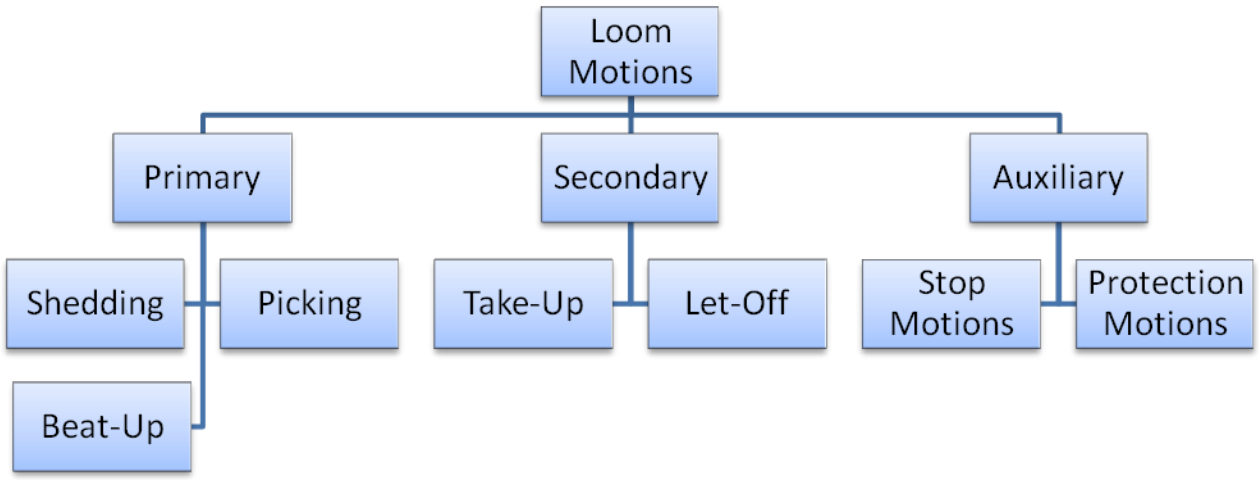


Figure: Basic structure of a loom

Motions of loom:



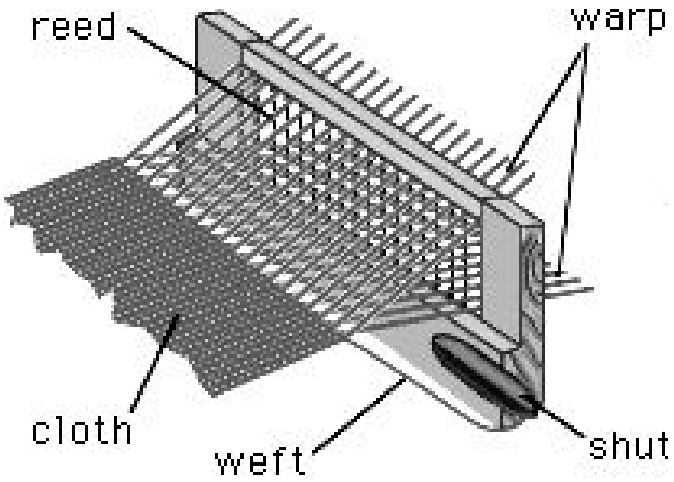
The motions of a plain loom can be classified as:

1. Primary motions
    a) Shedding – separating warp yarns into two layers (one raised and other is lowered) to form a shed.
    b) Picking -inserting pick or weft yarn across the warp yarns into the shed.
    c) Beat up -pushing the weft yarn towards the cloth.
2. Secondary motions
    a) Let-off –releasing warp from warp beam and keeping necessary tension in the warp.
    b) Take-up –winding the woven cloth on cloth roll.
3. Auxiliary motions
    a) Warp protector -stops the loom to protect warp from damage when shuttle do not reach to the shuttle box.
    b) Warp stop -stops the loom when a warp yarn breaks.
    c) Weft stop - stops the loom when weft yarn breaks or weft runs out of the pirn.

Primary motions in detail:

Primary motions are essentially required (very necessary) for weaving. Without these motions, weaving is not possible. The 3 primary motions are:

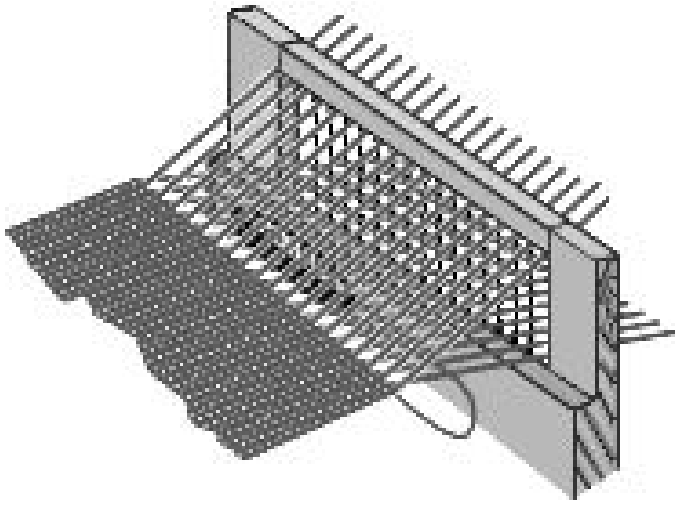
1. **Shedding** -
    - Shedding is the first primary motion of weaving.



- Shedding is seperating the warp yarns into two groups. One group is raised and other is lowered to make a ‘shed’.
- Shed gives the space for passage of the shuttle.
- Heald shafts are used for raising or lowering of groups of warp yarns.
- Shed can be formed with the help of tappets, dobby and jacquard mechanisms. These are the 3 different shedding mechanisms.

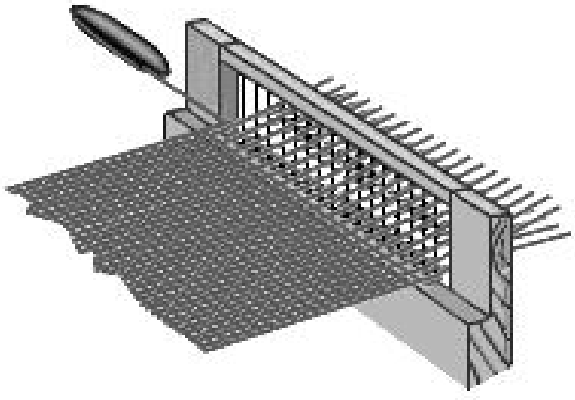
2. **Picking-**

- Picking is inserting pick or weft yarn across the warp yarns into the shed.
- Picking can be done with the help of shuttle, projectile, rapier, air-jet or a water-jet.

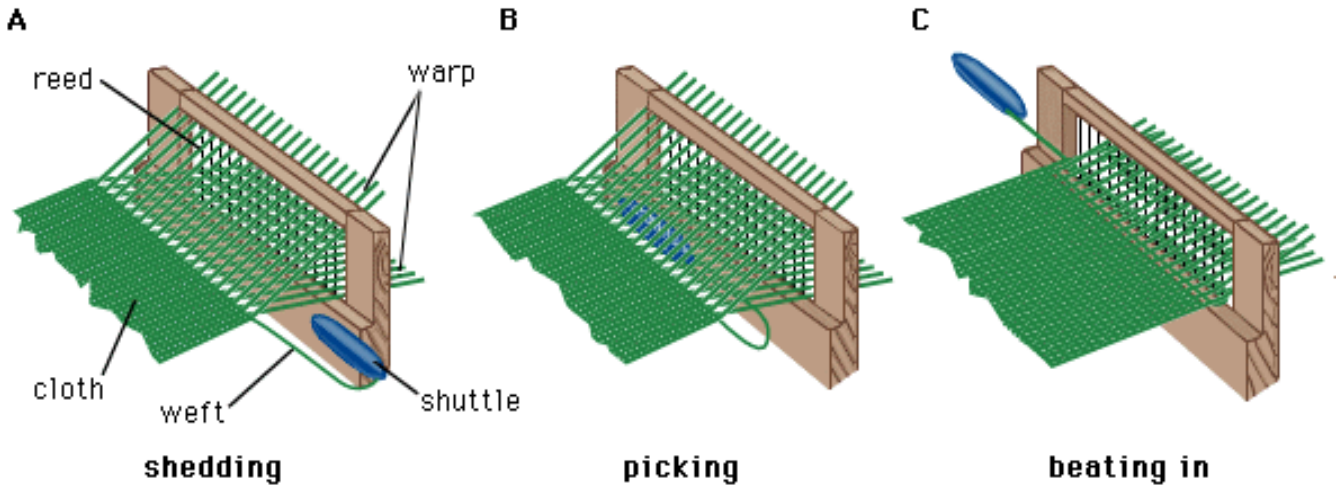


3. **Beat-up**:

- Beat-up is the process of pushing the inserted weft yarn towards the woven cloth.
- Beat-up is done with the help of ‘reed’.
- After beat-up, the weft yarn becomes the part of the cloth.



These three motions namely shedding, picking and then beat-up are done in sequence one after the other and the fabric is produced. Then the fabric is passed over the front rail and wound of the cloth roller.

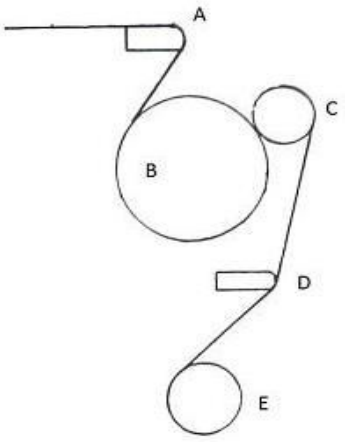

A
B
C
reed
warp
cloth
weft
shuttle
shedding
picking
beating in

Secondary motions in detail:

These motions are next in importance to the primary motions. Secondary motions are necessary for 'continuous weaving'. The 2 secondary motions are:

1. **Take-up** -

- Take-up is the process of winding the woven cloth on cloth roll.
- The cloth is taken from the weaving area at a constant rate.
- The take-up motion gives the required pick-spacing (in picks/inch or picks/cm).
- The cloth roll is covered with emery cloth or hard rubber depending upon the type of cloth woven.



A= Breast beam, B= Take up beam, C= Felt covered roller
D= Crease boards, E= Cloth roller

2. **Let-off -**

- The let-off motion delivers the warp to the weaving area.
- The warp yarns are realized from the warp beam at constant rate.
- The let-off motion maintains the necessary tension in the warp yarns.

These two secondary motions are carried out simultaneously. Also the amount of cloth take-up is equal to amount of warp let-off.

Auxiliary motions in detail:

These motions are required for defect-free weaving and to stop the machine automatically when such a fault occurs. The main auxiliary motions are:

1. Warp protector –This motion protects the warp threads by stopping the loom when the shuttle fails to reach the shuttle box.

2. Warp stop Motion-This motion stops the loom when a warp yarn breaks. This also helps in detection of broken end. Warp stop motion can be mechanical or electronic.

3. Weft stop – This motion stops the loom when weft yarn breaks or weft runs out of the pirn.

Types of Loom-
The looms can be classified as shown below:

1. Conventional / Conventional Shuttle Loom-

- In Conventional or Conventional Shuttle Looms, the picking is done with the help of shuttle.
- These looms can be hand operated or power (electricity) operated.
- In these looms, shedding can be done with the help of different mechanisms. On the basis of shedding, the conventional shuttle looms can be of following three types:

1) Tappet Looms
2) Dobby Looms
3) Jacquard Looms

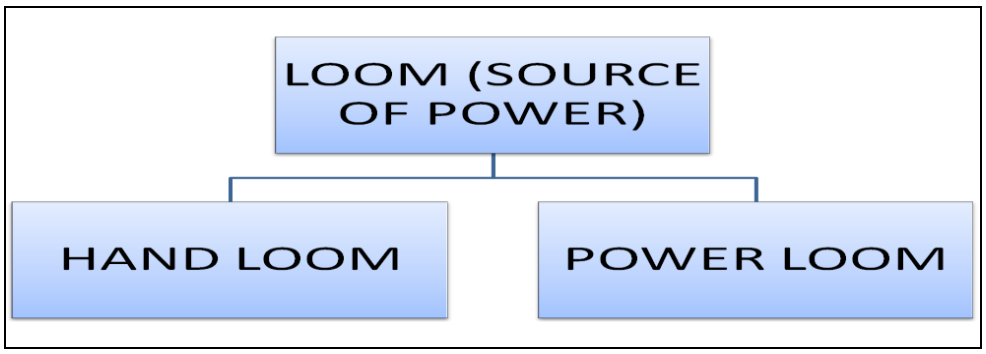
2. Automatic Loom-

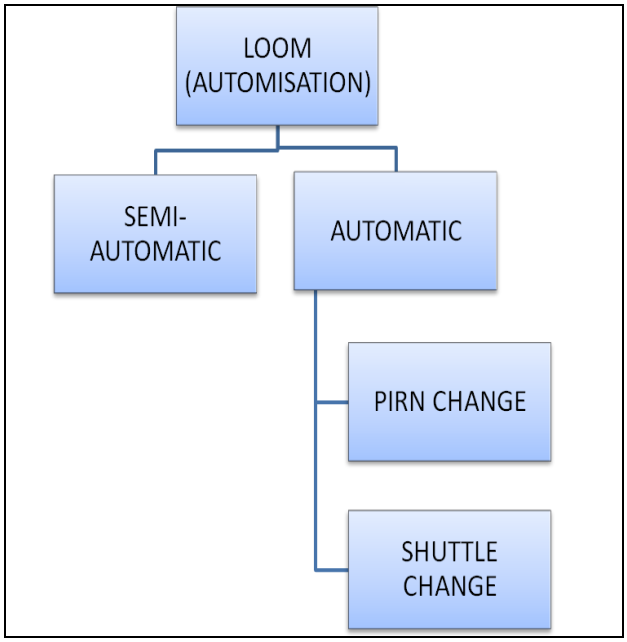
It is a power operated shuttle loom on which some functions are done automatically. The functions like automatic warp let-off, automatic warp stop motion, and the shuttles or pirns are changed automatically.

