Textile Science

[For 1st Year Diploma Students of Fashion Designing]

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Unit 1

Introduction to Textiles

Objectives

After studying this unit, you would be able to:

- Classify different fibers
- Describe the basic composition of different fibers.
- Explain the basic nature of different fibers and their uses

Introduction

"The term '**Textile**' deals with the study of fibers, and it is used to define and understand various fabrics."The Progression from raw

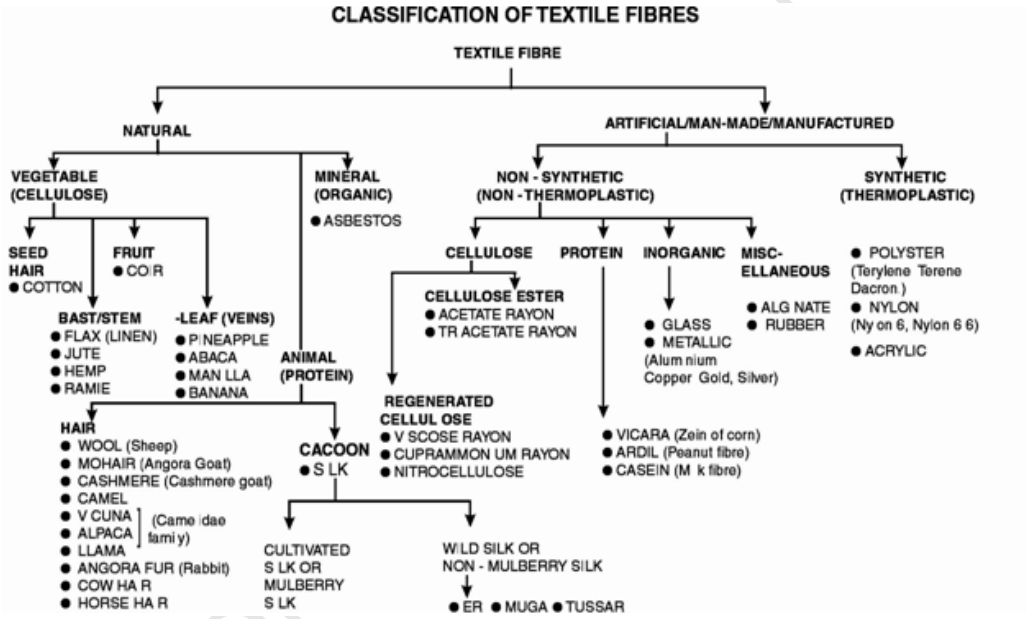
- The Cultivation of Natural or manufacture of fibers
- The Twisting of Fibers into yarn called as **Spinning.**
- The interlacing (**Weaving**) or interloping (**Knitting**) of yarns into fabric.
- The combination of fibers ,yarns and fabric (**non-woven**)
- The finishing of fabric prior to sale.

The study of textiles is important for fashion designers for many reasons mainly for selecting the fibres. Complete knowledge of textiles will facilitates an intelligent appraisal and develop adequate ability to select and will distinguish quality in fabrics. It will help a designer to identity suitable fabric for their collections.

Fibers are the basic visible units formed by molecular structure from which fabrics are made". Fibrous raw materials are divided into two Classes on the basis of length.

1. Filaments are natural or man-made fibers of continuous length, measurable in yards or meter.
2. Staple fibre is short length fibers which are measurable in inches.

Classification of Textile Fibers



Natural Fibers: Are the fabrics obtained from nature. On the basis of source of origin they are classified as

- **Vegetable Fibers** are found in cell walls of plants and are mainly composed of carbon, hydrogen and oxygen. They are generally composed of cellulose -COTTON, LINEN, JUTE.

- **Animal Fibers** are reaped from different animals and these are protein in nature with a polymer of amino acids.- SILK and WOOL
- **Mineral Fibers** are obtained from natural rocks of certain types and are inorganic in nature and are used for fire proof fabric. Eg- Asbestos

Man-Made Fibers: There are man-made or synthesized artificially in laboratory. These are classified on the basis of their raw-material.

- **Cellulosic Fibers** are derived from various natural sources. For e.g., the natural material of cellulose taken from the cotton linters and wood pulp and is processed chemically and changed into fiber of various length. These are RAYON, ACETATE, TRIACETATE
- **Non-cellulosic Fibers** are developed to imitate properties of natural fibers or to develop other characteristics or to combine properties. These are synthesized by combining carbon, oxygen, hydrogen, and other simple chemical elements into larger complex combination or structures called Polymers.EG-NYLON,ACRYLIC,POLYESTER
- **Rubber Fibers** are manufactured fibers in which the fiber forming substance comprises natural or synthetic rubber. It is used to make certain elastic fabrics
- **Metallic Fibers** are composed of metal, plastic-coated metal, metal-coated plastic or a core completely covered by metal. It is used as decorative yarns. EG SILVER ,GOLD ,ALUMINIUM
- **Mineral Fibers** are manufactured in various fibers-GLASS

General Properties of Textile Fibers

A textile fibre is of practical value or commercial importance only when it possesses certain desirable physical, chemical and microscopic properties. All fibres possess certain basic characteristics. By knowing these properties it can be determined whether a fibre is suitable for a specific fabric. For example, if a soft, absorbent fabric is desired for a man's innerwear, cotton would be excellent, while nylon would be undesirable. However, for a ski jacket shell where great strength and wear resistance are required, nylon fibre would be a good choice whereas cotton would not serve the purpose. It is not only the properties of fibres, but also those of other component - yarns, fabric construction, coloration and finish, which governs how the textile material will ultimately perform. If a property of any component is altered, then there will be change in the property of the fabric.

Some of the important properties to be possessed by a fibre to be a textile are as follows:

1. **High Length to Width Ratio:** Fibers must be considerably longer then wider, as the length will determine its spinability and strengths. A minimum ratio of 1: 100 is essential. Fibers shorter than an inch are rarely used in yarn manufacturing as spinning will be difficult.
2. **Tenacity:** The strength of a fiber denotes its tenacity. Fibers must have sufficient strength to withstand chemical or mechanical processing while manufacturing. Fibers strength would provide adequate durability to the end product hence it is Important.
3. **Flexibility:** Flexibility is ability of fiber to bend easily. Usually thinner the fiber more flexible it is and better is its drapability.

Flexible fiber such as Acetate can be made into a highly drapable fabric and garment. A rigid fiber like glass usually makes fabric relatively stiff.

4. **Cohesiveness:** Cohesiveness is the ability of fibers to stick together or mass during yarn manufacturing process. It may be due to longitudinal contours or cross-section shape that enables them to fit together and adhere to each other. Filament fibers twist easily into yarn then Short fibers. Texturized fibers have high cohesiveness.
5. **Uniformity:** To convert into yarn, fiber must possess similar length and width. Spinning Quality and Flexibility must be alike. Uniformity in yarn will provide fabric of uniform appearance. Non-uniformity will result into fabrics with undesirable properties and poor quality.
6. **Abrasion Resistance:** It is ability to resist wear and tear from rubbing. It contributes to fabric durability. Fabric with poor abrasion resistance will result in pilling which will eventually spoil the surface appearance and less strength. Garment made from fibers that possess both high breaking strength and abrasion resistance can be worn for long period of time.
7. **Absorbency:** It is the ability to take-in moisture. Fibers that are capable of absorbing the water readily are called as hydrophilic fibers. All natural fibers and rayon and acetate are Hydrophilic fibers. Fibers which do not readily absorb water are called hydrophobic; all man-made fibers except rayon and acetate are hydrophobic.
8. **Elasticity:** It is ability of fiber to increase in length or stretch when under tension and then return to the original length when released which is referred as elastic recovery. Fabric which possesses good

elasticity makes more comfortable garment. Better elasticity also increases the breaking strength of the fabric.

9. **Luster:** It is a gloss, sheen or shine of the fiber. Luster in fiber is determined by its ability to reflect light. Even reflections results in more lustre and uneven reflection in no or less luster. Silk has highest sheen and cotton has minimum.
10. **Pilling:** It is the formation of tiny balls by groups of short or broken fibers on the surface of the fabric. It is formed due to wear tear or poor abrasion resistance. Hydrophobic fabric tends to pill much more then hydrophilic fabric.
11. **Resiliency:** It is ability to return to its original shape after compression, bending or creasing. Fabric that has good resiliency does not wrinkle easily.
12. **Flammability:** Flammability of textile product should be considered during the wear. It's the rate at which a fibre burns on catching the fire. Fibres with low incidence of burning will be safer than fibres that burn quickly.

Summary

- Fibers are broadly classified as natural and man-made fibers
- Natural fibers are classified as animal, vegetable and mineral fibers.
- Man-made fibers are classified as cellulose, non-cellulose, rubber, metallic and man-made mineral fibers.
- You will also study the classification of these fibers on base of its composition.
- Different properties of fiber make its characteristic into existence.
- By knowing these properties it can be determined whether a fiber is suitable for a specific fabric and used for a particular garment.

Self Assessment Questions

1. _____ is a regenerated cellulose fiber.
2. Wool is composed of a _____.
3. _____ is a natural fiber obtained from rocks.
4. Tenacity is otherwise called as_____ of a fibre.
5. _____ is the ability of the fabric to resist wrinkles
6. The formation of tiny balls on the surface of the fabric is called as_____
7. _____is a man-made fibre which is hydrophilic in nature

Terminal Questions

1. What are staple fibres?
2. Give the classification of textile fibres.
3. What are the various vegetable fibres?

Unit 2

Cotton

Objectives

After studying this unit, you would be able to:

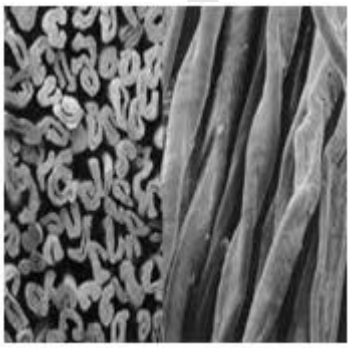
- Describe the manufacturing process of cotton.
- Understand the properties and performance of cotton fabrics.

Introduction

There are various types of natural vegetable fibers obtained from the plant sources such as cotton, flax, jute, ramie etc. Cotton is soft fiber that grows around the seeds of the cotton plants.

Cotton is most widely used fibre for fabric because of its strength, durability and breathability. They are composed of cellulose.

Cotton pod



Cotton microscopic view

Cotton mall

The Cellulose fibers have several properties in common. They are soft and absorbent due to high amorphous regions and so usually give comfortable products. The fabrics could be easily laundered and can withstand strong detergents, high temperature and bleaches. They burn easily, giving off a smell like that of burning paper and deposit a

light fluffy ash. They can decomposed by acids but have excellent resistance to alkaline solutions.

Manufacturing Process of Cotton

The manufacturing process of the fibre starts with cultivation and is followed in following steps.