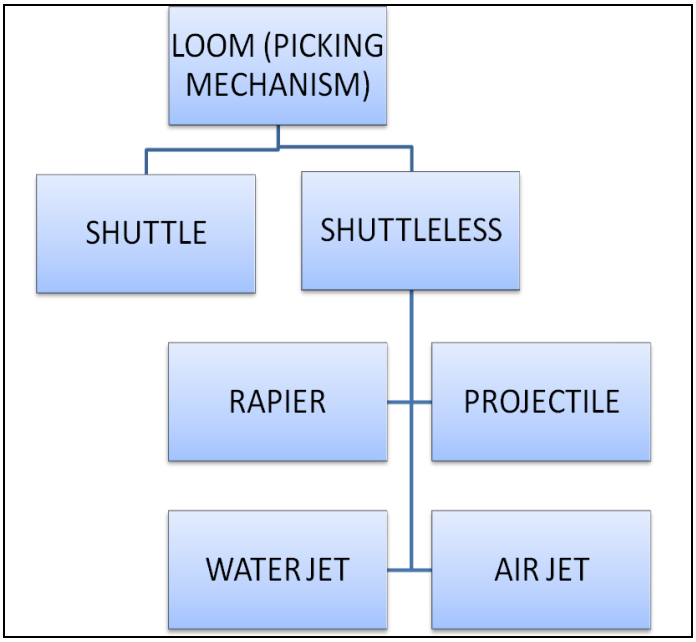
3. Modern / Shuttle-less Loom-

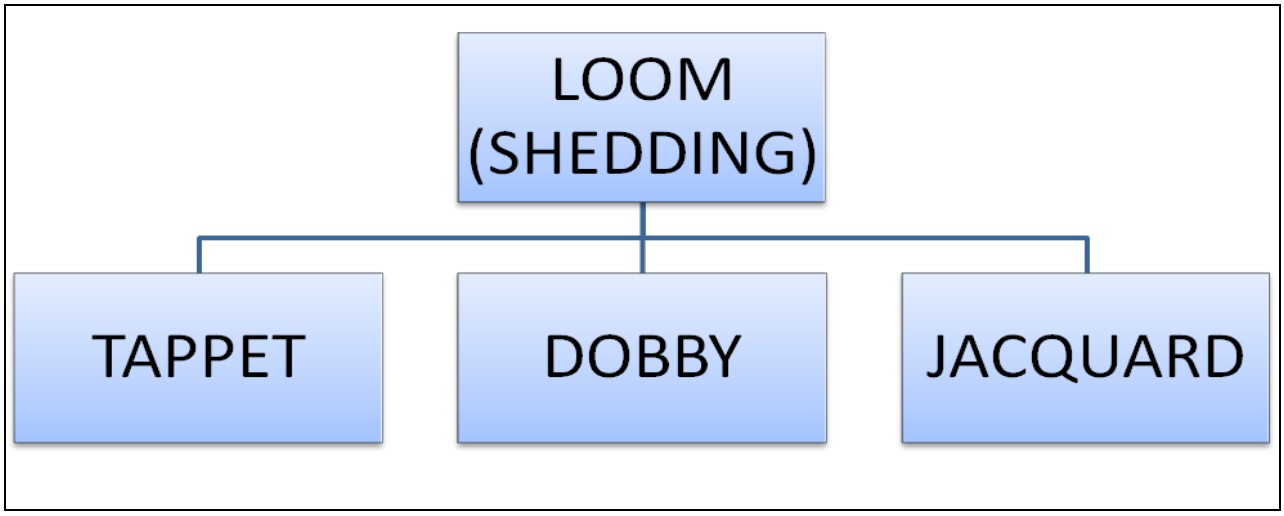
- In shuttle-less looms, the picking is done with means other than shuttle.
- These looms are power operated and have high speed.
- The main shuttle-less looms are:

1) Missile/ Projectile Looms - A small metal projectile grasps the weft yarn and passes it through the warp shed.
2) Rapier Looms – one or two steel rapiers (clip type) are used for weft insertion.
3) Air-Jet Looms - A jet of air is used to insert the weft yarn.
4) Water-jet Looms - A jet of water is used to insert the weft yarn.


LOOM (SOURCE OF POWER)
HAND LOOM
POWER LOOM


LOOM (AUTOMISATION)
SEMI-AUTOMATIC
AUTOMATIC
PIRN CHANGE
SHUTTLE CHANGE

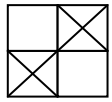

LOOM (PICKING MECHANISM)
SHUTTLE
SHUTTLELESS
RAPIER
PROJECTILE
WATER JET
AIR JET


LOOM (SHEDDING)
TAPPET
DOBBY
JACQUARD

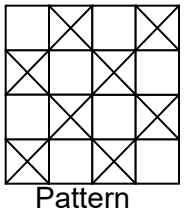
Basic weaves:

Weave: The weave is the manner in which the warp and weft are interlaced.

A **repeat** is the smallest unit of the weave. When repeat is repeated the **pattern** or **design** is produced in the fabric.



Repeat

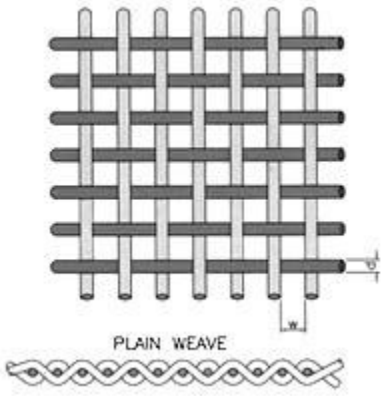


Pattern

Weave representation:
1. The vertical line (column) represents warp yarn
2. The horizontal line (row) represents weft yarn
3. 'X' represents warp over weft
4. Empty box represents weft over warp

The three basic weaves in common use for the fabrics are plain, twill, and satin.

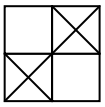
1. **Plain Weave**



- This weave is the most simple and less expensive to produce.
- In this weave, each weft yarn goes over one warp yarn and under the next warp yarn.
- The plain weave repeats on 2 Ends × 2 Picks.

Repeat size = 2

Interlacing = 1/1

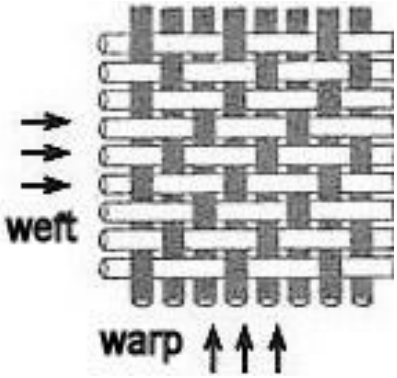


- This weave gives maximum interlacing.
- The characteristic of fabric made of plain weave are
  1) Good strength
  2) Durable
  3) Good tearing strength
  4) Suitable for dyeing, printing and finishing
- The fabrics made by plain weave are muslin, crepe, chiffon, organdy, voile, cambric and taffeta.

2. **Twill weave**

- Twill is the second basic weave.
- It can be identified by diagonal lines on the fabric.

- In this weave, the weft yarn goes over more than one warp yarn, but not more than four.



- A Twill Weave is denoted by using numbers above and below a line. For example:

  1/2 twill, 2/1 twill, 2/2 twill, 2/3 twill, 3/2 twill, 3/3 twill, 1/3 twill, 3/1 twill, 4/4 twill, 1/4 twill, 1/2 2/3 twill

  1/2 twill (one up two down twill) –

  Repeat size = 3

  Interlacing = 1/2

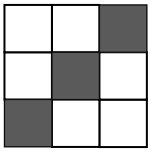


fig 1

  3/1 twill (three up one down twill) –

  Repeat size = 4

  Interlacing = 3/1

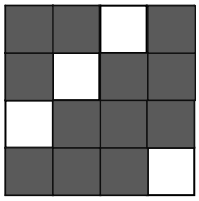


fig 2

- The two directions of twill are:

  a) Left-hand twill- when the direction of the diagonal line is top left, it is left hand twill.

  b) Right-hand twill- when the direction of the diagonal line is top right, it is right hand twill.

- The twill weave can be warp-face or weft face.

  a) Warp-face twill- when more warp yarns are on face side, it is warp face twill. (see fig 2)

  b) Weft-face twill- when more weft yarns are on face side, it is weft face twill. (see fig 1)

- The characteristic of fabric made of twill weave are

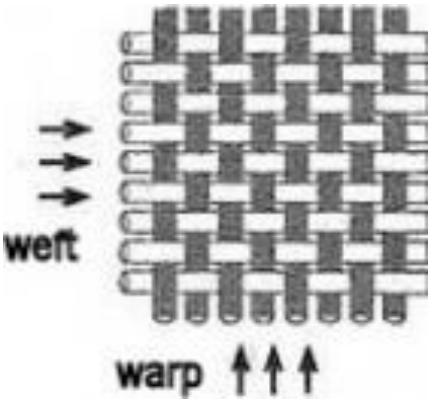
  1) Good strength and durability

  2) Good drape

  3) Good flexibility and resiliency

  4) Diagonal line design

  5) Smooth fabric than plain weave

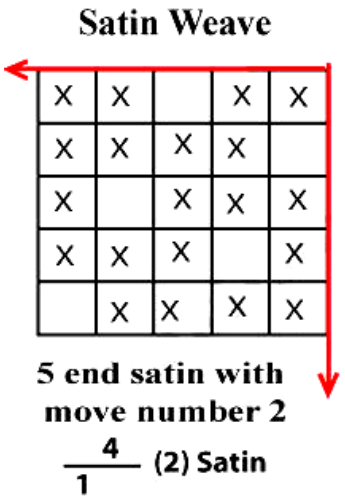


- The fabrics made by twill weave are denim, drill, tweed, jean, khaki, gabardine, flannel, board cloth. Twills are generally used for men's clothing (like suits, pants, coat), uniforms and work wears.

3. Satin weave

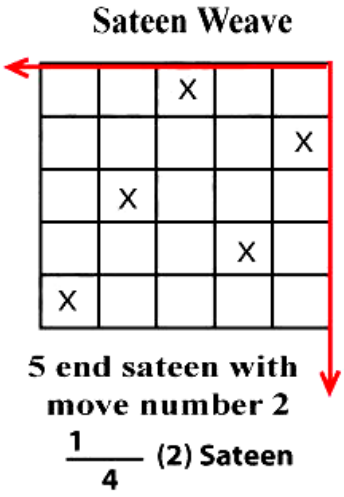
- Satin is the third basic weave.
- It can be identified by long warp floats on the fabric.

- In this weave, the weft yarn goes under more than four warp yarns.
- The repeat size for satin weave can be 5, 8 and 12 etc. So the weave is called 5 end satin, 8 end satin, and 12 end satin.
- The number of interlacing is equal to the number of warp yarn in the repeat. Means total 5 interlacing in 5 end satin.
- The fabric has long floats on the surface.
- The fabric with satin weave is smooth, lustrous and drapable.
- Satin fabric is used to make coats, suits, swimsuits, curtains, labels, tags, neck-tie, undergarments, bedsheets etc.



4. Sateen weave

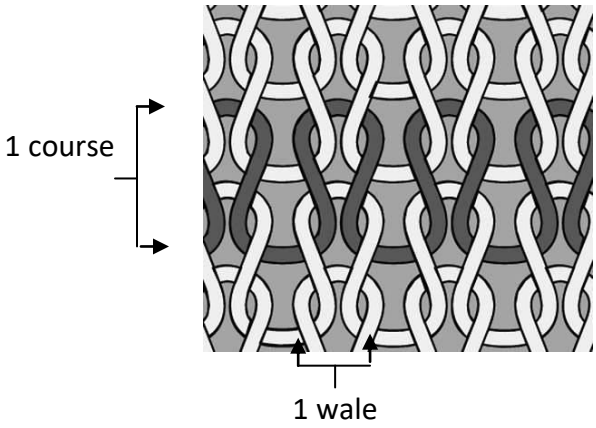
- The construction of sateen weave is same as satin weave.
- Sateen weave has long weft floats on the fabric surface.
- In this weave, the warp yarn goes under more than four weft yarns.
- Same as satin, the repeat size for sateen weave can be 5, 8 and 12. So the weave is called 5 end sateen, 8 end satin, and 12 end sateen.
- The fabric characteristic of sateen weave is same as satin weave.

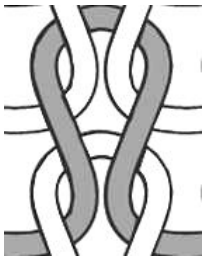


Unit 1: Knitting

Knitting:

- Knitting is a process of intermeshing of loops of one or many yarns.
- In knitting, loops of one or more yarns are intermeshed to make the fabric.
- The vertical row of loops is called wale and horizontal row of loops is called course.
- Knitting is done on knitting machine.
- The fabric made up of network of loops is called knitted fabric.
- Knitted fabrics are used as t-shirts, socks, sweaters, mufflers, gloves, undergarments, nets, curtains, body fitted garments.



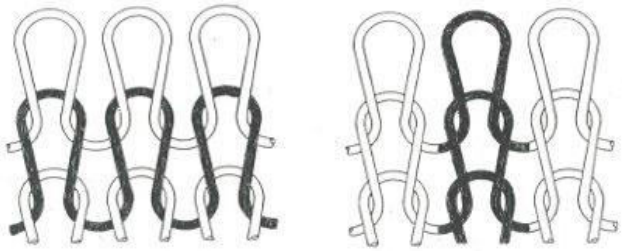


1 loop

WPI: Wales per inch

CPI: Courses per inch

One loop is part of both the course and the wale.

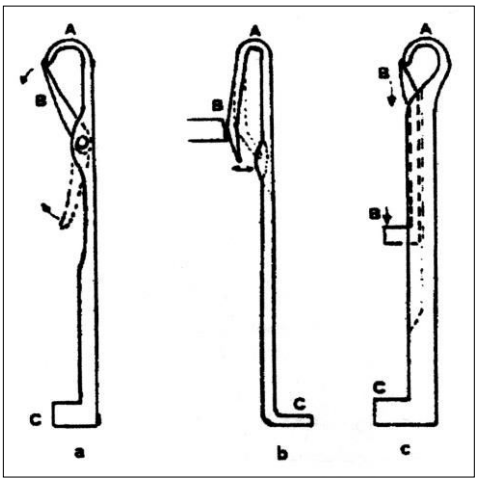


Knitting needle: The hooked metal needle is the principal (main) knitting element of the knitting machine.

3 types of knitting needles are:

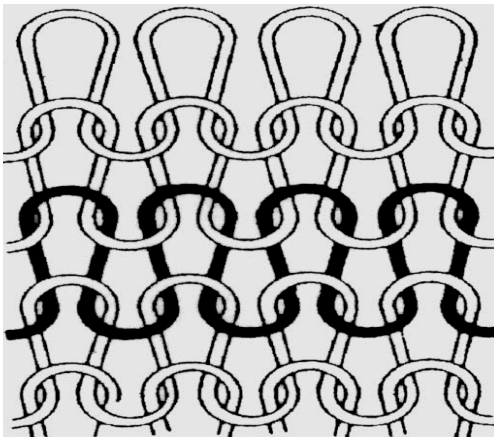
1. Beard needle (b)
2. Latch needle (a)
3. Compound Needle (c)

Latch needle is the most common type of needle used. These needles are arranged side by side to each other in a series on a bed (Needle-bed).



Classification of knitting:

A. Weft knitting
B. Warp knitting



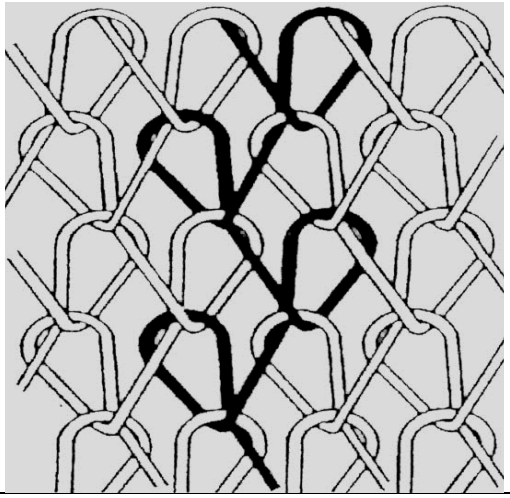
Weft knitting:

In weft knitting, the loops are made in course direction (horizontal direction).

Weft knitting is so called because the loops are formed in weft direction.

Direction of loop formation= horizontal

No. of yarns used = at least one



Warp knitting:

In warp knitting, the loops are made in wale direction (vertical direction).

Warp knitting is so called because the loops are formed in warp direction. Yarns are fed walewise.

Direction of loop formation= vertical

No. of yarns used = no. of wales or needles

Difference between weft knitting and warp knitting:

Weft knitting	Warp knitting
No of yarns equal to 1 to 4	No of yarns equal to no. of wales or needles
Yarns are fed in course direction	Yarns are fed in wale direction
Weft knit fabric is cheaper	Warp knit fabric is more costly because a warp beam is needed
More extensible	Less extensible
Lesser recovery from stretch	Higher recovery from stretch
Less dimensional stability (curl easily at the edges)	More dimensional stability (do not curl at the edges)
Limited designing possible	Many designs are possible
Uses: sportswear, t-shirts, undergarments, socks, casual wear	Uses: Formal ladies wear, suiting, curtains, decorative laces

Knitting Machine:

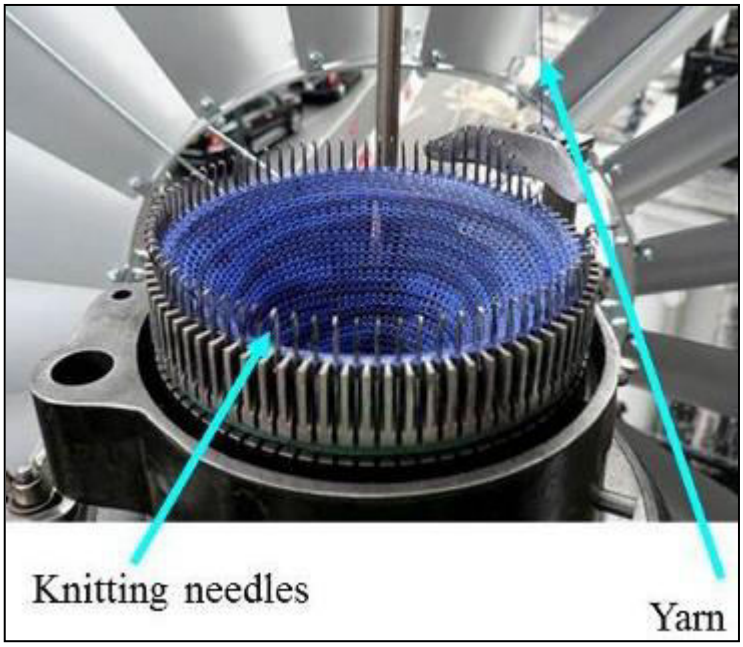
A knitting machine is an apparatus for applying mechanical movement to needles in order to convert yarn into knitted loop structures. These machines can either be powered by hand or by an external power source.

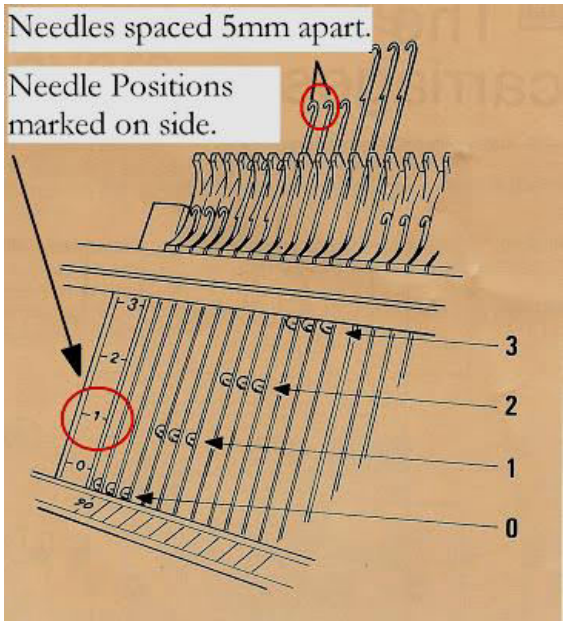
The two main types of knitting machines are:

- Circular knitting machine (shown in Figure)
- Flat bed machines

The common features of both types of machine include:

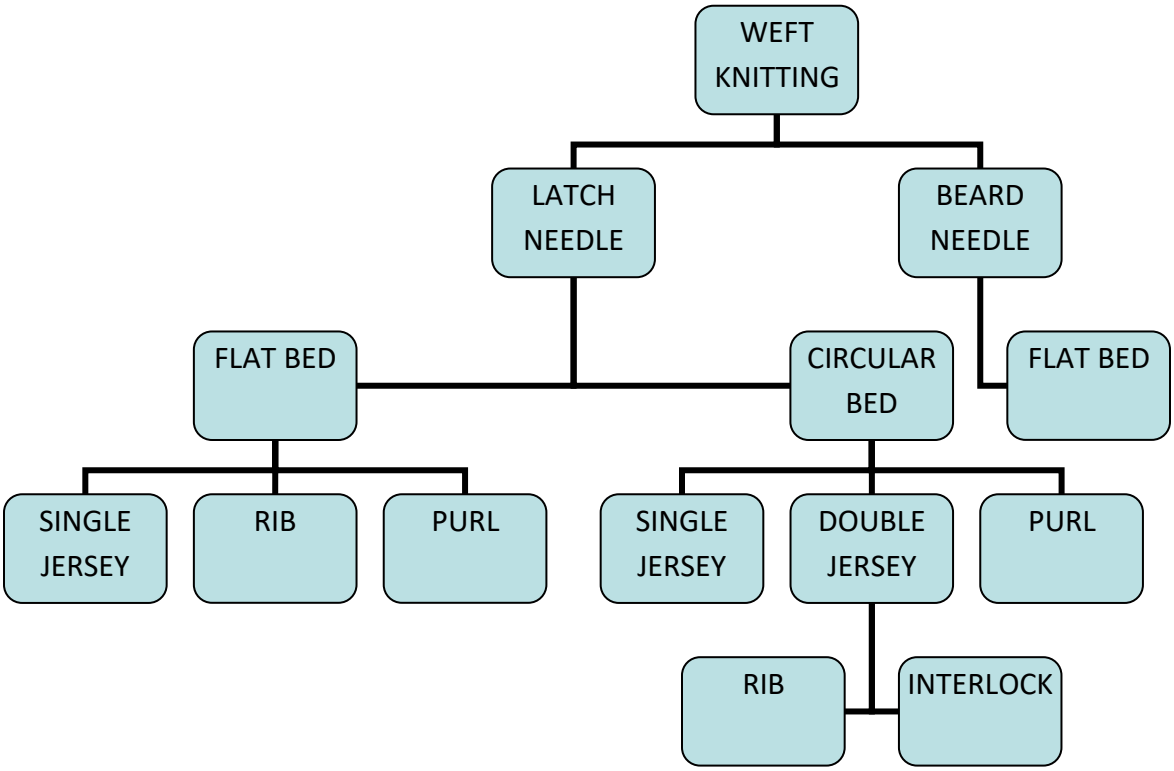
- Needle bed
- Yarn feeder
- Yarn guide
- Cam mechanism
- Fabric take-down
- Fabric winding mechanism





Both warp and weft knits can be made either on circular knitting machine or on a flat-bed knitting machine. Circular knitting machine produces a tube of fabric, while a flat-bed machine produces a flat fabric.