1. **Picking:** The cotton balls are picked by hand or machine.
2. **Ginning and Bailing:** This process is mainly intended to separate the lint (fibers) and seed. Foreign materials like seeds, leaf fragments, dirt, etc. must be removed before the fiber is bailed. The seeds are removed by cotton gin and process is referred as ginning
3. **Grading:** Here the long fibres and short fibres are separated and, it is further cleaned.
4. **Breaking:** The cotton after grading undergoes a series of machines which further tears it and removes impurities .Then the fibres are converted to thick bales
5. **Carding:** The fibres undergoes in carding machine , it is an operation were remaining impurities are removed and they are arranged in thick slivers where all the fibres are made parallel
6. **Combing:** It is employed only when the fiber is intended for fine yarns. In this process, fibers are passed through additional straightening process. The short fibers, called linters are combed out and completely separated from the longer fibers by combing operation.
7. **Drawing:** They are drawn and processed to eliminate the irregularities in sliver. The drawings are inserted with slight twist and are called as rovings.

8. **Spinning:** The roving goes into the spinning machine which draws them to the required length and twist them to form cotton yarn

Characteristics of Cotton Fabrics

1. **Composition:** Cotton fiber is composed chiefly of cellulose, which constitutes about 90%, and about 6% moisture and other natural impurities.
2. **Strength:** It is the ability of fiber to withstand the stress or tension without being pulled or torn apart. Cotton is relatively stronger which is due to its fiber structure when put in water, its strength increases by 25%.
3. **Elasticity:** Cotton fiber has very little natural elasticity.
4. **Resiliency:** Cotton fabric tends to wrinkly very easily which shows a poor resilience of it.
5. **Drapability:** Cotton does not have good drapability.
6. **Heat Conductivity:** Cotton has high degree of heat conductivity which makes it best for summer apparel. It is considered as cool fiber.
7. **Resistance to Mildew:** Cotton fabrics should never be stored in damp condition; it develops greenish-black or rust color spots caused by fungus.
8. **Resistance to Insects:** Cotton is not digestible by moth larvae, so the fabric will not be attacked by moths.
9. **Reaction to Alkalis:** Cotton is not harmed by alkalis hence can be easily laundered using a detergent.
10. **Reaction to Acids:** Cotton is not damaged by such volatile organic acids as acetic acid, whereas concentrated cold or diluted hot mineral acids, such as sulphuric acid, destroys it.

11. **Affinity for Dyes:** Cotton fabrics due to its good absorbency and the composition have a good affinity for dyes.
12. **Resistance to Perspiration:** Alkali perspiration does not deteriorate cotton. However, acid perspiration has slight effect.

Burning Test

- Fiber Approaching Time-Scorches and ignites easily
- Fibers Flame- Burns quickly with yellow flame
- Odour- Burning paper
- Ash –Light, feathery grayish black ash

Fabrics of Cotton

1. Denim
2. Muslin
3. Voile
4. Searsucker
5. Organdy
6. Lawn
7. Toweling Material
8. Cambric
9. Canvas
10. Gauze
11. Gingham
12. Casement
13. Poplin

Summary

- Cotton is major natural textile which is obtained from different parts of the world.
- These are composed mainly of cellulosic components.
- Cotton fibers are composed of carbon, hydrogen and oxygen.
- These are fibers generally a fibrous mass obtained from the seed of the cotton plants.
- Cotton has to pass through many process like, Ginning, Blow room operation, carding, combing, drawing, simplex and spinning for form fine yarn.
- Cotton exhibit excellent qualities such as shrinkage, good affinity to dyes, bleaches, and heat conductivity.

Self Assessment Questions

1. Cotton fibre is composed of _____
2. _____ is the ability of a fabric to hang easily and fall into graceful shape and folds.
3. _____ is a cool fibre.

Unit 3

Linen

Objectives

- Describe the manufacturing process of Linen
- Explain the Properties and performance of linen fabrics.

Introduction

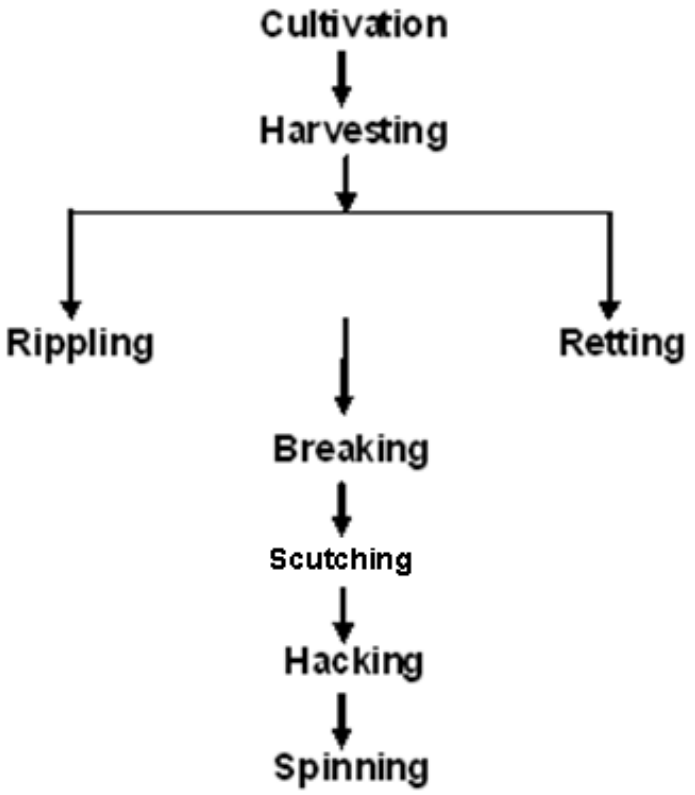
Linen is an elegant, beautiful, durable, and refined luxury fabric. It is obtained from the flax stalk. It is considered to be the oldest fibre used in western world .Belgium; Ireland, New Zealand and Soviet Union are the major growers of **flax**.

Linen is the strongest of all the vegetable fibers and has 2 to 3 times the strength of cotton. Linen yarn is spun from the long fibers found just behind the bark in the multi-layer stem of the flax plant. . These fibers are held together under the stem's bark principally by a gummy substance, Pectin. In order to retrieve fibers from the plant, the woody stem and inner pith, which holds the fibers together in a clump, is rotted away. The cellulose fiber from the stem is spinnable and is used for the production of linen thread, cordage, and twine. Linen fibers are known for the luster and strength

Linen yarns

Linen fabric

Linen Manufacturing Process



Manufacturing Process of Linen

1. **Cultivation Process:**

Cultivation of linen requires deep, rich well ploughed soil and a cool, damp climate. Land with good supply of soft, fresh water. For a good crop, the soil must be enriched for 6 years. Only one crop in 7 yrs. can be raised in a specified portion of land. The flax seeds are sown with hand in April or May. Plant should be protected from weeds. In 3-4 months, the plant will grow with straight, slender stalks that may be 2-4fts high with small blue or white fibers. The flax plant turns yellow and seeds turn brown, indicating the time to harvest.

2. **Harvest**:

Plant must be pulled as soon as it appears brown, as delay may result in dull Luster fibers. The stalk should be removed from the ground intact by hand or machine. If the stalk is cut the sap is lost. Tapered ends of stalk gives smooth spun to yarns. These stalk are tied in bundles, called beets and are ready for extraction of the flax.

3. **Preparation of the Fiber**:

It involves two processes namely Rippling and Retting.

a. **Rippling** is the first stage after harvesting, where the seeds and the leaves are removed from the stems. In this, the top ends of the bundle of stems are pulled through a 'Ripple', a comb like tool consisting of 20-30 vertical steel pins.

b. **Retting** is next process which involves steeping the bundles of plants in water so that the tissue or woody part surrounding flax fiber will decompose by the growth of micro-organism. It only loosens the woody bark. If the flax is not fully retted, the stalk of the plant cannot be separated from the fiber without injuring the fiber.

Different methods of Retting

- **Dew Retting:** In this process the flax stalks are spread on grass and are exposed to atmosphere for 3-4 weeks and produces strong, dark gray flax. The dew facilitates the microbial growth resulting in decomposition.
- **Pool Retting:** This process involves the use of stagnant pools of water and requires 13 days. It produces brittle and weak fibers.
- **Stream Retting:** In this method the streams of water are used and it produces high-quality flax fibers.

- **Vat Retting:** Here the flax is immersed in wooden vats of warm water at 25 to 30° C, which decomposes the bark. Flax is then removed and passed between rollers.
- **Chemical Retting:** Chemicals such as soda ash, oxalic soda and caustic soda in warm or boiling dilute sulphuric acid solution are used to separate the pith and the bark.

4. **Breaking:**

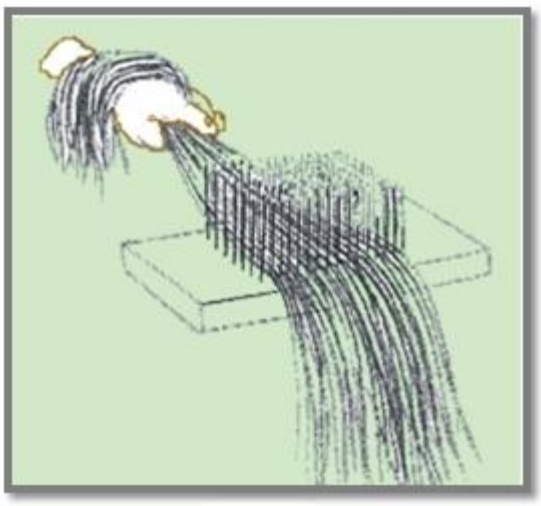
When the decomposed woody tissue is dried after retting, it has to be crushed. They are sent through fluted rollers, which breaks up the stem and separate the exterior fibers from the bast that will be used to make linen. Small pieces of barks, broken in this process are called Shives.

5. **Scutching:**

Scutching is either done by machine or hand. The machine removes the broken shives with rotating paddles. This process, finally releases the flax fibers from stalk.

6. **Hackling (combing)** :

Hackling is done to remove remnants of the fibrous core and bark and align the bundles of fibers for spinning. A series of iron combs, ranging from coarse to fine are used. The fibers are pulled through the teeth of combs beginning with coarser one leaving the fine fibers. This separates the short fibers from the longer and more luxurious linen fibers.



Hacking

Short fibers are called Tow and it is used for making coarser, sturdy goods. The very finest flax fibers are called line or dressed flax, and the fibers may be from 12 to 20 inches in length. Finally the yarn is sent for spinning.

Characteristics of Linen Fabric

- **Absorbency:** Linen absorbs moisture and dries quickly when compared to cotton. This good moisture absorbency makes linen a comfortable fiber.
- **Cleanliness & Washability:** Linen launders well and gives up stains readily. Its softness enhanced by repeated washing.
- **Reaction to Bleaches:** Linen is weakened by sodium hypochorite bleaches. Sodium per borate bleaches is effective and safe.
- **Shrinkage:** Linen fabric does not shrink as much as cotton while washing.
- **Effect of Heat:** Linen will withstand moderate heat, like cotton.
- **Effect of Light:** The resistance of linen fabrics to light is more than cotton but it will gradually deteriorate with protracted exposure to direct sunlight.

Burning Test

Burning characteristic: Scorches and ignites easily

Flame: Yellow flame little low then cotton

Odour: Burning Paper

Residue: Ash Light feathery Grayish ash

Summary

- Linen is second major vegetable fiber which is in common use.
- It is natural fibers obtained from flax composed of cellulosic component like carbon, hydrogen and oxygen.
- The linen fibers in general have good luster and strength.
- Being cellulosic fiber it is easily affected by insects and acid.
- It is best suited for towels and handkerchiefs.
- These plants are grown once in 6 yrs. and require a well ploughed soil.
- The yarn formation process involves ripping, retting, breaking, scutching, hackling and spinning.
- The strength of the fiber increases by 10% when wet.

Terminal Questions

1. _____ will quickly destroy and weaken linen fabrics. (Acid / Alkali)
2. _____ fibre is more suitable for towels and handkerchiefs
3. What is hackling process?
4. Why is linen suitable for handkerchiefs?
5. Give the flow chart in manufacturing linen fabrics

Unit 4

Jute

Introduction

Jute is the second most important vegetable fibre after cotton. **Jute** is also called as **Bast** Fiber .It has a **yellow to brown or gray** colour with silky luster. This fibre is difficult to bleach and hence brown or tan colored. It is 61% cellulose. It is grown throughout Asia, chiefly in India and Bangladesh.



It is bundle of short fibre which are brittle and hence weakest of cellulosic fibre. It is **100% bio-degradable** & recyclable and thus environment friendly. Jute is a natural fibre with golden & silky shine, and hence nicknamed as The Golden Fibre. Jute is the cheapest vegetable fibre procured from bast of the Jute plant and it falls into the category of bast fibres. Jute has high tensile strength, and low extensibility resulting in poor elasticity and elongation. Jute stem has very high volume of cellulose, that can be procured within 4-6 months, and hence it also can save the forest and meet cellulose requirement. The best varieties of Jute are **Bangla Tosha - Corchorus olitorius (Golden shine)** and **Bangla White - Corchorus capsularis (Whiteish**

Shine). Raw Jute and Jute goods are interpreted as Burlap, Industrial Hemp, and Kenaf in some parts of the world. The best source of Jute in the world is the Bengal Delta Plain, which is occupied by Bangladesh and India.

Cultivation and Processing of Jute

1. To grow jute, farmers scatter the seeds on cultivated soil.
2. When the plants are about 15-20 cm tall, they are thinned out.
3. About four months after planting, harvesting begins. The plants are usually harvested after they flower, but before the flowers go to seed. The stalks are cut off close to the ground.
4. The stalks are tied into bundles and **retted** (soaked) in water for about 20 days. This process softens the tissues and permits the fibres to be separated.
5. The fibres are then **stripped** from the stalks in long strands and washed in clear, running water.
6. Then they are hung up or spread on thatched roofs to dry. After 2 - 3 days of drying, the fibres are tied into bundles.
7. Jute is **graded (**rated) according to its colour, strength, and fibre length. The fibres are off-white to brown and 1- 4 m long.
8. Jute is **pressed** into bales for shipment to manufacturers.

Properties

1. Moderate strength
2. Poor elastic recovery and low elongation
3. Good resistance to micro-organisms its texture is rough and course

Burning test

- **Burning characteristics**- scorches and burns easily
- **Flame**- Yellow flames burns low then cotton
- **Odour-**Burning Paper
- **Residue**-Light feathery grayish and blackish ash

Uses

Jute is one of the most versatile natural fibres that has been used in raw materials for packaging, textiles, non-textile, and agricultural sectors. Jute is used chiefly to make cloth for wrapping bales of raw cotton, and to make sacks and coarse cloth. The fibres are also woven into curtains, chair coverings, carpets, hessian cloth, and backing for linoleum. However, jute is being replaced by synthetic materials for many of these uses.

The fibres are used alone or blended with other types of fibres to make twine and rope. Jute butts, the coarse ends of the plants, are used to make inexpensive cloth. Conversely, very fine threads of jute can be separated out and made into imitation silk. Jute fibres can also be used to make paper, and with increasing concern over forest destruction for the wood pulp used to make most paper, the importance of jute for this purpose may increase.

Self Assessment

1. Jute is known as_____fibre.
2. _____ and _____are the two best varieties of Jute.
3. Jute is graded **(**rated) according to its_____ ,_____ , and.

Unit 5

SILK

Objectives

After studying this unit, you would be able to:

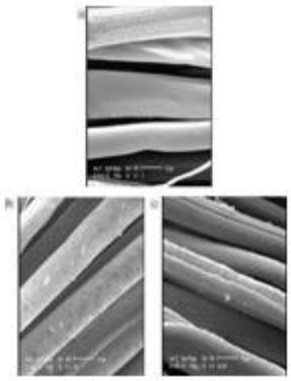
- Describe the manufacturing process of silk fibres.
- Evaluate the characteristics of silk fabrics

Introduction

Silk is another **natural protein fiber** which is obtained from the cocoons of the silk worm. It is natural **filament** produced by the salivary glands of silkworms. The origin of the silk dated back to 2600 B.C and the country producing the best quality of silk is China which is also the birth place for the silk fiber. It is **protein** in nature and so exhibits the natural characteristics which resemble the wool fiber. Silk Fibre is a twin filament incased in a gummy layer with nodes. Silk protein is called as **Fibroin** and silk gum is called as **Sericin**. The cultivation and manufacturing process of silk fiber is a costly affair and is known as **sericulture.** Different varieties of silk produced in India from different species of silkworm are mulberry silk, muga silk, eri silk and tussar silk. These days we even find **silk mark** on 100 % silk fabrics.

Silk Fibre and Cocoons

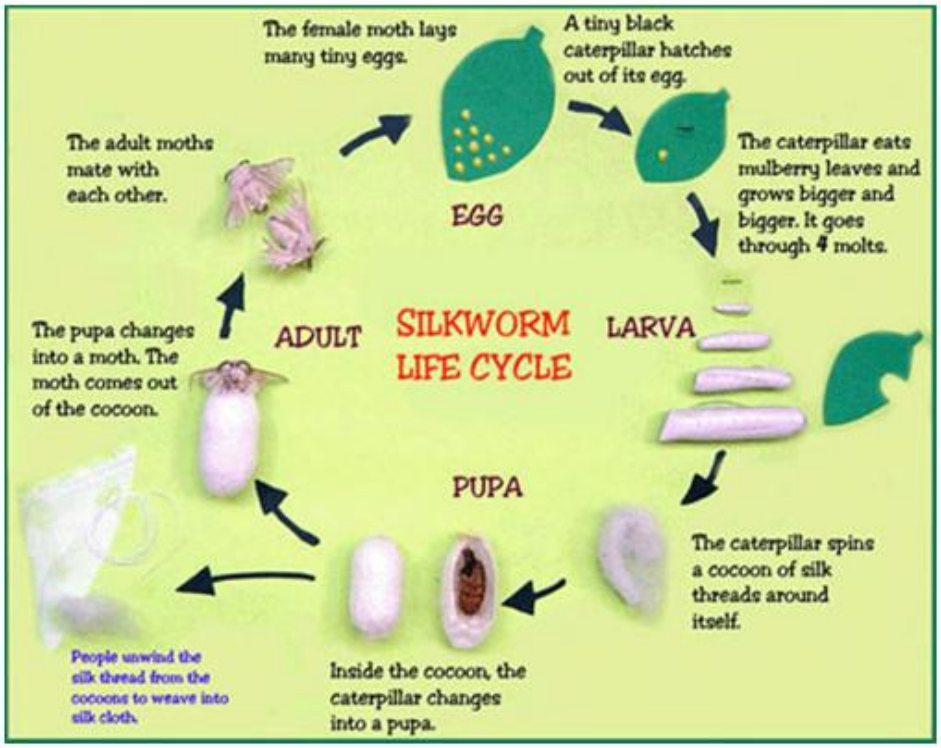
Silk Mark



Silk Fibre - Microscope

Manufacturing Process for Silk Yarns

Cultivation of Cocoons for the production of raw silk is called as Sericulture. There are 4 stages in the life cycle of the moth which are as explained in the figure below



Life cycle of the silk worm

1. **Filature Operation**: The cocoons are delivered to factory called Filature, for different process to unwind the silk. The different operations are as follows:
   a. **Sorting Cocoons** is the process in which cocoons are first sorted according to color, size shape and texture. Cocoon from China are white, Japanese cocoons are creamy white and yellow and Italian cocoons are yellow.
   b. **Softening the Sericin** is the process in which cocoons are heated in boiling water to soften the gummy substance that holds the cocoon filament. Raw silk consists of about 80% fibroin and 20% sericin.
   c. **Reeling the Filament** is the process of unwinding the filament from the cocoon.

Cocoon softening and Reeling silk

Silk filaments are unwound in the reel and combined together to make thread of raw silk. The filaments from 4 to 8 cocoons are joined. The resulting is called raw silk, which is consists usually of 48 individual silk fiber. The sericin acts as adhesive in holding the several filaments. The length of the reeled filament is approximately a quarter of mile long

2. **Throwing** is the process of twisting of one or more threads of the raw silk into a strand sufficiently strong for weaving or knitting.

   Raw silk skeins are sorted according to size, color and length or quality. It is then soaked in warm water with soap and oil. After mechanical drying the skeins are wound on bobbins. During this winding, single strands may be given any desired amount of twist. If two or more yarns are to be doubled, they are twisted again in same direction.
3. **Degumming of Thrown Silk:** The process of degumming involves putting thrown silk yarn through final soap bath to remove the silk gum sericin. This process brings out the natural luster and soft feel of the silk. 25% of the weight is lost by this process. After degumming, the silk fiber or fabric is creamy white and less stiff.

Characteristics of Silk Fabric

1. **Composition:** Silk is composed of 80% of fibroin, which is protein in nature and 20% of sericin.
2. **Strength:** Silk has good tensile strength, which allows it to withstand great pulling pressure.
3. **Elasticity:** It is an elastic fiber and may be stretched from 1/7 to 1/5 of its original length.

4. **Resilience:** Silk fabric retains their shape and has moderate resistance to wrinkling.
5. **Drapability:** Silk has a liability and suppleness that, aided by its elasticity and resilience, gives it excellent drapability.
6. **Heat Conductivity**: Silk is a protein fiber and is a non-conductor of heat. It make suitable for winter wear
7. **Absorbency:** Silk fabric has good absorbency. Silk can absorb 11% of its weight in moisture, but range varies from 10% to as much as 30%.
8. **Cleanliness and Washability**: Silk does not attract dirt because of its smooth surface. Dirt can be easily removed by washing or dry cleaning.
9. **Reaction to Bleaches:** Silk is deteriorated with chlorine bleaches like sodium hypochlorite. Mild bleach of hydrogen peroxide or sodium per borate may be used for silk.
10. **Shrinkage:** Silk fabrics are subjected only to normal shrinkage which can be restored by ironing.
11. **Effect of Heat:** Silk is sensitive to heat and begins to decompose at 165°C.
12. **Effect of Light**: Silk fabric weakens on exposure to sunlight
13. **Resistance to Mildew:** Silk will not mildew unless left for sometime in damp state.
14. **Resistance to Insect:** Silk may be attacked by the larvae or cloth moths or carpet beetles.
15. **Reaction to Alkalis:** Silk can be damaged if the concentration and temperature is high. A mild soap or detergent in lukewarm water is advisable.