Weft Knitting Flowchart:



Weft Knitted Fabric Structures:

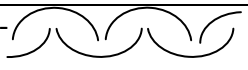
The most common weft knitted fabric structures are:

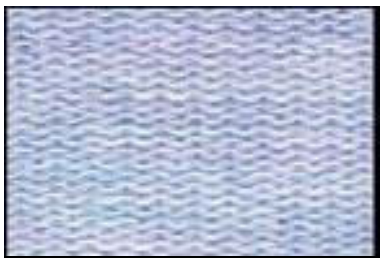
- Single Jersey or Plain Knit
- Rib
- Purl
- Interlock

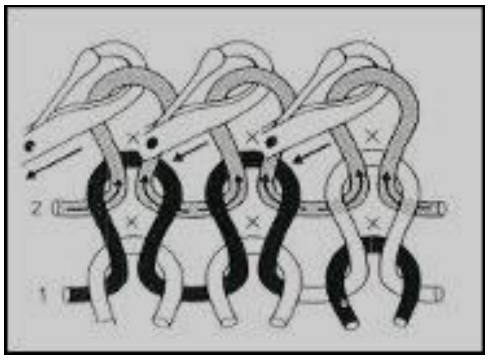
<u>Single Jersey or Plain Knit:</u>

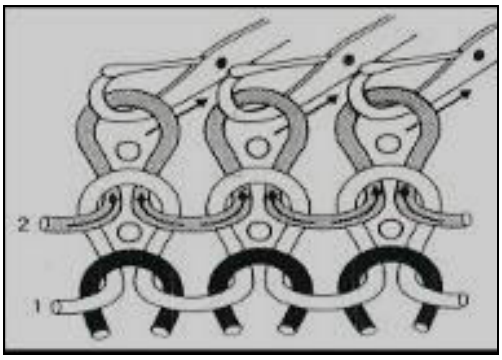
The simplest and most commonly used weft knit fabric is “single jersey” or “plain knit”.

It can be produced on both flat knitting machine or on circular knitting machine.

Technical face	Technical Back
Appearance- V shaped 	Appearance- 
Smooth feel	Rough feel







The properties of the single jersey of plain knit:

1. Plain knit is not reversible because of different appearance on both sides (face and back).
2. Plain knit has poor dimensional stability. Fabric curls towards the face side at cut edges.
3. Plain knit has higher elasticity. Width wise elasticity is higher than length wise.
4. The production speed of plain knit is higher because of simple structure.
5. Plain knit is cheaper because of higher production speed.

Uses:

It is generally used for hosiery, sweaters, underwear, gloves, socks, t-shirts etc.

Rib knit:

Rib is a weft knitted fabric with face wale and back wale at alternate positions.

Rib has a vertical cord appearance because the face loop wales move over and in front of the back loop wales.

The simplest rib fabric is 1x1 rib.

Other examples of rib knit are: 2x2, 2x1, 3x3, 2x3, 3x2, etc.

1x1, 2x2, 3x3, etc are reversible rib knits.

2x1, 3x2, etc are irreversible knits.

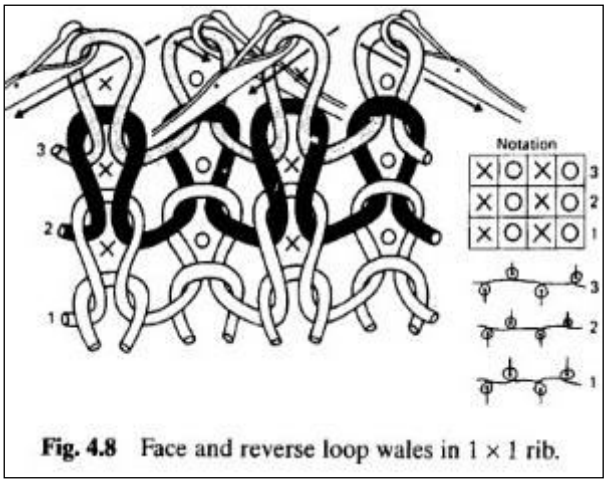
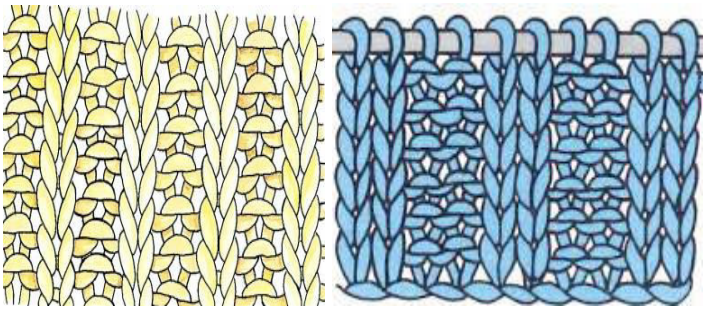
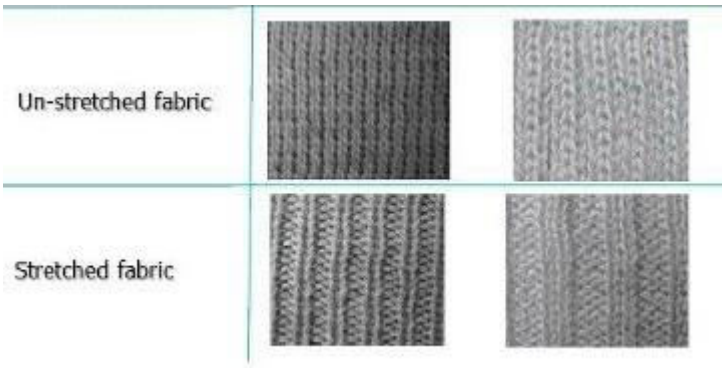


Fig. 4.8 Face and reverse loop wales in 1 × 1 rib.





The properties of the rib knit:

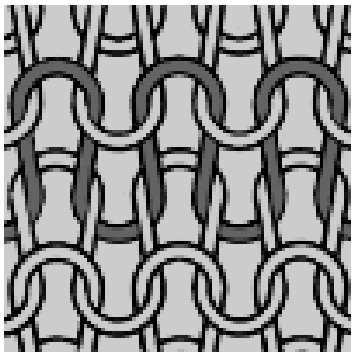
1. Rib is reversible because of no technical face and back side.
2. Rib has good dimensional stability. It does not curl at cut edges.
3. Rib has higher elasticity than plain knit. Width wise elasticity is higher than length wise.
4. Rib is heavier and thicker than plain knit.
5. Rib is expensive than plain knit.
6. Rib has more designing scope than plain knit.
7. Rib knits are more durable than plain knit.

Uses:

The elasticity of rib make it suitable for the extremities of articles such as tops of socks, cuffs of sleeves, rib borders of garments, and strapping for cardigans. Rib knit is often used at the cuffs of a plain knit garment.

Purl knit:

Purl is a weft knitted fabric with face course and back course at alternate positions.



Purl has a horizontal cord appearance because the face loop wales move over and in front of the back loop wales.

Purl knit is 1x1(as shown in diagram).

The properties of the purl knit:

1. Purl knit is reversible as it has same appearance on both sides.
2. Purl knit has higher elasticity in lengthwise direction.
3. Purl knit has good dimensional stability. It does not curl at cut edges.
4. Purl knit is heavier and thicker than plain knit.
5. Production cost of purl is higher because of complex machine.
6. Purl knit is expensive than plain knit and rib knit.

Uses:

Purl knits have vertical elasticity so they are used to make children wear, socks, gloves, sweaters and sportswear.

Interlock knit:

Interlock is a double jersey weft knit fabric.

In interlock knit, the wales on each side are exactly opposite to each other and are locked together.

The both sides of interlock have the appearance similar to the technical face of plain knit.

The properties of the interlock knit:

1. Interlock knit is heavier and thicker than plain, rib and purl knit.
2. Interlock knit has excellent dimensional stability.
3. It has poor elasticity.
4. Interlock knit is expensive because of it slow production speed and complex structure.

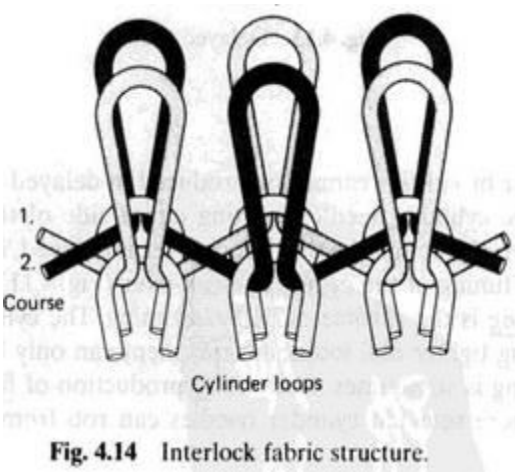


Fig. 4.14 Interlock fabric structure.

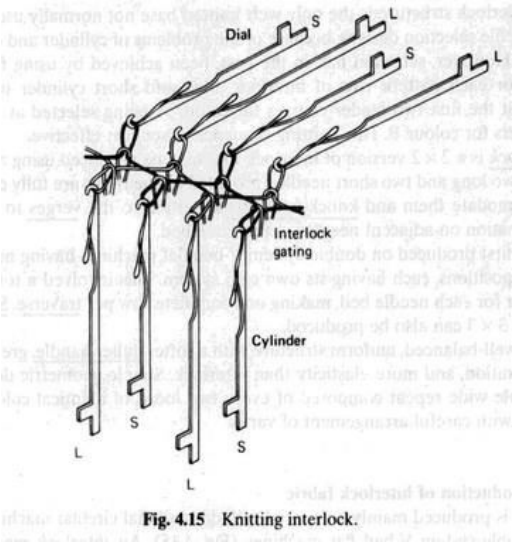


Fig. 4.15 Knitting interlock.

Uses:

Interlock knit is generally used for formal wear, sportswear, outerwear, women wear etc.

Warp Knitting:

In warp knitting, the loops are made in wale direction (vertical direction).

Warp knitting is so called because the loops are formed in warp direction. Yarns are fed wale wise.

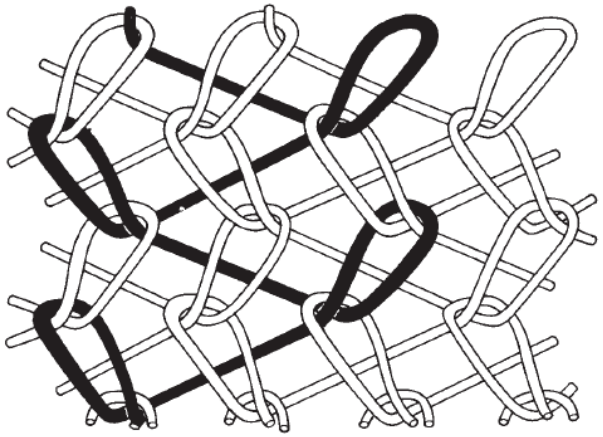
Direction of loop formation= vertical

No. of yarns used = no. of wales or needles

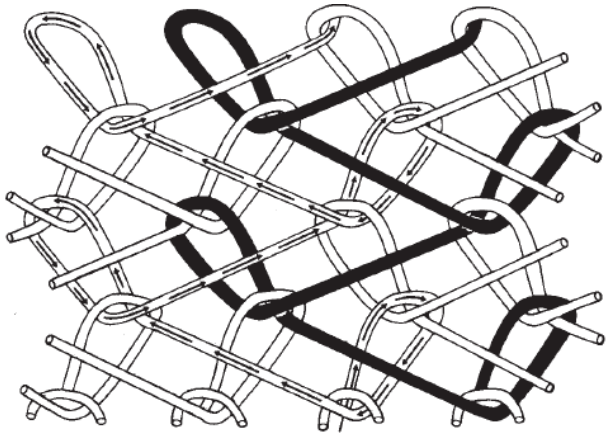
Appearance:

On technical face side of warp knit, the loops appear at a slight angle.

On technical back side of warp knit, the floats appear at a slight angle. These floats are called "underlaps". The warp knit can be identified by these underlaps on the back side.



(a) Technical Face



(b) Technical Back

Properties of warp knit:

- Warp knits have good dimensional stability like woven fabrics.
- Warp knits have good smoothness, shine, strength and wrinkle resistance.
- Warp knits do not ravel and curl.
- Warp knits have superior dimensional stability.

Warp knitting Machine:

Warp knitting machine can be flat or circular machine.

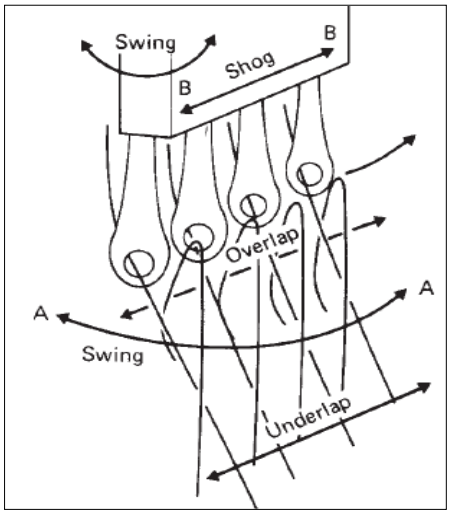
The main parts of a warp knitting machine are: needle bar, warp beam, guide bar, guides etc.