16. **Reaction to Acid:** Concentrated mineral acids will dissolve silk faster than wool. Organic acids do not harm.
17. **Affinity for Dyes**: Silk has good absorbency and thus has good affinity for dyes.
18. **Resistance to Perspiration:** Perspiration weakens and yellows silk fabric.

Care

Dry cleaning is preferred .But can be laundered at home using mild neutral detergent .It should be ironed at medium to low temperature by placing a semi wet muslin fabric. It should be dried in shade.

Storage

Silk should be stored clean and dry, by placing naphthalene balls or neems leaves or they can be sealed and stored in vaccum bags.

Summary

- Silk is a protein fiber, which is obtained from cocoons of the silkworms.
- The fabric made of twisted fibers exhibits good strength and is very elastic in nature.
- These fibers are suitable for winter apparels as these are bad conductors of heat and also provides comfort in warmer weathers
- Silk is called as hygienic material as it does not attract dirt.
- Silk absorb the dyes very well because of their amorphous nature.

Self Assessment Questions

1. Silk Protein is called as _____.
2. Silk is obtained from cocoons of _____species of silk worm.
3. The process of unwinding the filament from the cocoon is called as _____.
4. Silk is damaged by _____, so it is not laundered using detergent.

.

Unit 6

Wool

Objectives

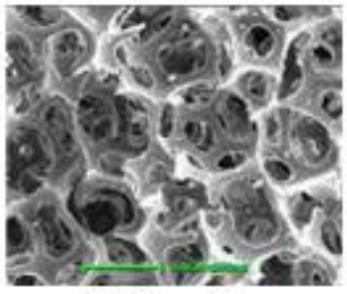
- Understand the different properties of wool.
- Evaluate the performance and maintenance

Introduction

Wool fiber is the natural hair grown on sheep and is composed of protein substance called as Keratin. Wool is composed of carbon, hydrogen, nitrogen and sulfur. It has crimps or curls, which create pockets and give the spongy feel and create insulation for the wearer.

Wool fibers are animal fibers, which are obtained from sheep. The color of fiber ranges from white to brown depending upon the nature of sheep from which it is sheared. Wool, after shearing, it is graded and then scoured with alkaline solution. Then it is subjected to next process depending upon whether it is meant for worsted purpose or woolen products. These are the only natural fibers, which have considerable low strength. The color of fiber ranges from white to brown depending upon the nature of sheep from which it is sheared. It is water repellent and the water droplets can be brushed off easily from the surface, it can also absorb about 20% of its water without feeling damp. These fabrics are best intended for winter purpose as very good insulating properties.

Longitudinal view of wool



Scaly surface

Sheep

Wool mark

The characteristic of protein fibers

- They are composed of **amino acids.**
- They have **excellent absorbency**.
- Moisture regain is high.
- They tend to be **warmer t**han others as they are bad conductors of heat.
- These are the only natural fibers, which have considerable **low strength**.
- They have **poor resistance** to **alkalis** but **good resistance** to **acids**.
- They have **good elasticity** and **resiliency**.

Properties of Wool

Composition: The chief constituent is protein substance called **Keratin.** Chemically it contains carbon, hydrogen, oxygen, nitrogen and sulfur.

- **Strength:** Wool is the weakest fiber. Fabric is strengthened by the use of ply yarns. It loses about 25% strength when wet

- **Elasticity:** Each wool fiber is a molecular coil-spring making the fiber remarkably elastic. It can be stretched 25 to 30% of natural length and stretch up to 50% when wet. This is the reason why one should be careful while laundry.
- **Resilience:** Wool is the **most resilient** fiber because it has a natural crimp that keeps its shape.
- **Drapability:** Wool's excellent draping quality is aided by its pliability, elasticity and resiliency.
- **Heat Conductivity**: Wool fibers are **non-conductor** of heat and acts as a natural insulator, they permit the body to retain its normal heat and It is natural insulator and keeps body warm in winter.
- **Resistance to Mildew**: Moisture is the main factor for the development of mildew on a fabric. When fabric is left damp condition, mildew develops. Since it is protein in content it is easily degraded by mildew.
- **Resistance to Insects**: Wool is especially vulnerable to the larvae of moths and such other insects as carpet beetles. These cause holes on woolen fabrics.
- **Reaction to Alkalis:** Wool is quickly damaged by **strong alkalis**, which make it essential to use mild soap or detergent for laundry..
- **Reaction to Acids:** Although wool is damaged by hot sulfuric acid, it is not affected by other acids.
- **Affinity for Dyes**: The dye reaches the core of the fiber and bonds permanently. It absorbs many different dyes deeply, uniformly and directly without use of combining chemicals.
- **Resistance to Perspiration**: Wool is weakened by alkali perspiration. Perspiration generally will cause discoloration.

- **Absorbency:** Wool fiber is original wicking fiber. Wool can be easily absorb up to 30% of its weight in moisture without feeling damp.
- **Cleanliness and Washability**: The wool adheres dirt and requires thoroughly cleaning. Care should be taken while laundering as the fiber is softened by moisture and heat which results in shrinking.
- **Reaction to Bleaches:** Chlorine bleaches like sodium hypochlorite are harmful for wool. They can be bleach by hydrogen peroxide or sodium per borate.
- **Shrinkage:** Wool shrinks when washed.
- **Effect of Heat:** Wool becomes harsh at 100°C and begins to decompose at slightly higher temperature. It does not burn freely when touched by flame.
- **Effect of Light:** Wool is weakened by prolonged exposure to sunlight.

Laundry:

Wool is laundered using neutral detergent or shampoos as the alkaline detergents damage wool. Do not wring them for removing excess of water, but by rolling in between the towel or absorbent pad .It is dried flat on a paper with traced outline to bring back to its original shape as wool undergoes shrinkage on laundry.

Storage:

Wool is stored in clean and dry in vacuum bags with naphthalene balls to avoid the damage by moth, mildew and insects

Difference between woolens and worsteds

Woolens	Worsteds
Processing Spun from wool fibres of: ➢ **Length:** spun from short fibres of 1-3” ➢ **Diameter:** medium or coarse The fibres are washed, scoured and carded.	**Processing** Spun from wool fibres of: ➢ **Length:** longer than 3” ➢ **Diameter:** fine diameter Fibres are washed, scoured, carded, combed and drawn
Yarn ➢ Bulky ➢ Uneven ➢ Low to medium slack twist ➢ Tensile strength lower than worsted	**Yarn** ➢ Fine ➢ Smooth ➢ Even ➢ Tighter twist ➢ Higher tensile strength
Fabric Appearance ➢ Soft ➢ Fuzzy ➢ Heavier weight	**Fabric Appearance** ➢ Crisp ➢ Smooth ➢ Lighter weight
Characteristics ➢ Insulator due to trapped air ➢ Does not hold a crease well ➢ Less durable than worsted	**Characteristics** ➢ Less insulator ➢ Holds creases and shape ➢ More durable than woollens
Uses ➢ Sweater ➢ Carpets ➢ Tweeds	**Uses** ➢ Suits ➢ Dresses ➢ Gabardines ➢ Crepes

Woollen fabric

Worsted fabric

Summary

- Wool fibers are animal fibers, which are obtained from sheep.
- Wool, after shearing, it is graded and then scoured with alkaline solution. Then it is subjected to next process depending upon whether it is meant for worsted purpose or woolen products.
- These are the only natural fibers, which have considerable low strength.
- The color of fiber ranges from white to brown depending upon the nature of sheep from which it is sheared.
- It is water repellent and the water droplets can be brushed off easily from the surface, it can also absorb about 20% of its water without feeling damp.
- These fabrics are best intended for winter purpose.

Self Assessment Questions

1. _____ is the weakest of natural fibers.
2. _____ is necessary for the development of mildew on fabrics.
3. _____ is the only animal fiber, which contains sulfur in its composition.
4. _____ fabric is used for suiting and shirting.
5. Give differences between woolens and worsted fabrics.

Unit 7

Viscose Rayon

Objectives

- Explain the manufacturing process of the rayon fibers
- Evaluate the Rayon fabrics for different properties

Introduction

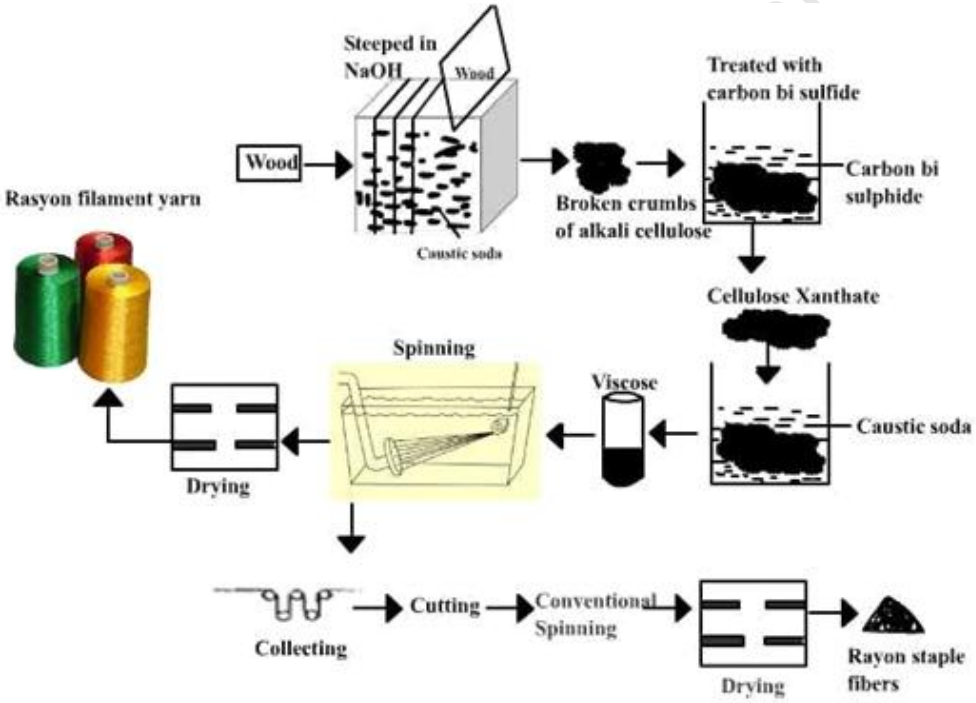
The man-made fibres which are obtained from the cellulose base are called man-made cellulose fibres. It has many qualities of natural cellulose. The technological advancement has resulted in production of rayon such as lyocell and modal, which are stronger when damp.

Rayon fibres are known as regenerated cellulose fibre whereas acetate and triacetate are treated as cellulose acetates. Rayon was the first manufactured man-made fibre and was called “artificial silk”. It is the man-made fibre, made from cellulose based raw material that has been reformed or regenerated and has properties similar to those of natural cellulosic fibres and thus referred as regenerated fibres. India was importing the rayon fabrics as well as the rayon yarns, but since 1942 the Board of Scientific and Industrial Research has taken efforts to starting factories for making rayon yarn and many plants have been set up since then. Bamboo and Bagasse cellulose from the sugar industry is used for making rayon in India.

Manufacturing process

The important steps in manufacturing the filament in each of these processes are:

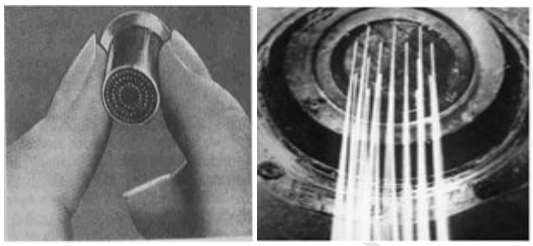
- Treating cellulose chemically for making them or rendering them into a liquid.
- Extruding the liquid through the fine holes.
- Solidifying the liquid stream into solid cellulose filaments.



Manufacturing process and Viscose Rayon

- Purified cellulose is chemically converted into a soluble compound.
- This solution is passed through the spinneret to form soft filament that are then converted or **"regenerated**" into almost pure cellulose.

- A liquid substance of cellulose is forced through a nozzle about the size of thimble. This nozzle is made of platinum-rhodium alloy as it is not affected by acids or alkalis.
- Filaments extruded through tiny holes of the spinneret are solidified by **a liquid bath**.
- These filaments are combined by twisting to make any required diameter of rayon yarn.



Properties

1. **Composition:** Rayon fabric is mainly composed of cellulosic components.
2. **Strength:** Rayon fabrics are considerably strong and durable. Regular rayon is stronger than wool but weaker than cotton and **weak** when **wet**, HWM (High Wet Modulus Rayon) rayon are strong as cotton when damp.
3. **Elasticity:** Rayon has greater elasticity than cotton, but less than wool. Elongation at break varies from 10 to 30% dry and 15 to 20% wet.
4. **Resilience:** Rayon **creases readily** as it lacks the natural resilience of wool and silk. Fabric wrinkles easily.
5. **Drapability:** Rayon **drape well** as its heavy weight and it can be made heavy with use of coarse filaments.

6. **Heat Conductivity:** It is **good conductor** of heat and fit for summer. Fuzzy surface of spun rayon provides insulation for winter wear.
7. **Absorbency:** Rayon is extremely absorbent but however, the loss of strength of regular rayon when wet.
8. **Cleanliness & Washability:** Smoothness of rayon renders to produce hygienic fabric that shed dirt. It can be washed easily and require mild soap or detergent.
9. **Reaction to Bleaches:** Rayon is white and does not normally discolor. They can be bleached with sodium hypo chlorite, sodium per borate or hydrogen peroxide. It is affected by bleaches **at very high** concentration and elevated temperature.
10. **Shrinkage:** Rayon tends to shrink more than cotton.
11. **Effect of Heat:** It has burning properties like cotton, and loses strength above 149 °C. It chars and decomposes at 177 to 204 °C. Rayon do not melt.
12. **Effect of Light:** It has good resistance to sunlight, but prolonged exposure causes loss of strength and yellowing of fabric.
13. **Resistance to Mildew:** Resistance of rayon to mildew is similar to cotton, rayon has tendency to mildew when allowed to remain damp for prolonged time.
14. **Resistance to Insects:** Rayon resists damage similar to cotton. Moth are not attracted to cellulose.
15. **Reaction to Alkalis:** Bases does not attack rayon, however concentrated solutions of alkalis disintegrate rayon.
16. **Reaction to Acid:** Rayon are disintegrated by hot dilute and cold concentrated acids.

17. **Affinity for Dyes:** Rayon being hydrophilic absorbs dyes evenly. Dye stuff is added to the spinning solution before extruding through spinneret.
18. **Resistance to Perspiration:** Rayon is fairly resistance to deterioration from perspiration.

Summary

- There are many methods of producing the rayon fabrics the basis of which is a cellulosic component.
- The basic steps in producing the fibre involves chemically treating the cellulosic fibres converting it into a viscous solution which is then extruded through spinneret.
- There are different varieties of rayon like high wet modulus rayon, regular rayon etc.
- Filament yarns are cut into the staple length and can be made into spun yarns.
- Characteristics exhibited by these yarns are similar to that of cotton fibre.

Self Assessment Questions

1. _____ method is used for spinning of viscose rayon.
2. _____ is a regenerated cellulose fibre.
3. Rayon filaments extruded through the spinneret are solidified in ___.
4. _____ is used as a raw material for production of rayon.

Unit 8

Cellulose Acetate

Objectives

- Explain the manufacturing process of the cellulose acetate fibers
- Evaluate the cellulose acetate for different properties

Introduction

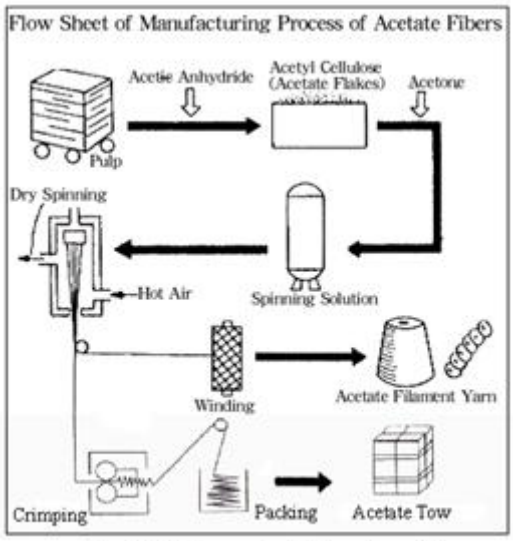
Cellulose acetate, is a synthetic compound derived from the **acetylation of cellulose**. They are the acetate ester compounds of cellulose. Cellulose Acetate is spun into textile fibres known variously as acetate rayon, acetate or triacetate**.** The cellulose acetate fibres are of two types – **Acetate fibres** and **Triacetate fibres.** These fibres are similar in many of their properties but differ in the chemical compounds. **Triacetate** are the primary acetate containing no hydroxyl group, whereas acetate fibre is secondary acetate having few hydroxyl groups. The cellulose acetate are not pure cellulose compounds like rayon.

Manufacturing

The raw material for manufacturing acetate includes **cellulose** which is obtained from cotton linters and wood pulp and chemicals.

The cellulose are **shredded** and mixed with **glacial acetic acid** and kept for sometime .Then it is mixed in a mixing machine where some chemicals are added during which the cellulose turns to liquid and changes into **cellulose acetate** which are made into the **flakes.**

These flakes are **dissolved** in solvents (Acetone) .The spinning solution are forced through the spinnerets into warm air chamber .Here the acetone evaporates and the acetate becomes hard into filament .This method is called as **dry spinning**.



Manufacturing of cellulose Acetate

Cellulose Acetate fabric

Properties

1. **Dimensional Stability:** Shape and luster can be controlled by adding a delustering agent – titanium dioxide.
2. **Resiliency**: It has a very **low resiliency** so wrinkles easily
3. **Moisture regain:** It is slightly less then cotton
4. **Effect of Temperature**: Acetate is a thermoplastic fibre and is easily softened at high temperature

Fabric characteristics

1. A Silk like appearance, possesses a **luxurious and soft feel**.
2. It has **excellent draping** qualities.

3. It ends to collect **static electricity**.
4. It dyes well.
5. It has relatively **low strength**.
6. Resistant to mildew and moths.
7. It can be **weakened** by **sunlight**.
8. It is **moderately absorbent**.
9. Holds in body heat.
10. **Resistant** to **stretch** and **shrinkage.**
11. Commonly blended with other fibres.

General care

It is usually dry-cleaned. It can be hand wash or cool to warm gentle machine wash. Need to be ironed at a low temperature while damp, on the wrong side of the fabric. Acetone (nail varnish remover) damages acetate fabric.

Common fabrics

Common acetate fabrics include: satin, jersey, taffeta, lace, brocade, tricot and crepe

Summary

- There are two types of cellulose acetate fabrics, which include acetate and triacetate.
- There are different types of yarns produced for these fibres, which mainly depend upon the holes of the spinneret.
- Thick yarn would be obtained if the hole of spinneret is wide enough and in the same way a monofilament is produced with spinneret with

one hole and multifilament is produced if spinneret is having more then one hole.

- Yarns produced are highly absorbent and are resistant to the moderate temperature.
- The main advantages of cellulose acetate fabrics are shrink resistance and wrinkle resistance.

Self Assessment Questions

1. Discuss the characteristics of cellulose acetate for the following properties:
   a. Strength
   b. Resistance to insects
2. Explain the Manufacturing process of cellulose acetate.

Unit 9

Acrylic

Objectives

- Discuss the manufacturing process of acrylic.
- Explain the characteristics of acrylic and spandex fabrics

Introduction

Acrylic was developed by **DuPont in 1944** and was first commercially produced in 1950. It is Also Known as Orlon. It is lightweight, soft and warm with a wool-like feel. Even though acrylic can be considered a replacement for wool, there are some differences and similarities between wool and acrylic. Like wool, acrylic is crimped when it goes through the dry spinning process, but acrylic unlike wool provides bulk and warmth with no excess weight. Due to the fact that acrylic is the best substitute for wool, it is readily available to consumers and is significantly less expensive.

Acrylic yarns

Acrylic Fabric

Acrylic has advantage of being used as an alternative for cashmere due to the similar feeling of material. Acrylic fibers are produced from **acrylonitrile**, a petrochemical. The acrylonitrile is usually combined with small amounts of other chemicals to improve the ability of the resulting fiber to absorb dyes. Some acrylic fibers are dry spun and others are wet spun. Acrylic fibers are used in staple or tow form.

Properties of Acrylic

1. **Strength:** Acrylic have fair to **strong tenacity**. It tends to **lose the tenacity** in a **wet medium.**
2. **Abrasion Resistance:** They have high resistance to damage by abrasion.
3. **Elasticity:** Acrylic have **low elasticity**. Elongation increases when the fibre is wet.
4. **Resilience:** Acrylic fibres have good resiliency and recover from bending. It will not wrinkle easily and therefore it good for dresses, suits and slacks.
5. **Drapability:** Acrylic have **satisfactory draping qualities** which greatly vary according to the fabric construction, type of yarn used in form of yarn.
6. **Heat Conductivity:** Acrylic are **bad conductors** of heat and can provide warmth with light weight.
7. **Absorbency:** Acrylic have **low water regain**.
8. **Cleanliness and Washability:** It is easy to keep acrylic clean, and they can be dry-cleaned.
9. **Reaction to Bleaches:** Acrylic are white in color and do not require bleaching.