-warp beam is placed above the machine

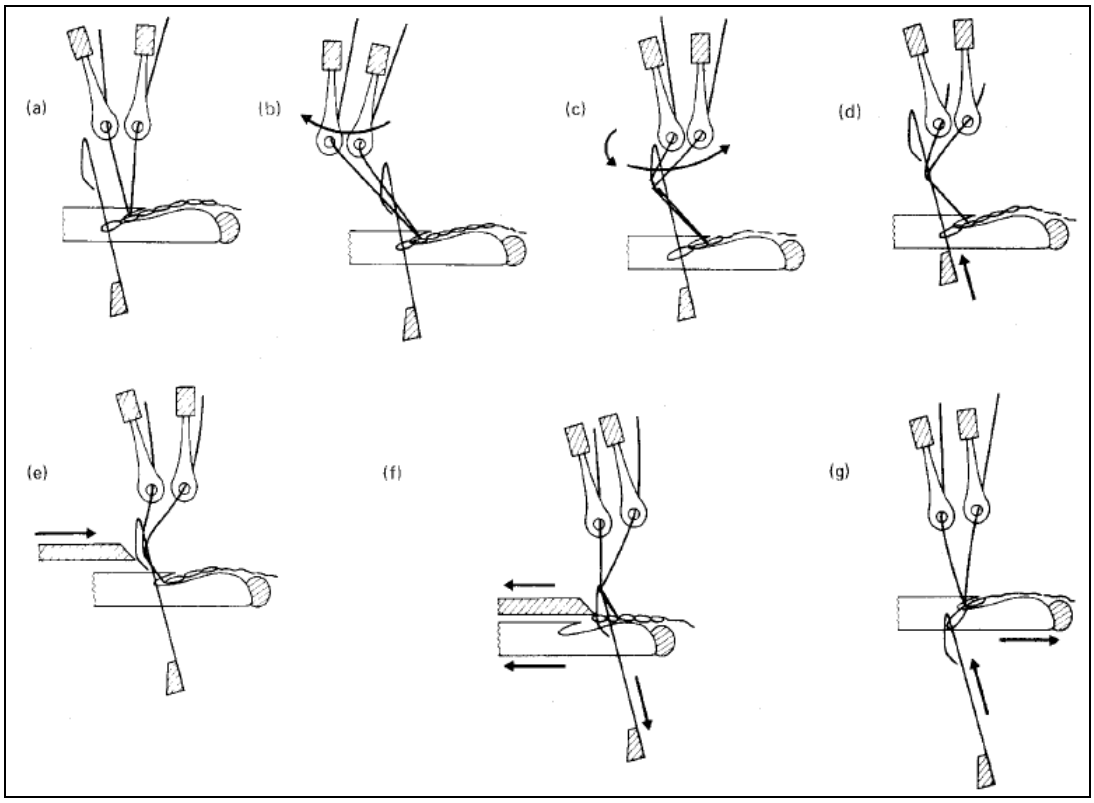
- beam supply the yarns in parallel sheet form to the guide bars

-guides are thin metal plates with a hole at their lower portion

-the upper portion of guides is fixed in to the guide bar



-one guide passes one warp yarn to one needle.



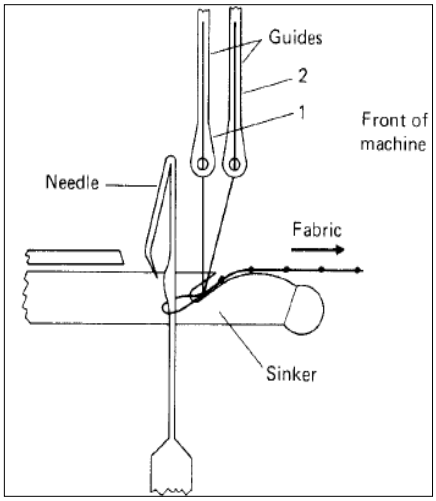
Knitting cycle of a beard needle warp knitting machine

Warp Knitted Fabric Structures:

The most common warp knitted fabric structures are:

- Tricot knit
- Raschel knit

<u>Tricot:</u>



- The fabric made on tricot machine is called “tricot knit” fabric.
- Generally beard needles are used in tricot machine.
- Tricot knits are generally made with fine yarns.
- Process:

  -the guides with the yarn move forward and side wise

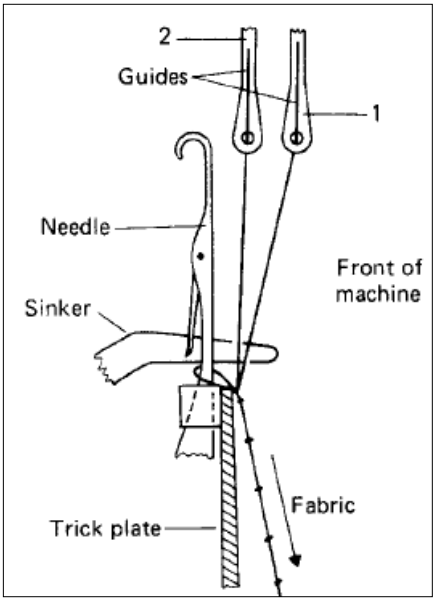
  -the yarn is placed under the hook of the needle

  -the presser moves and presses the beard of the needle to hold the yarn

  -then the needle goes down pass the loop from the previous loop

- Uses: tricot fabrics are used for shirts, blouses, dresses, sleepwear, underwear, uniforms, outer-wears and automobile seat covers.

Raschel:



- The fabric made on Raschel machine is called “Raschel knit” fabric.
- The Raschel machine uses latch needles.
- The Raschel fabrics are made with little thick yarn.
- Mostly laces like structures are made on Raschel machine.
- Process:

  -the guides with the yarn move forward and side wise

  -the yarn is placed under the hook of the needle

  -the presser moves and presses the beard of the needle to hold the yarn

  -then the needle goes down pass the loop from the previous loop

- Uses: Raschel fabrics are used to make laces, dresses, curtains, home furnishing fabrics, scarf, stolls etc.

Finishing

Introduction and Importance:

As the fabric comes out of the loom or knitting machine, it is not attractive because it gets dirty in spinning and weaving processes. So to improve its appearance, quality and to prepare it for the market, fabric is passed through various processes. All these processes are called finishing.

Definition:

Finishing includes all the processes which are applied to the fabric after leaving the loom or knitting machine and before entering the market.

Finishing includes the final treatment of every kind of fabric made from every kind of fibre.

(Grey Fabric: Newly constructed fabric as it comes from the mill is called grey fabric. It is an unfinished fabric.)

Objectives of finishing:

The objective of textile finishing is to make textile goods fit for their end use.

The objective of a particular finishing process may be any one or many of the following-

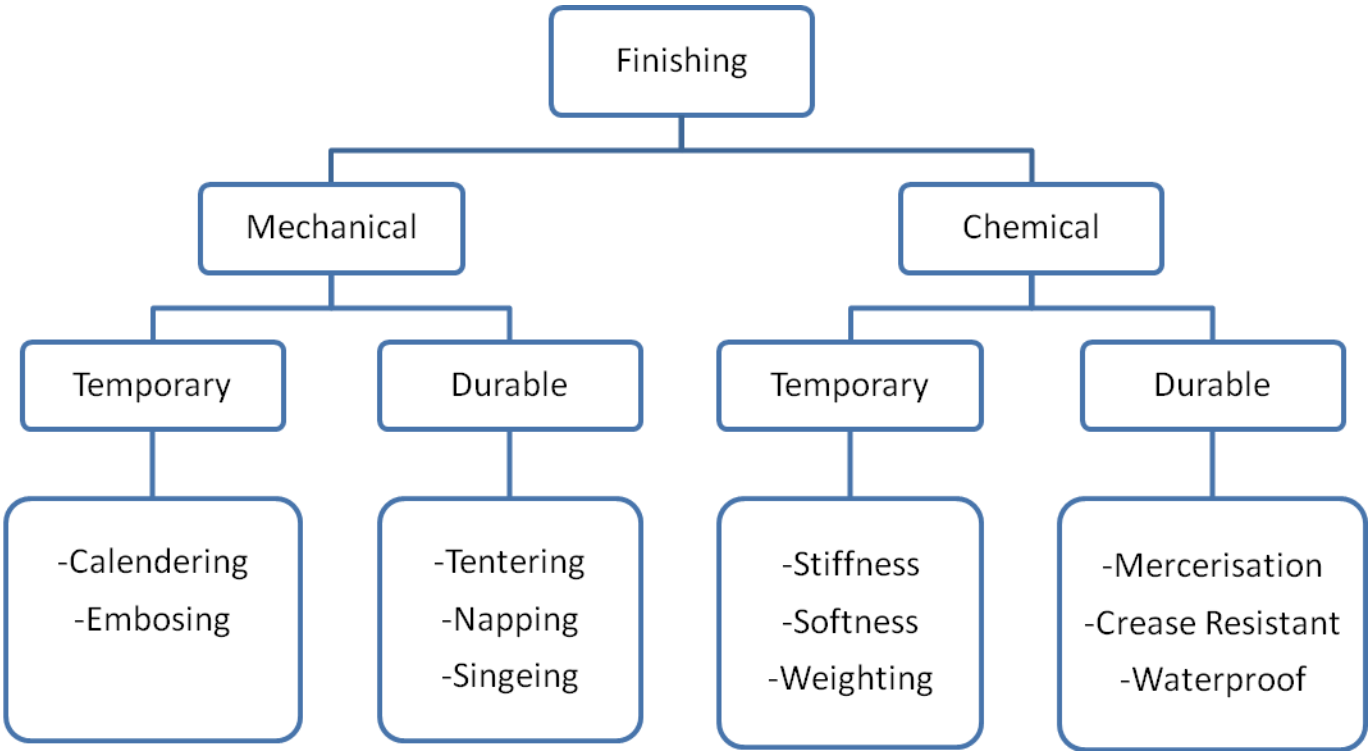
1. To improve the appearance.
2. To improve the feel or texture.
3. To improve the wearing qualities.
4. To produce special properties required for particular use.
5. To cover the faults in the fabric.
6. To increase the weight of fabric.

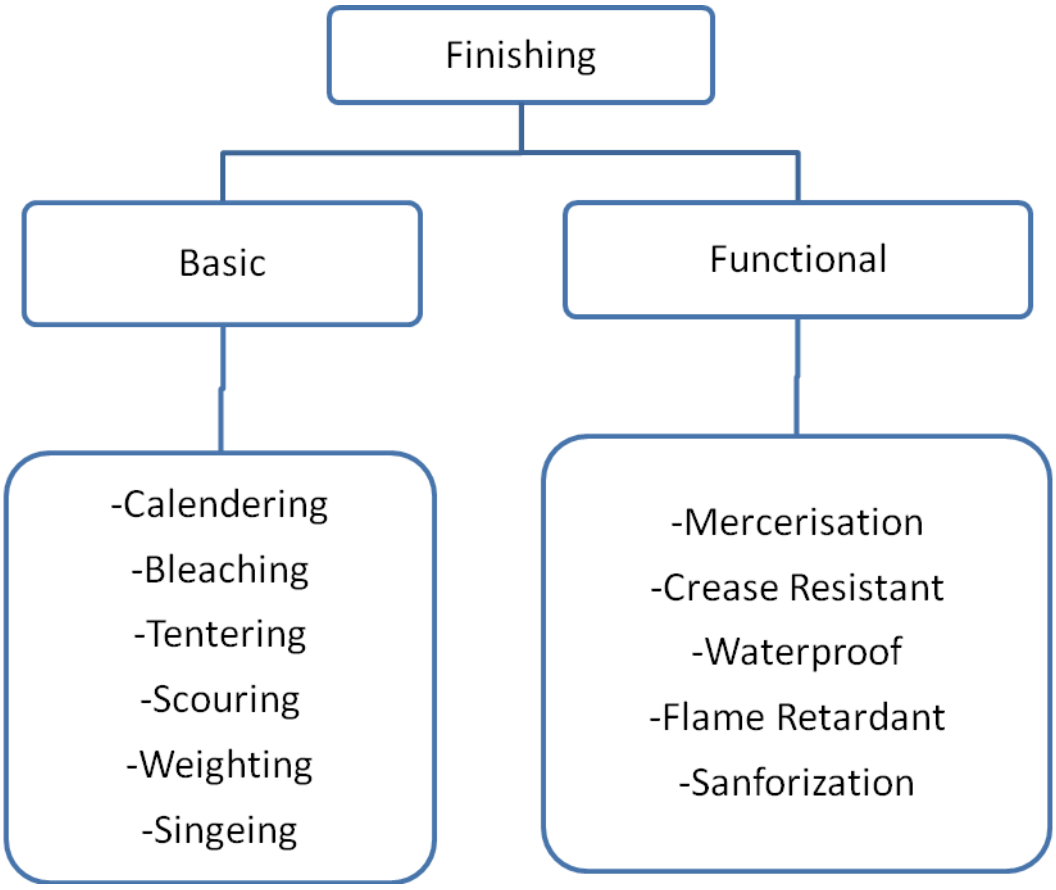
Objective	Example of Finishing
appearance	Bleaching, calendering, mercerization, embossing, glazing
feel or texture	Stiffening, softening, flocking, napping
wearing qualities	Anti-soiling, anti-creasing, anti-shrinking, softening, wash-n-wear
special properties	Water-proofing, flame-proofing, anti-bacterial, anti-microbial, anti-odour
cover the faults	Napping, calendering
increase the weight	Starching, gum, clay

Factors on which finishing techniques depend:

1. Nature of fabric- fibre type, fabric structure (woven or knitted).
2. Physical properties of the fabric- feel softness, stiffness, strength, elasticity, etc.
3. The end-use of the material.