10. **Shrinkage:** Acrylic **do not shrink** and has **moderate dimensional stability**. They tend to shrink when exposed to boiling water at high temperature.
11. **Effect of Heat:** Acrylic cannot be heat set. They tend to discolor and decompose when heated.
12. **Effect of Light:** Acrylic have excellent resistance to the exposure of sunlight. After initial stage of the tensile loss, the fabric tend to have excellent resistance to sunlight.
13. **Resistance to Mildew:** Acrylic has excellent resistance to mildew and do not get stained or weakened.
14. **Resistance to Insect:** Acrylic are unaffected by moths or other insects.
15. **Reaction to Alkalis:** Acrylic fabrics are resistant to **weak alkalis** and have moderate resistance to the strong and cold alkalis.
16. **Reaction to Acid:** Acrylic fabric have **excellent resistance** to the acid.
17. **Affinity for Dyes:** They can be dyed with disperse or cationic dyes in wide range of color. In addition, most of the synthetic filaments are solution dyed.
18. **Resistance to Perspiration:** Acrylic are resistant to perspiration
19. **Resistance to Sunlight:** Excellent resistance to sunlight and weathering

Major Acrylic Fiber Uses

- **Apparel:** Sweaters, socks, fleece wear, circular knit apparel, sportswear and children wear
- **Home Furnishings:** Blankets, area rugs, upholstery, pile, luggage, awnings, outdoor furniture

- **Other Uses:** Craft yarns, sail cover cloth, wipe cloths
- **Industrial Uses:** Asbestos replacement; concrete and stucco reinforcement

General Acrylic Fiber Care Tips

Wash delicate items by hand in warm water. Generation of static electricity may be reduced by using a **fabric softener**. Gently squeeze out water, smooth or shake out garment and let dry on a non-rust hanger. Sweaters, however, should be dried flat. While machine washing, use warm water and add a fabric softener during the final rinse cycle. Machine dry at a low temperature setting. Remove garments from dryer as soon as tumbling cycle is completed. If ironing is required, use a moderately warm iron.

Summary

- Acrylic is a synthetic polymer obtained from the petroleum derivatives.
- It is a long chain of polymer constituted with 85% of acrylonitrile units.
- There are different types of acrylic such as orlon acrylic, zeflan acrylic etc.

Self Assessment Questions

1. Acrylic fibre is produced from _____.
2. Explain why acrylic is used in sweaters?
3. Acrylic fabrics are used as a replacement to _____ fabrics.
4. List and explain the properties of Acrylic fabric.

Unit 10

Spandex

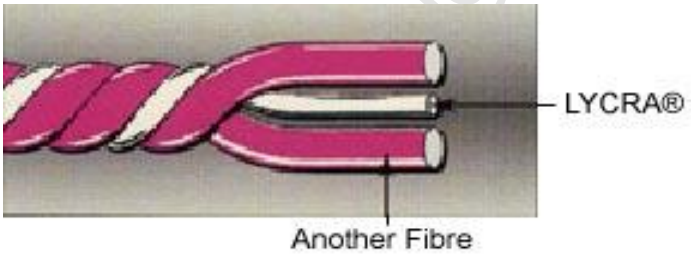
Objectives

- Explain the characteristics of spandex fabrics
- Understand the fabric characteristics and performance.

Introduction

Spandex is elastomeric fibre with the superior elasticity. **Lycra** is the famous brand name associated with spandex fibre. It is defined as a manufactured fibre, in which the fibre forming substance is long chain synthetic polymer composed of at least 85% of segmented **polyurethane.**

Lycra is never used alone, it is always combined with another fiber (or fibers), natural or man-made. Fabrics enhanced with Lycra retain the appearance of the majority fibre.



The type of fabric and it's end use determine the amount and type of Lycra required to ensure optimum performance and aesthetics. As little as 2 percent Lycra is enough to improve a fabric's movement, drape and shape retention, while fabrics for high-performance garments such as swimwear and active sport wear may contain as much as 20-30

percent Lycra. Weaving or knitting techniques, together with fabric type and end use, determine whether Lycra is used in a bare or covered yarn form.

Properties

1. **Strength:** Spandex filament is **weak b**ut it does not reach the breaking point until the fibre has been stretched to its maximum length.
2. **Elasticity:** Spandex have **excellent elasticity**. It has more shape retention than any other fabric. It can be stretched up to 500 times.
3. **Resilience:** Spandex have **excellent resiliency**. It quickly recovers its original length.
4. **Drapability:** Spandex is generally **light in weight** and are **pliable.** It contributes to the draping qualities of fabric.
5. **Heat Conductivity:** Spandex are **bad conductor** of heat which is evident by some degree of heat sensed when wearing the clothes made of spandex.
6. **Absorbency:** Spandex is **hydrophobic** in nature and have very low absorbency.
7. **Cleanliness and Washability:** Spandex have good **resistance** to the dry-cleaning. It can also be machine washed using detergents under moderate temperature.
8. **Reaction to Bleaches:** Spandex fabric are white in color and do not require bleaching. If the spandex combined with other fibres require bleaching, sodium chlorite is the safest bleach.
9. **Shrinkage:** Spandex will not shrink by exposure to water.
10. **Effect of Heat:** Spandex are **heat sensitive** and **thermoplastic**. Excessive heat may result in loss of elasticity.

11. **Effect of Light:** Spandex do not have degrading effects on exposure to the sunlight. Strength may be lost, or turn yellow if exposed for long time.
12. **Resistance to Mildew:** Spandex have excellent **resistance to damage by mildew**.
13. **Resistance to Insect:** Spandex are unaffected by insects and moths.
14. **Reaction to Alkalis:** Spandex are **sensitive to alkalis**. It turns yellow or dark color on reaction with alkalis.
15. **Reaction to Acid:** Spandex fabrics are generally resistance to acids.
16. **Affinity for Dyes:** Spandex is affinities for many dyes such as disperse, acid, chrome and other dyes. Color of spandex may be affected by repeated exposure to the sea water.
17. **Resistance to Perspiration:** Spandex are resistant to perspiration.

Usage

Widely used for weaving items like Apparels, Socks & stockings, Seamless garments, Gloves, Sweaters, Swimwear, Narrow fabrics, Smocking, Medical bandages, Head bandages, Wrist bands

Care

Hand or machine wash in lukewarm water. Never use chlorine bleach on any fabric containing Lycra. Either drip dry or machine dry using low temperature settings

Summary

- Spandex is synthetic elastomeric fabric having superior elasticity.

- The long chain polymer consists of rigid and flexible segments which contribute to the strength and the elasticity of the spandex.
- They are resistant to degradation by body oils, sea water etc., which make them suitable for swim wear.

Self Assessment Question

1. Spandex has resistance to _____ bleach.
2. The stretch which is important where the holding power and elasticity are needed is termed as _____.
3. Explain the use and care of spandex fabric

Unit 11

Nylon

Objectives

After studying this unit, you would be able to:

- Explain the manufacturing process of nylon fibres.
- Discuss the different properties of nylon fiber

Introduction

Nylon is the first man made synthetic fibre (pure chemical fibre). It is **thermoplastic polyamide fibre,** mainly composed of carbon, hydrogen, oxygen and nitrogen. The basic manufacturing process includes the synthesis of polymers from the petroleum derivatives which are extruded from the spinneret and drawn into the desired length. Nylon is manufactured by **polymerization of caprolactum**. Nylon 6 polymer is formed under the pressure, extruded, chipped into pallets of flakes and then **melt spun** through a spinneret .Then the filaments are **cold drawn**.

Nylon Yarn

Nylon Net

Properties of Nylon

1. **Strength:** It has good tenacity and strength is not lost with age. It is strongest textile fiber. Strength is **lost** when **wet**. It has **excellent abrasion resistance.**
2. **Elasticity:** It has **good elasticity**. It has **high elongation** and **excellent elastic recovery**.
3. **Resilience:** It has **excellent resilience**. Nylon retain their smooth appearance and wrinkles from daily activities.
4. **Drapability:** It has **excellent draping** qualities. Light weight sheer nylon has high draping quality. Medium weight can drape very nicely.
5. **Heat Conductivity:** Nylon used in open construction would be cooler when compared to closed construction.
6. **Absorbency:** It has **low absorbency**. Water remains on surface and hence dries quickly, so its suitable for raincoats.
7. **Cleanliness and Washability:** It is easy care garments. Dirt doesn't cling and can be cleaned by using damp cloth. Hot water should be avoided during washing as it is a thermoplastic fibre.
8. **Reaction to Bleaches:** Nylon are white and do not require **bleaching.** Greying nylon should be bleached with oxidizing bleaches such as hydrogen peroxide.
9. **Shrinkage**: Nylon retains shape after washing and it has good stability and does not shrink.
10. **Effect of Heat:** It should be ironed at low temperature. Hot iron results in glazing and then melting of fabric.
11. **Effect of Light:** Nylon has low resistance to sunlight. They are not suitable for curtains or draperies.

12. **Resistance to Mildew:** Nylon have absolute resistance to develop mildew.
13. **Resistance to Insect:** Nylon is resistance to the moth and fungi.
14. **Reaction to Alkalis:** Nylon has excellent resistance to alkalis but frequent and prolonged exposures to alkalis will weaken the nylon fabric.
15. **Reaction to Acid**: Nylon is less resilient to the action of acids and is damaged by strong acid.
16. **Affinity for Dyes:** Nylon can easily be dyed and has good resistance to fading.
17. **Resistance to Perspiration:** Nylon are resistant to perspiration.

Recommended Uses

Lingerie, dresses, suiting, blouses/shirts, knitwear, hosiery, children's wear, beachwear, raincoats, gloves, tights, fur fabrics, blankets, curtaining and upholstery, carpets, ropes, nets and tyre cords.

Care

When washing nylon, separate whites from coloured and use cold to hot water. Dry nylon flat, line dry or put in the dryer on a cool temperature. Use a warm iron on the reverse side of the fabric. Use only a little steam, if necessary. You can dry-cleaning nylon, but avoid bleaching

Summary

- The basic manufacturing process includes the synthesis of polymers from the petroleum derivatives which are extruded from the spinneret and drawn into the desired length.

- Nylon is thermoplastic polyamide fibre, mainly composed of carbon, hydrogen, oxygen and nitrogen.
- Basic raw material is coal from which the nylon polymers are obtained.
- These fabrics have excellent strength, resilience, resistance to insects etc.
- Fabric has low absorbency making them suitable for the rain wear.

Self Assessment Question

1. Nylon fabrics can be bleached with _____ bleaches.
2. Nylon fabrics have low _____ (Absorbency ,Color fastness Resistance to alkalis , Strength)
3. Explain various properties of nylon fabric.

Unit 12

Polyester

Objectives

- Explain the manufacturing process of polyester fibres.
- Discuss the different properties of polyester fibres

Introduction

Polyester is a chemical term, which can be broken into **'poly'**, meaning many, and **'ester',** which is a basic organic chemical compound. Polyester is a term often defined as **long-chain** polymers, chemically composed of at least 85% by weight of an **ester** and a **dihydric alcohol** and a **terephthalic acid.** In other words, it means the linking of several esters within the fibers. Reaction of alcohol with **carboxylic acid** results in the formation of esters.

Polyester Yarns

Polyester Fabrics

Properties of Polyester

1. **Strength:** Polyester has good tenacity and good resistance to abrasion. Tenacity remains unaltered even when wet.

2. **Elasticity:** Polyester fabrics do not have high degree of elasticity. They are stiff and are of hard handle.
3. **Resilience:** Polyester have excellent resilience. Polyester resist wrinkling in dry and also in we condition. Any wrinkling even under humid conditions disappears when garments are hung up.
4. **Drapability**: Polyester have satisfactory draping qualities.
5. **Heat Conductivity**: Polyester have poor heat conductivity and the low heat resistance. They have moderate thermal retention but is not as comfortable as wool for the winter season.
6. **Absorbency:** Polyester are hydrophobic in nature. They are least absorbent of the textile fibres. This is suitable for water repellent purposes.
7. **Cleanliness and Washability:** Polyester wash and dry easily and have excellent wash-and-wear characteristics. Low absorbency tens it to resist the water-bone stains.
8. **Reaction to Bleaches:** Polyester are white and do not require bleaching. If polyester develop any stain, they can be bleached with chlorine or oxidizing bleaches.
9. **Shrinkage:** Polyester retain shape after wash and they have good stability and do not shrink.
10. **Effect of Heat:** Polyester is heat thermoplastic. They may be heat set to obtain stability and permanent pleats.
11. **Effect of Light:** Polyester have very good sunlight resistance..
12. **Resistance to Mildew:** Polyester have excellent resistance to mildew and do not get stained or weakened.
13. **Resistance to Insect:** Polyester is resistance to the attack of the insects.

14. **Reaction to Alkalis:** Polyester have good resistance to weak alkalis and fair resistance to strong alkalis. Resistance is reduced with increased temperature. It dissolves n strong, boiling alkalis.
15. **Reaction to Acid:** Polyester have good resistance to acid. High concentrated solutions of mineral acid, such as sulphuric acid at relatively high temperature will result in degradation.
16. **Affinity for Dyes:** Polyester dyed with appropriate dyes produce a good shade with excellent wash, and light fastness.
17. **Resistance to Perspiration:** Polyester fabrics are resistant to perspiration and do not lose strength.

Uses of Polyester

The most popular and one of the earliest uses of polyester was to make **polyester suits**. Polyester clothes were very popular. Due to its strength and tenacity polyester was also used to make **ropes** in industries. **PET** bottles are today one of the most popular uses of polyester.

Polyester care tips

Taking care of polyester clothing is really easy and very time efficient. Polyester clothing can be machine washed and dried. Adding a **fabric softener** generally helps. Dry the fabric at **low temperatures** to get maximum usage from the clothing. Though polyester does not require much ironing, if you must then iron warm. Polyester can be **dry-cleaned** with no hassles.

Summary

- Polyester fibres are made up of long ester molecules.

- The basic mineral for the synthesis is ethylene, obtained from petroleum.
- Polyester is used for various applications due to its desirable characteristics.
- The most desirable characteristic of polyester fabrics are its strength and durability.
- The fibres are relatively strong and are very resistant to wrinkling, attack by insects, perspiration etc.
- These are suitable for winter apparel depending upon the type of construction.

Self Assessment Question

1. Polyester fabrics have excellent resistance to _____. (Alkalis. Perspiration. Acids. All the above)

2. _____ and tenacity of polyester fabrics are unaffected by water.

3. _____ and _____are the raw materials used for manufacturing of polyester.

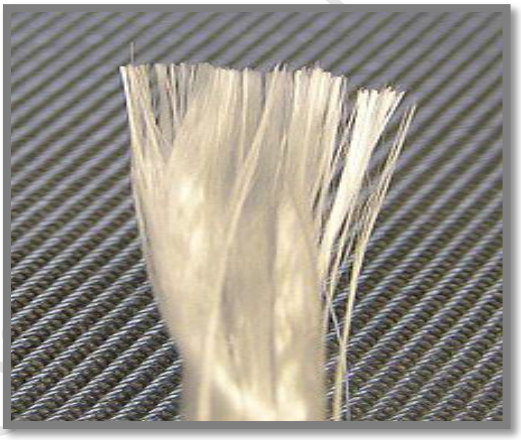
4. Write about the performance and care of polyester fabric with reference to the properties.

Unit 13

Glass fiber

Introduction

Glass Fiber is a material consisting of numerous extremely fine fibre of glass. Glass fiber is formed when thin strands of silica -based or other formulation glass are extruded into many fibers with small diameters suitable for textile processing. The technique of heating and drawing glass into fine fibers has been known for millennia; however, the use of these fibers for textile applications is more recent. Until this time, all glass fiber had been manufactured as staple (that is, clusters of short lengths of fiber)



Properties

1. Glass fibers are good thermal insulators
2. Excellent strength
3. Excellent resiliency

Unfavorable properties

1. Heavy Fibre
2. Poor drape
3. Poor elastic recovery
4. Poor Hand or feel
5. Completely Hydrophillic

Uses

It is used for curtains and tyres.

Unit 14

Yarn Spinning

Objective

- Explain the different methods of spinning.
- Describe the blends and methods of blending.

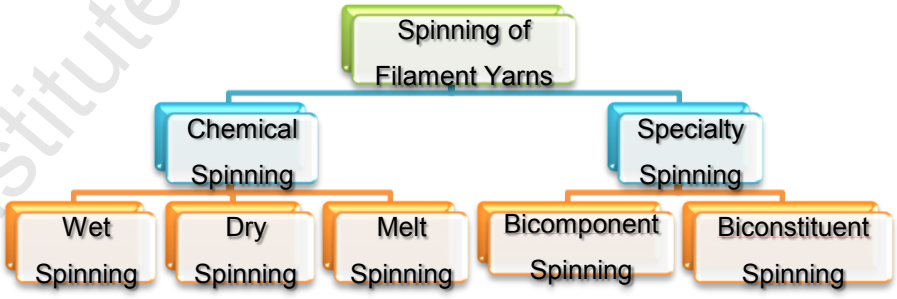
Introduction

Spinning is a method converting the fibrous raw material into yarn or a thread.

The **staple yarns** like cotton, wool etc. are spun on **conventional method of spinning** that includes different stages like blow room operation, carding, combing, drawing, roving and spinning. The spun yarn can also be made by the variation in the conventional system. Some stages of the conventional spinning are eliminated in these methods of spinning which include open-end spinning, twist less spinning etc. There are different methods of spinning the filament yarns such as wet spinning, dry spinning, melt spinning, etc.

Spinning of filament Yarn

Filaments are spun by chemical spinning which includes the process of extruding the polymer extrusion through the spinneret.



Spinning of Staple Fibres (Conventional)

Staple fibres are converted into yarns by conventional or ring spinning technique. The conventional is a long time practiced method of spinning employed for natural fibres like cotton, wool and Lenin. The stages of operations involved in conventional spinning are:

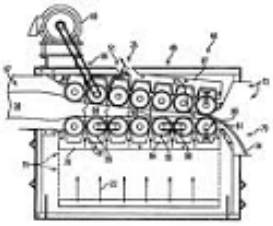
- Preparing the fibres for spinning that includes cleaning the fibres and opening the lumps of the fibres.
- Individualization of fibres and forming a **coarse** strand of fibres
- Drawing out of the fibres into a fine strand.
- Twisting the fibres to keep them together to gain cohesive strength.

The cotton spinning system is representative of the conventional spinning system.

1. **Preparing the fibres**: Cotton comes in bale form, which are cleaned in blow room operation and ginning operation. These fibres are converted into form of lap and sent for carding operation.


Bales

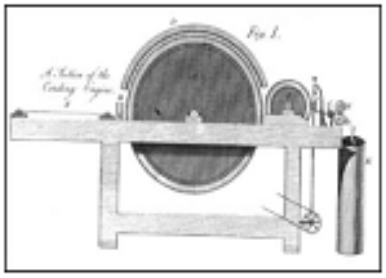

Blow Room Operation


Ginning Machine

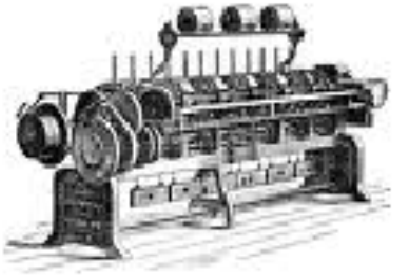

Lap

2. **Carding:** Carding is mainly intended for individualization of the fibres. In carding operation the lap of fibres is converted into a soft rope of fibres called as card slivers.

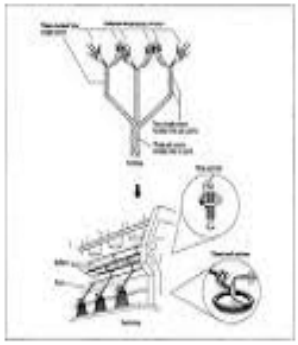
3. **Combing:** Combing process produces a yarn which is superior in quality than the carded yarn in terms of strength, fineness, evenness and smoothness.
4. **Drawing Out:** Drawing process eliminates the irregularities in the sliver by pulling the staples over one another from several slivers placed parallel, thereby producing longer and thinner sliver.
5. **Roving:** The drawn slivers are fed through a machine called simplex roving. It increases parallelism of the fibre and low amount of twist is inserted.
6. **Spinning:** The spinning process adds the required amount of twist into the rove slivers and converts them into the yarn.



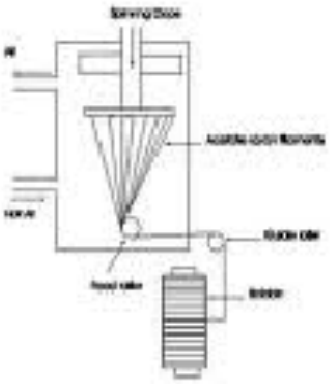
Carding Machine



Combing machine



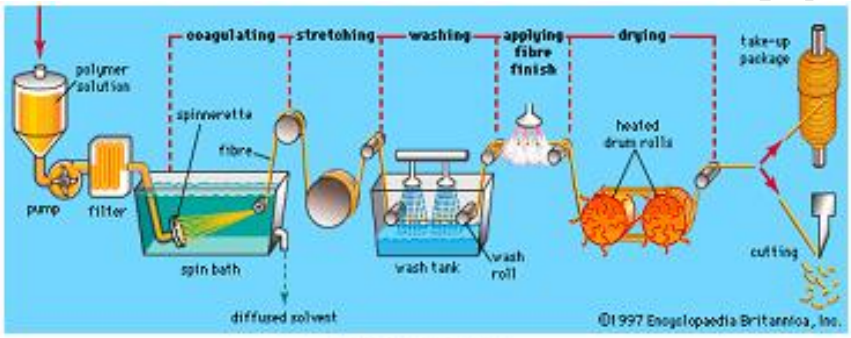
Roving Machine



Spinning

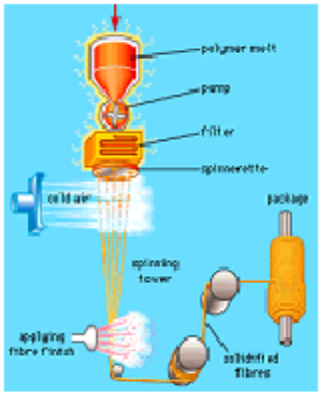
Chemical Spinning

1. **Wet Spinning:** This is more suitable for Rayon fibres. This involves extrusion of appropriate liquid solution through the spinneret in a chemical bath that coagulates the solution into filament strand. These are then drawn out of bath, washed and dried before wounding on the spools.