Classification of finishes:





Basic Finishes:

Basic finishes are also called routine finishes. Routine finishes are applied to almost all fabrics to improve their appearance.
Basic finishes include Bleaching, Calendering, Tentering, Scouring, Weighting, and Singeing.

1. Desizing:

- Desizing is a chemical treatment applied on woven fabric to remove sizing compounds. The size components are previously applied to warp yarns.
- Desizing is usually the first wet finishing operation performed on woven fabric.
- Desizing techniques are different depending on the type of sizing components applied. Sizing components can be water-insoluble like starch-based or water-soluble like PVC, CMC etc.
- Desizing can be done by using chemicals or enzymes.

2. Scouring: (also known as boiling-off or kier boiling)

- Scouring is a durable type chemical finishing treatment.
- Scouring is a process of removal of impurities such as oils, wax, gums, soluble impurities and solid dirt from the fabric.
- Main objective of scouring is to make fabric more absorbent and clean.
- Scouring is done in alkali (sodium hydroxide or sodium carbonate) and requires heat for boiling.
- This treatment can be carried out on filaments, yarns and fabrics.

Objectives of Scouring:

- ✓ To remove natural as well as added impurities like oil and wax etc
- ✓ To increase the absorbency of textile material
- ✓ To make the fabric suitable for next process (bleaching , dyeing, etc)

Machines for scouring:

- ➢ Kier Boiler
- ➢ J-Box dyeing machine
- ➢ Jigger dyeing machine
- ➢ Winch dyeing machine

General recipe for cotton scouring in Kier boiler:

Alkali (NaOH)	-	2 to 5 gm per liter.
Soda ash	-	x gm per liter to adjust PH (PH required for scouring is 10.5).
Wetting agent	-	1 gm per liter.
Sequestering agent	-	1 gm per liter.
Detergent	-	1 to 2 gm per liter.

Temperature - 100 to 125°C.

Time - 6 hours (close vessel) and 8 hours (open vessel)

Material: Liquor - 1 : 6

3. Bleaching:

- Bleaching is a durable type chemical finishing.
- Bleaching is done for whitening of textiles.
- In bleaching, the natural color and impurities of textiles are **decolorized** by using chemicals.
- The chemicals used for bleaching are: Hydrogen peroxide (H_2O_2) and Sodium Chlorite ($NaClO_2$). Also optical brightening agents are commonly used to obtain a whitening effect.
- Hydrogen peroxide is universal bleaching agent which can be applied to all kinds of fabrics.
- Bleaching can be done on yarns, fabrics (woven & knitted) as well as garments.
- Bleaching is done for cottons, woolens and silks. Man-made fabrics do not need bleaching as they are manufactured white.

Functional Finishes:

Functional finishes are applied for a specific function or end-use. The type of functional finish to be applied depends on the material (fabric) and end-use. Some examples of functional finishes are: mercerization, water proof finish, flame proof finish, wash-n-wear etc.

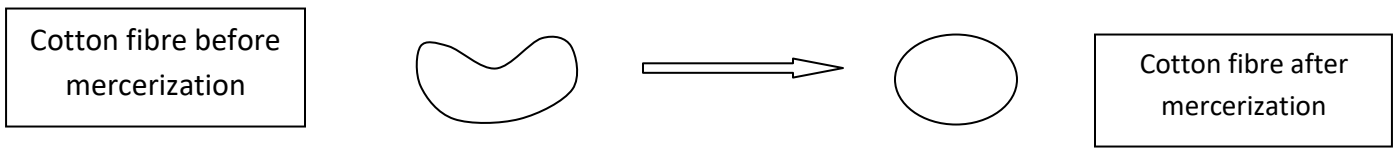
4. Mercerization:

Mercerization is a chemical finish with permanent effect.

Mercerization is done only for cotton fibre at yarn stage or fabric stage.

Process:

Mercerization is swelling of cotton fibres with **20 to 23% Caustic soda solution** at room temperature under **tension** for **1-2 minutes**.



Tension during mercerization is necessary to improve luster.

The cotton threads used for stitching and embroidering are also mercerized.

Purpose of Mercerization:

- ✓ To improve luster
- ✓ To improve dye-ability
- ✓ To remove crease marks
- ✓ To make soft feel.

5. **Shrinkage:**

It is the tendency of a textile element to decrease in size either lengthwise or widthwise or in both directions generally after washing.

Shrinkage is mostly measured as a percentage of the original dimentions and reported separately for length and width.

Importance of shrinkage calculation:

1. Shrinkage calculation helps a pattern master to draft patterns for a given fabric.
2. By shrinkage calculation, we can avoid measurement problem due to shrinkage.
3. It can save consumer from cheating.

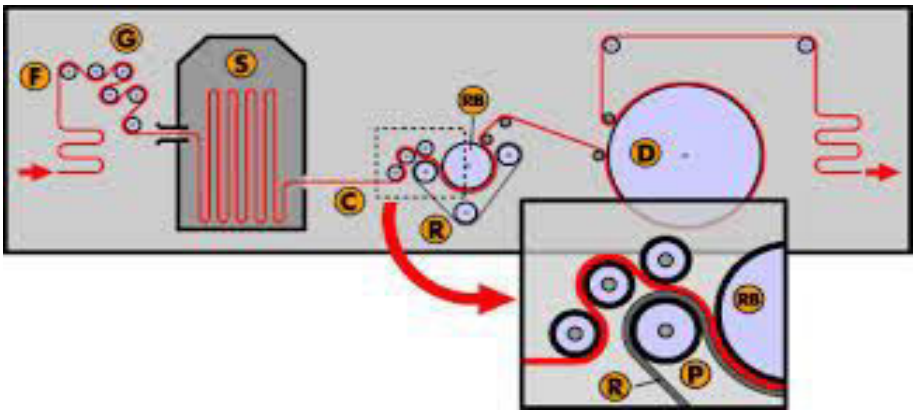
Procedure of shrinkage calculation:

a) Relax the fabric for 24 hours.
b) Cut a sample.
c) On the sample, draw a square of 12.5 inches with a permanent marker.
d) Mark the warp direction with an arrow.
e) Wash and dry the fabric (Do not press or iron the fabric, this will change the dimension).
f) Re-measure the side of the square and calculate shrinkage.
g) Repeat measuring for the wrap (weft) direction.

$$\text{Shrinkage \%} = \frac{\text{Measurement before washing - Measurement after washing}}{\text{Measurement before washing}} \times 100$$

Sanforization:

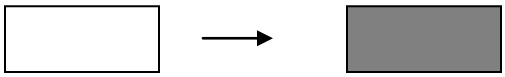
- Sanforization is a finishing process to control the shrinkage of the fabric.
- Sanforization is a method of stretching, shrinking and fixing the woven cloth in both length and width, to reduce the shrinkage at later stage (after washing).
- Sanforization treatment can be used for fabrics and textiles made from natural or chemical fibres.
- The aim of this process is to prepare fabric which does not shrink much during cutting, ironing, sewing or, especially, by wearing and washing the finished clothes.
- Garments and articles finished with sanforization may have special label to display specific shrink-proof value (if pre-shrunk), e.g., of under 1%.



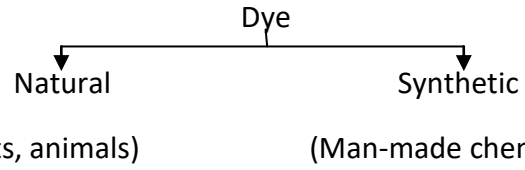
6 Wash-n-wear finishes:

- Wash and wear finishes are applied to minimize ironing after washing or laundering.
- Wash and wear finished fabrics/garments retain their shape and their pressed appearance even after many uses, washing and tumble drying.
- This finish is generally used for cotton and other cellulose containing fabrics.
- Wash and wear finishes are also known as “Durable press” or “wrinkle Free” finishes.
- This finish is generally used for shirting, draperies and other items that do not required set-in crease or pleats.

Dyeing

Dyeing: It is a process of coloration of textile materials throughout. 

Dye: Dye is the chemical that chemically attach to the textile material during dyeing and produce color.



Natural	Synthetic
Safe and pollution free	Toxic and pollutant
Limited colors and in less quantity	Large range of colors available
Cost is high	Production is high and cost is low
Example: Saffron, Mehendi, Indigo	Example: Direct, Reactive, Vat

Difference between color and dye:

Color: Color is any color material like neel, ink, gulal, etc.

Dye: Dye is color material that permanently colors the textile materials.

All colors are not dye but all dyes have color.

Dye classes: Dyes are classified in different classes according to their application method, fastness properties and cost etc.

Direct Reactive Vat Sulfur Azoic Mordant Acid

Basic Pigment Disperse

Dyes for different fibre types:

For cellulosic fibres (cotton, linen, viscose): Direct, Reactive, Vat, Sulfur, Pigment and Azoic.

For protein fibres (wool, silk): Acid, Basic and Mordant.

For synthetic fibres (nylon, polyester, acrylic): Pigment, Disperse, Reactive, Acid, Vat and Sulfur.

Stages of dyeing (stages of dye application):

Color may be added to textile materials during the fibre, yarn, fabric and product stage. So dyeing may be done during-

1. Fiber stage
2. Yarn stage
3. Fabric stage
4. Garment stage

Factors on which stage of dyeing depends:

-Color effect required
-Quality of product
-End use

1. Fibre dyeing (or stock dyeing):

-Fibres are dyed before spinning.

-Both natural and manmade fibers can be dyed at this stage.

-It gives very uniform dyeing and excellent colorfastness.

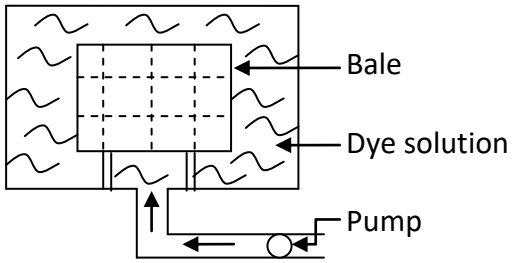
-But there is a lot of wastage during further processing of fibres.

Three types of fibre dyeing are:

a) Bale dyeing
b) Dope or solution dyeing
c) Top dyeing

1 (a). **Bale dyeing**:

- Bales of fibres are dipped into the dye solution.
- Large quantity of fibres can be dyed in one time.
- Large amount of dye is required.
- Save time and labour cost.

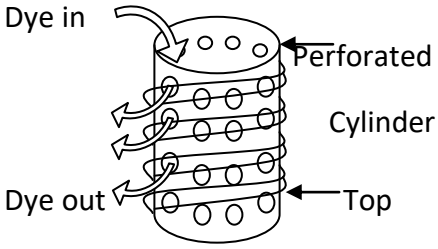


1 (b). **Dope dyeing**:

- Used for man-made fibres only.
- Dye is added to the spinning solution of the fibre before solution spinning.
- Dyeing is uniform and has excellent color fastness.
- It saves time and money.
- Preferred for fibres those are difficult to dye by other methods.
- Examples of dope dyeing are black polyester, Acrylics.

1 (c). **Top dyeing**:

- Top dyeing is used for wool.
- The wool sliver is called "top".
- The top is wound on perforated cylinders and dye solution is circulated through it.
- Uniform dyeing is possible with this method.



2. Yarn Dyeing:

-When dyeing is done after the fiber has been spun into yarn, it is called as yarn dyeing.

-Yarns are dyed, especially when they have to be sold as such. For example: embroidery thread, sewing threads, knitting (woolen) yarns and novelty yarns.

-Cloth made of dyed yarns is called "yarn-dyed".

- The main reason for yarn dyeing is to create interesting checks, stripes, and plaids with different-colored yarns in the weaving process.

-Yarn dyeing is less costly than fibre dyeing.

-Example of yarn dyed fabrics are Gingham, Chambray.

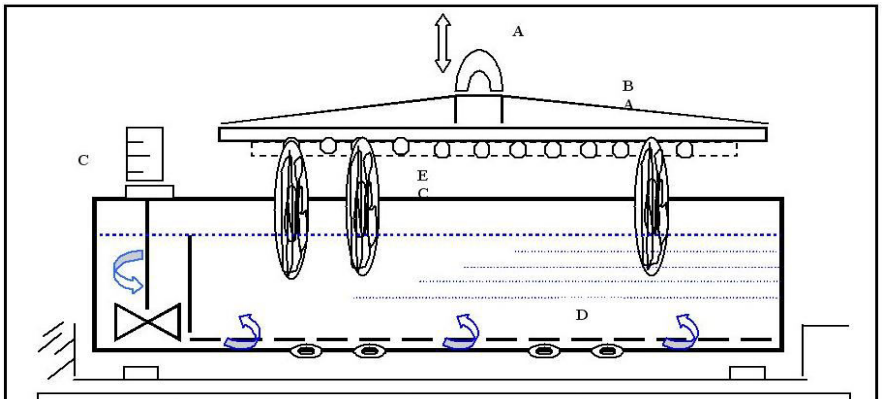
Types of yarn dyeing are:

Yarns may be dyed in the form of hanks, packages, or on beams. Special dyeing equipment is required for each of these batch processes.

a) Hank dyeing
b) Package dyeing
c) Beam dyeing
d) Space dyeing

2 (a).**Hank dyeing**:

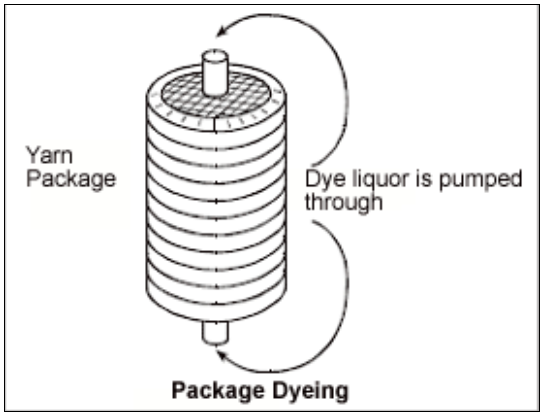
- In hank dyeing, large hanks of yarn are loosely hang on sticks and placed in dyeing solution.
- More uniform and deep dyeing than other yarn dyeing techniques.
- Costly method.



A: Lifting crane to raise lid. B: Machine lid with hanks suspended on sticks.
C: Impeller housing, weir plate and motor to circulate dyeliquor. D: Heating Coils. E: Hanks

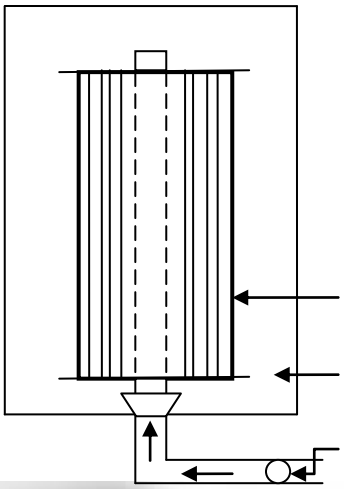
2(b). **Package dyeing**:

- In package dyeing, the yarns are wound onto a number of perforated tubes to make packages.
- Packages are stacked on perforated spindles and then dye solution is circulated outward through the spindle under pressure.
- Less costly method.



2(c). **Beam dyeing**:

- Warp beam is prepared by winding a number of yarns on a perforated beam.
- Beam is dipped in dye solution.
- Dye solution is circulated from inside to outside under pressure.
- Less costly method.
- Large amount of yarn can be dyed at one time.
- Used when dyed warp is required for fabric weaving.
  For example: denim, chambray, dobby, jacquard and brocade, etc.



2(d). **Space dyeing**:

- In space dyeing, yarns are dyed at different spaces along the length.
- The color-and-white or multicolored effects are formed along the length of the yarn.

3. Fabric dyeing (or Piece dyeing):

- In piece dyeing, the fabric is passed through a dye solution where the fibers in the fabric absorb the dye.

-The piece dyed fabrics are called "solid dyed".

-Fabrics may be dyed in either continuous or batch processes. In continuous dyeing, the cloth continually passes through the dyebath. Batch process is used for dyeing shorter lengths of fabric.

-Fabrics can be dyed in open widths or in rope form. Stretchable fabrics like knitted or spandex containing fabrics and delicate woven materials are processed in "rope" form.

Types of piece dyeing are:

a) Union dyeing
b) Cross dyeing
c) Winch dyeing
d) Jigger dyeing
e) Foam dyeing

3 (a). **Union dyeing**:

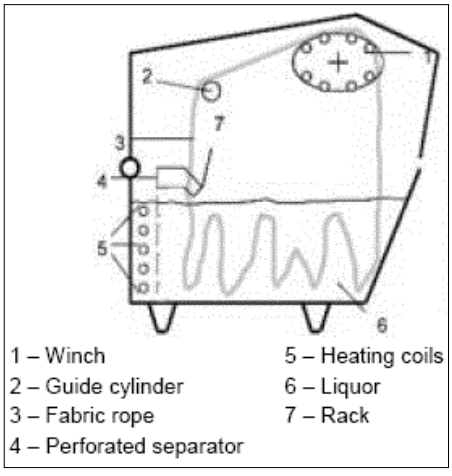
- This process is used for dyeing fabrics made of different fibers or yarns.
- The fabric made of different fibres or yarns is dyed **in one color** and in **one dye bath**.
- The appropriate dye type for each type of fiber is put into the same dye bath.
- Union dyeing gives a solid color finished fabric.

3 (b). **Cross dyeing:**

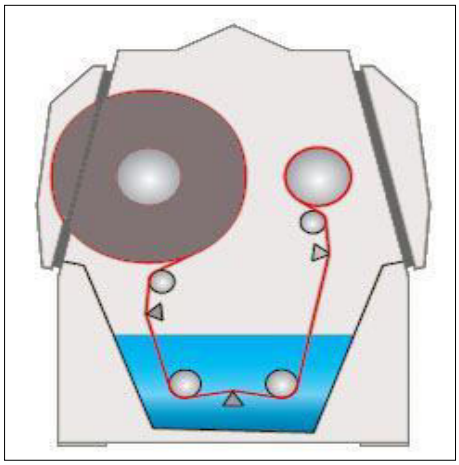
- This process is used for dyeing fabrics made of different fibers or yarns.
- Cross dyeing is used so that **different fibre types** are dyed **in different colors**.
- Cross dyeing could be
  - combination of stock and piece dyeing
  - combination of Yarn dyeing and piece dyeing
  - Two dye bath process with different dye-class
  - Single dye-bath with two different dye-classes can be used one for each fiber type.
- For example: the warp yarns may be stock-dyed or yarn-dyed and weft yarns left undyed. The fabric is piece-dyed after weaving. Thus, warp and weft get different colors.

3 (c) **Winch dyeing**:

- Winch dyeing is a batch process. (means for short length of fabric)
- Winch dyeing machine is used.
- The fabric is dyed in rope form. So fabric is tension free.
- Used for knitted and delicate fabrics.
- Material to solution ratio is 1:5.



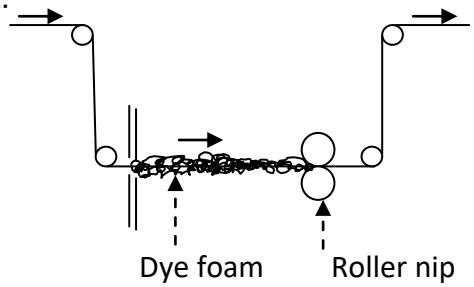
3 (d) **Jigger dyeing:**



- Jigger dyeing machine is used.
- Jigger machine has stationary dye bath with two rolls above the bath.
- Fabric is dyed in open width form.
- Also the fabric is under tension.
- Fabric is rolled on one roller in stretched form and placed above a stationary dye-bath. The fabric is passed through the dye-bath and wound on another roller.
- The fabric is repeatedly passed through the dye solution after every 20 minutes.
- Jigger dyeing is generally used for comparatively longer lengths of fabric.

3 (e). **Foam dyeing**:

- The dye solution is changed into foam by adding foaming agent.
- This foam is applied on the fabric and then the fabric is passed through a roller nip.
- Less energy and less water are used.
- Less water pollution.
- Fine to heavy fabrics can be dyed with foam dyeing.



Garment dyeing:

- Full garment is dyed.
- Some types of non-tailored apparel, like hosiery, pantyhose, socks and sweaters can be dyed as completed garments.
- A number of garments are loosely packed into a large nylon net bag. The bags are then put into a tub with a motor-driven paddle that circulates the dye solution and the garments.
- Less costly dyeing method.
- Less dye and less water are required.
- Allowance must be added for shrinkage.
- Multicolor cannot be dyed by this method.
- Other items like buttons, laces and sewing threads etc may show color variation in this method.

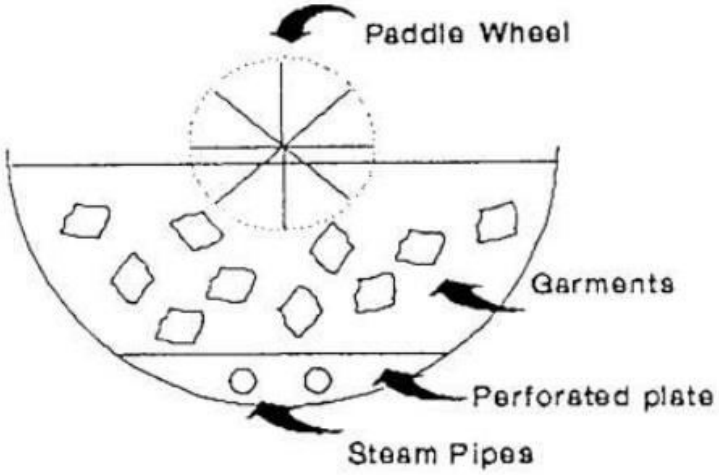


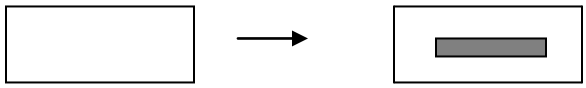
Fig. Paddle dyeing machine.

Paddle dyeing machines

Printing

Definition:

Printing is the localized coloration of a textile.



In printing, color is applied on some portion of fabric.

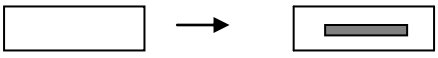
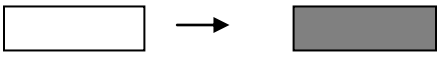
Need of Printing: We need printing for the following:-

a) Decoration
b) Value addition
c) Special Function (camouflage, optical wear, etc.)
d) Marking (brand logo, care label)
e) Cheap replacement of expensive textiles (strip printing as a copy of yarn dyed fabric)
f) Linked with regional and cultural crafts (tie & dye, kalamkari, etc.)

Uses of printing: Printing can be used in following:-

1. Home furnishing (curtains, bed sheets, table cloth)
2. Mattresses
3. Children wear
4. Women's wear
5. Sports wear
6. Military wear
7. Events wear (common wealth games, marathon race, etc.)
8. Banners, wall hangings
9. Art and craft
10. Optical wear (traffic jackets)

Difference between printing and dyeing:

	Printing	Dyeing
1	Coloration of some portion of fabric 	Coloration of the whole fabric 
2	Dye solution is viscous (thick)	Dye solution is very aqueous
3	Thickner is required	Thickner is not required
4	Printing is done on one side of the fabric	Dyeing gives equal color on both sides of the fabric
5	Printing can be done on yarns, fabrics and garments	Dyeing can be done on fibres, yarns, fabrics and garments
6	In printing, many colors can be used on one fabric	Mainly single color is used
7	Printing machines are roller, screen, transfer	Dyeing machines are Jet, Winch, Jigger, etc.
8	Examples of printed fabrics: Kalamkari, Batik, Tie & dye, Sanganeri prints, Ikat etc.	Examples of dyed fabrics: Solid dyed, Gingham, Denim, Chambray

Steps of printing:

Fabric preparation

↓

Printing (color application)

↓

Drying

↓

After treatment

(color fixation by using steam, dry heat, washing, high temp with pressure)

Printing paste and thickner:

Printing paste is a thick (viscous) paste made up of dye, thickner and other chemicals called additives.

Dye + Thickner + Additives = Printing paste

Thickner is a material which gives viscous paste in water. Examples of thickners are gum, starch and sodium alginate, etc.

((Why thick paste is used for printing?

To make the paste sticky so that the color does not spread out of the design outline.))

Styles of printing or **type of printing techniques**:

(style is a manner to perform an action)

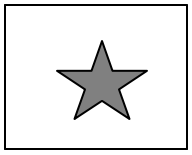
Style of printing means the manner in which the printing effect is produced on the fabric.

3 styles of printing are:

1. Direct
2. Resist
3. Discharge

1. Direct style of printing:

The color is directly applied to the design area and fixed by steaming.

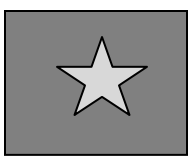


Examples of direct style of printing: Block, Roller, Flock printing.

In direct style, the dark colored designs are printed on white or light color background.

2. Resist style of printing:

In this style, some portion of fabric is resisted to coloration.



Examples of resist style of printing: Screen, Stencil, Batik, tie and dye.

In resist style, the off white and light colored designs are made on dyed background.

3. Discharge style of printing:

In discharge style of printing, the design is made by removing color from selected area of the fabric. The fully dyed fabric is printed with a chemical that will destroy the color in designed area.

In discharge printing, white or light color designs are made on dark color background.

Also, the outlines of the design are very sharp.

Methods of printing:

In printing the different styles are produced by different methods. Some common methods of printing are:

- Block
- Screen
- Roller
- Batik
- Tie and Dye
- Heat transfer

Block Printing:

- It is a direct style of printing and is a hand process.
- Oldest and simplest method.
- Blocks-

  -engraved wooden blocks are used.

  -no. of blocks used = no. of colors in design.

  -size of block is generally 6” x 6”.

  -more number of colors used; more expensive will be the fabric.

- Method-

  First one color of design is completed on fabric and after drying it, second color is applied one by one to complete the design.

- Advantages-

  -Decorated prints are produced.

  -used for short decorative pieces for home furnishing.

- Limitations-

  -slow and laborious process.

  -Block printing is a hand printing technique, so fabrics with block print are expensive.

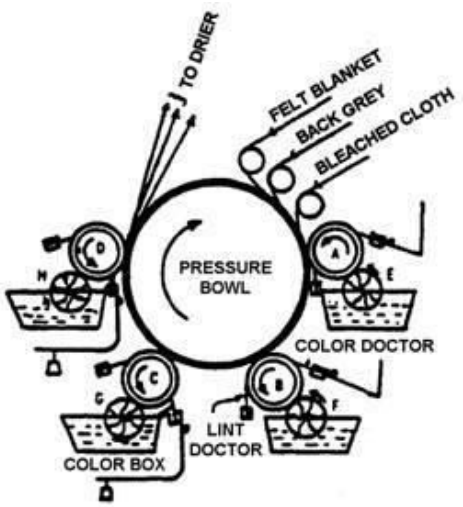
  -not possible to obtain the shading effect.

  -Design making on wood block is difficult and time taking.

-sometimes gap remain visible between two block prints.

-designs can be duplicated by other techniques for cheating costumers.

Roller Printing:

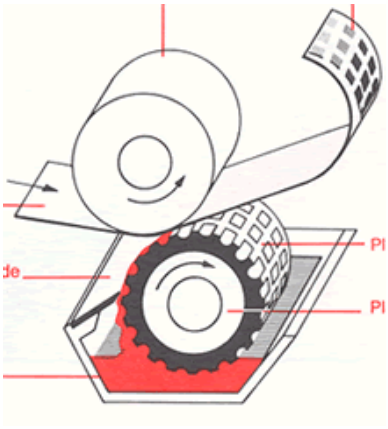


- Engraved copper rollers are used in roller printing.
- Design area is cut out from the roller during engraving.
- Roller diameter is generally 12.5cm (5 inchs).
- No. of rollers used = no. of colors in design.
- Maximum 16 rollers can be used.
- With each rotation of roller, one repeat of design is printed and in one color only.
- Roller printing is a fast method and 250m of fabric can be printed every minute. This makes it a cheap process.
- Roller method of printing can be used for any style of printing (e.g. direct, resist and discharge)
- Advantages-

  -high speed so a cheap method of printing.

  -no joint marks are visible between repeats.

  -Fully mechanical method.



- Limitations-

  -copper rollers are expensive.

  -not suitable for short lengths of fabric.

  -repeat size is short. (because roller diameter is small)

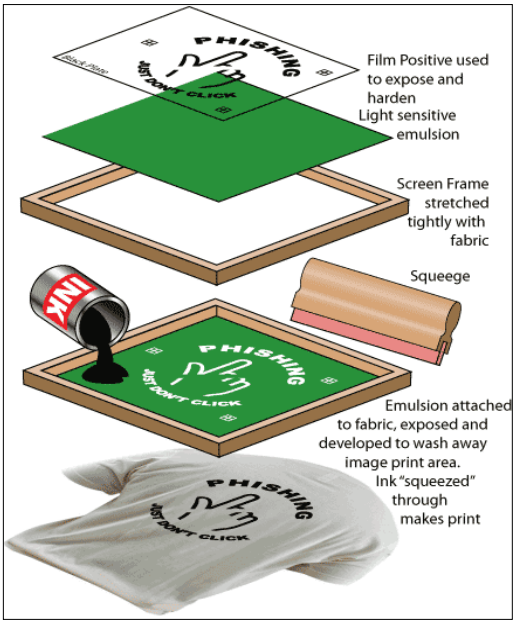
Screen Printing:

- Most widely used method of printing onto fabric.
- Screens are used for design printing.
- Screen is made of silk or nylon mesh stretched over a wooden frame.
- The area outside of the design is blocked by using chemical.
- The screen is placed on the top of the fabric and the thick printing paste is moved over the mesh with a **squeegee.** The dye passes through the design area to the fabric.
- No. of screens used = no. of colors in the design.
- Screen printing is faster than block printing but slower than roller printing.
- Types of screen printing are:

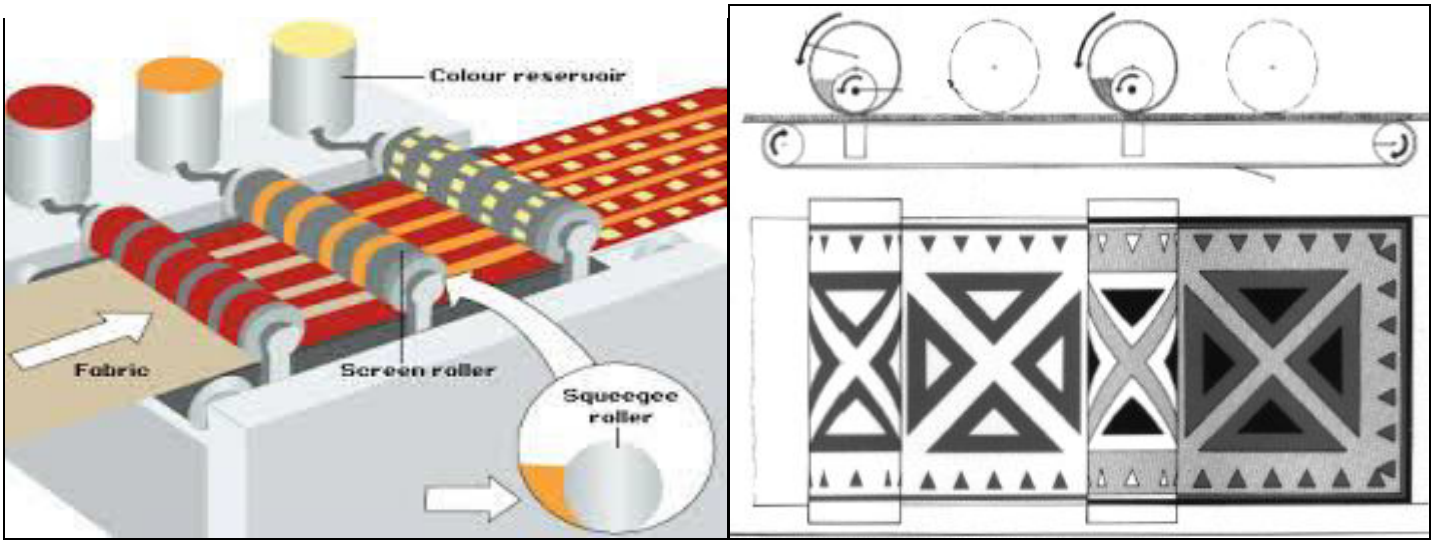
  -manual flat screen

  -mechanical flat screen

  -rotary screen



Manual flat screen printing



Rotary screen printing

Batik Printing:

- Batik is a resist style of printing.
- A mixture of bee wax and paraffin wax is used for resisting.
- Always cold dyeing is done.
- Multicolor designs can be made by resisting and dyeing one by one with each color. Dyeing is done from light to dark colors.
- After dyeing the fabric is washed with hot water to remove the wax.
- Special feature of batik is "vein effect". It is the appearance of fine lines of color in the design area. These lines appear due to the cracking of solid wax during handling.

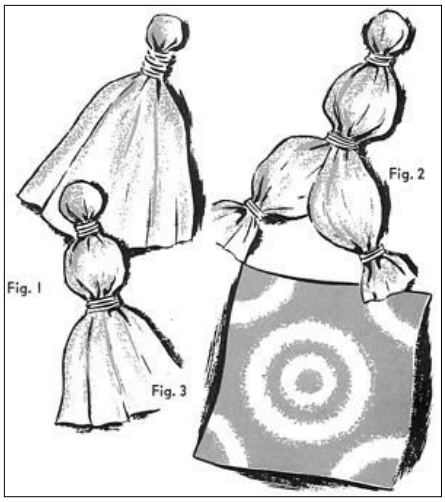
Tie & Dye:

- It is a resist style of printing.

- Resisting is done by tying the threads or knots.
- Tie-dyeing involves pinching areas of cloth and tying them tightly with thread before dyeing.
- Mono or multicolor designs can be made.
- Two types of tie & dye are:

  Bandhani

  Laheriya



- Bandhani-

  -small dots or diamond shaped designs are made.

  -design is printed or marked on the fabric in dot form using 'neel'.

  -threads are tied at each dot marks.

  -then fabric is dipped in dye solution.

  -after dyeing, the fabric is washed and dried.

  -the threads are opened.

- Laheriya-

  -stripe or diagonal line designs are made.

  -laheriya designs are given to thin, loose cotton, voile or fine silk fabrics.

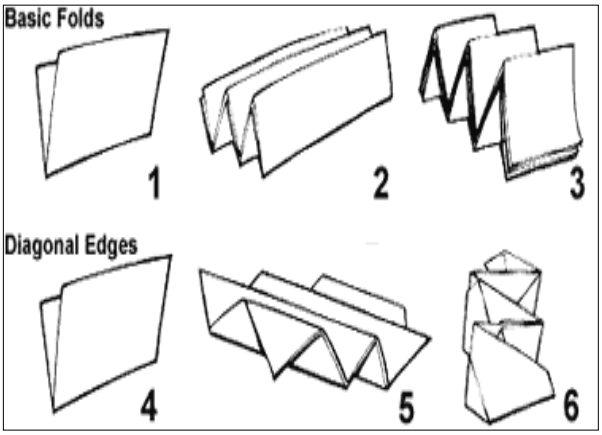
  -fabric is rolled and tied tightly at different places.

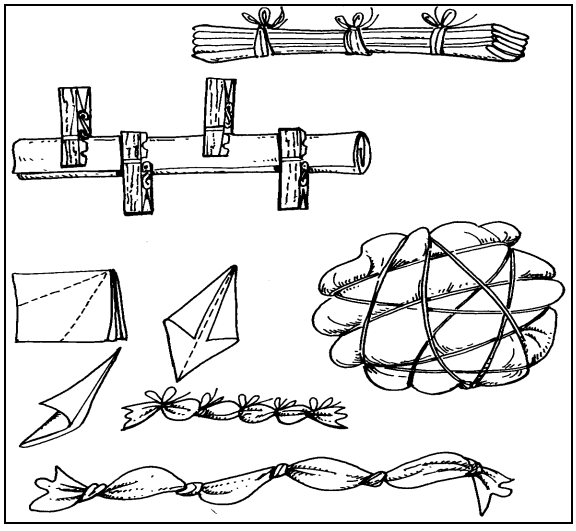
  -then fabric is dipped in dye solution.

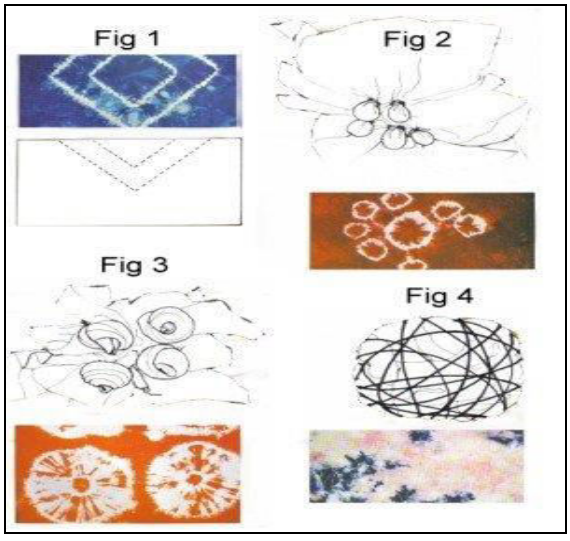
  - Some threads are opened and the process is repeated with darker dyes, to make stripes of multicolor.

  -after dyeing, the fabric is washed and dried.

  -the threads are opened.







Transfer printing:

- In transfer printing, the color is transferred from paper to fabric with the help of heat and pressure.
- Disperse dyes are used.
- Transfer printing is generally done on polyester fabric.
- Fabrics as well as garments are printed with transfer printing.
- 3 important factors for transfer printing are:
    -temperature
    -pressure
    -time
- Transfer printing is completely dry process.
- It gives better quality of print and shading effects are also possible.