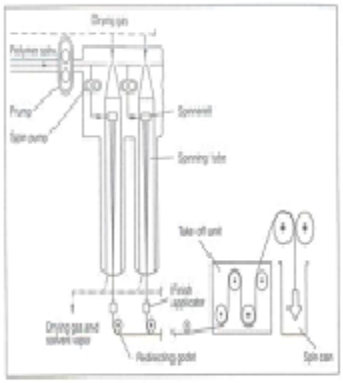


Wet Spinning

2. **Dry Spinning:** This is more suitable for Acetate yarns. It involves the extrusion of the suitable liquid solution through the spinneret into an air chamber. The air reacts with the extruded streams causing them to solidify twisted or processed further and wound onto spools.



Melt Spinning



Dry Spinning

3. **Melt Spinning:** This is more suitable for Polyester yarns. As name indicates the chips of fibres are melted and extruded through the

spinneret to obtain the fibres. The extruded stream cool and solidify into continuous filaments and are then drawn out of the chamber twisted and processed further and wound onto spools

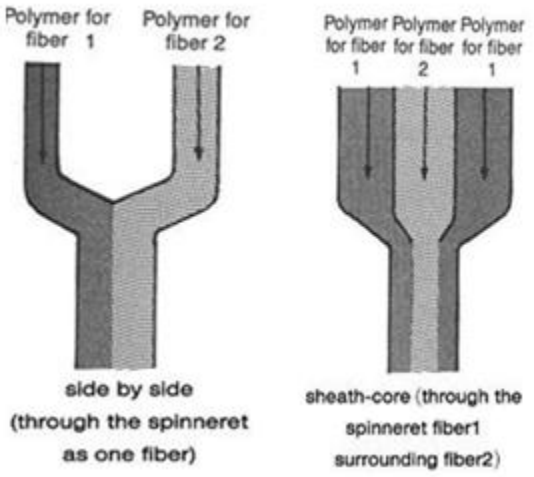
Specialty Spinning

1. **Bicomponent Spinning:** This involves the extrusion of **two different** types of the same polymer through the spinneret. There are three techniques of bicomponent fibre production.

   a) Side-by-Side extension through one spinneret hole of two varieties of same polymer.
   b) Second is basically that of using one spinneret inside another. One variant of polymer pumped through the core spinneret, while other is pumped through outer surrounding spinneret.
   c) The third one is distribution of drops of one molten polymer variant into another molten form of the same polymer.

2. **Biconstituent Spinning –** This involves the **extrusion** of **two different** polymers through the spinneret. Method of extrusion is similar to that of bicomponent spinning. The filament can be obtained by any of the three methods.

   Blending is the combining of different fibres together intimately to achieve a desired product characteristic.



Some of the advantages of blending are:

When two different types of fibres are blended, properties of both fibres are **synergized.** Blending is done to produce fabric, which is economical, by combining the aesthetic comfort properties of natural fibres with easy care and strength properties of synthetic fibres. Blending also helps to provide a light weight fabric with all desirable characteristics. It also improves **spinning, weaving** and **finishing** efficiency and uniformity of product.

Methods of Blending

In **opening stage**, fibres are spread one on top of the other and fed into the **blending feeder**. Blending can also be done in the **carding stage.** Similarly the **blending** can be done at **drawing** or **roving stage.** A filament yarn blended contains yarns of different deniers blended together. Then the Manufactured Fibres goes for further fabric manufacturing by weaving or any non Woven Method

Summary

- Spinning is a method converting the fibrous raw material into yarn or a thread.
- The staple yarns like cotton, wool etc. are spun on conventional method of spinning that includes different stages like blow room operation, carding, combing, drawing, roving and spinning.
- The spun yarn can also be made by the variation in the conventional system.

- Some stages of the conventional spinning are eliminated in these methods of spinning which include open-end spinning, twistless spinning etc.
- There are different methods of spinning the filament yarns such as wet spinning, dry spinning, melt spinning, etc.

Self Assessments Questions

1. List and describe different Chemical spinning Methods?
2. Explain the steps in spinning of a staple fibre?

Unit 15

Yarn

Objectives

Understand the structure of Yarn

- Explain the different simple yarns.
- Describe the varieties of fancy yarns.
- Describe the production of textured yarns

Introduction

As defined by ASTM, 'Yarn is a continuous strand of **textile fibres,** filaments or a material in a form suitable for **knitting, weaving** or otherwise i**ntertwining** to form a textile fabric.'

Types and appearance of a yarn plays a prominent role on the appearance of a fabric. It can also be **defined** as **continuous strand** of **twisted threads** of natural or synthetic material, used in weaving or knitting. Yarn is an assemblage of fibres that is laid parallel and twisted together to form a continuous strand. The method of making yarn involves arranging the fibres parallel to each other and twisting the fibres, by the process of **spinning,** using spinning machines, spindles and charkha in olden times

1. A **spun yarn** is composed of **short staple fibres** which are arranged parallel and twisted around each other.
2. A **filament** is composed of **long fibres** that are grouped and twisted. Yarns of one filament and yarns of several filaments are referred to as mono-filament and multi-filament, respectively.

3. **Blend**-A fibre blend is an intimate mixture of fibre of generic type ,composition, length, diameter, color spun together into one yarn .In intimate blends ,both fibres are present in a same yarn in planned proportion..when this yarn is unspun and tested both the fibres

   a. **Blending fibres** creates Fibres, yarns, fabrics with a more beneficial set of performance characteristics .An improvement in the quality of fabric, meeting specific end use requirements such as performance, comfort or ease of care that would not otherwise be available in single fibers. are individually observed.
   b. **Intimate blends**- An intimate blend is when two or more fibre types are combined to form a uniform mixture before the single yarn is spun. Intimate blends cannot be separated; they are mixed together throughout the entire yarn.

4. **Mixture Blends** a mixture fabric uses a combination of yarns; for example, one type of fibre is used in the warp and another fibre is used in weft weave. A mixture blend also occurs when two different yarns are knitted together. When the fabric of this type are unraveled the fibers can be separated by placing all the warps in one piles and wefts in other.

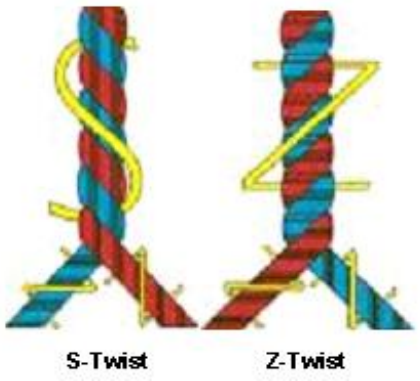
Blends mixture and other combinations produces fabrics with properties that are different from those obtained with only one fibre. Blending is done for several reasons, mainly to produce fabrics with better combination of performance characteristics and to improve the spinning, weaving and finishing efficiency to improve uniformity.

Yarn Types and appearance of a yarn plays a prominent role on the appearance of a fabric. The important feature of yarn which are evaluated to determine its quality are yarn number, strength, twist, appearance and evenness. The strength of yarn is increased with the increase in the twist of the yarn and at the same time the amount of the twist given depends upon the thickness of the yarn or otherwise called as yarn count. As yarn count of yarn increases the fineness increases which tends to increase the amount of twist to be given to a yarn which in turn increase the strength of the yarn.

Twist Direction

The direction of the twist at each stage of manufacture is indicated by the use of letters S or Z in accordance with the following convention:

- A single yarn has S twist if, when it is held in the vertical position, the fibres inclined to the axis of the yarn conform in the direction of the slope to the central position of the letter S.
- Yarn has Z twist if the fibres inclined to the axis of yarn conform in the direction of slope to the central position of letter Z.
- The yarn which are given a relatively lower amount of twist and given a lesser yarn counts make it appear coarser and thus the fabric made of it would be coarser.



The Amount of Twist

In B.S 946:1952, it is stated that the amount of twist in a thread at each stage of manufacture is denoted by a figure giving number of turns of twist per unit length at that stage. The amount of twist also depends upon the types of fabric to be woven:

- Yarns intended for soft surface fabric are given slack twist.
- Yarns intended for smooth surface fabric are given optimum twists.
- Yarns intended for crape fabrics are given maximum amount of twists.

Yarn Count

- Yarn count expresses the thickness of the yarn. The yarn count number indicates the length of yarn in relation to the weight. The yarn count and yarn twist are of a great importance in determining the final appearance of the fabric.
- The yarn which are given a relatively lower amount of twist and given a lesser yarn counts make it appear coarser and thus the fabric made of it would be coarser.

There are different definitions for yarn count. They are;

- Yarn count has a numerical expression, which defines its fineness as said by J.E. Booth.
- Yarn count is the degree of fineness in yarns – Corbman.
- Yarn count has the numerical designation given to it to indicate its size and the relationship of length to weight – Fair child
- The definition of yarn count as given by textile institute is a number indicating the mass per unit length or length per unit mass
- Yarn count may be defined as the thickness of the yarn.

Different Yarn Numbering Systems

There are different systems employed in numbering of the yarn may be broadly classified as **Direct system** and **Indirect system** which depends upon the weight per unit length or unit length per weight

1. **Indirect System:** This is traditional method of yarn count. In this system the yarn number or count is the number of units of length per unit of weight. The different types of indirect numbering system
   a) Cotton English System
   b) Worsted count
2. **Direct System:** In direct yarn count system the yarn number or count is weight of a unit length of yarn. The direct system of yarn numbering consists of:
   a) Denier System
   b) Tex System

Types of Yarns

1. **Simple Yarns:** These yarns are simple in appearance and provide greater amount of strength in fabric for which they are intended.

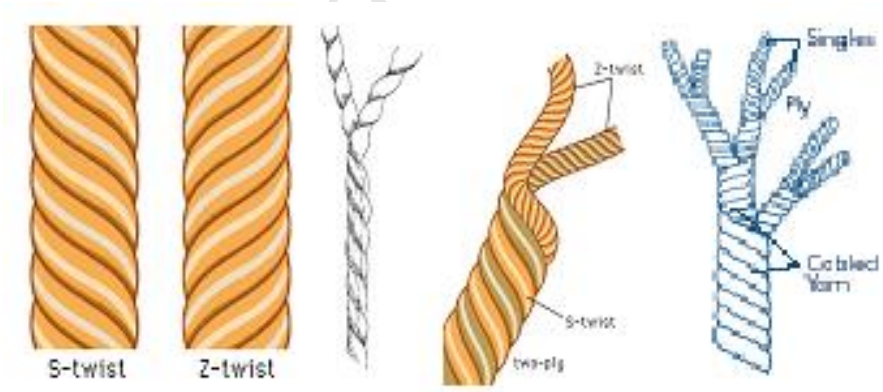
   Simple yarns are of different types as given below:

   a) **Single Yarns:** It is single strands composed of staple fibres held together by required amount of twist. The strength of these yarns depends upon the amount of twist, which is given to the yarns.

   b) **Ply Yarns:** It is composed of two or more single yarns twisted together. Singles are plied together to form the 2-ply, 3-ply and 4-ply yarns.

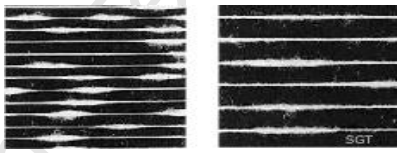
   c) **Cable Yarns:** Two or more ply yarns are twisted to form a cable yarn. It is constructed by twisting the plied yarns around each other successively in opposite direction of preceding direction i.e., S/Z/S or Z/S/Z.

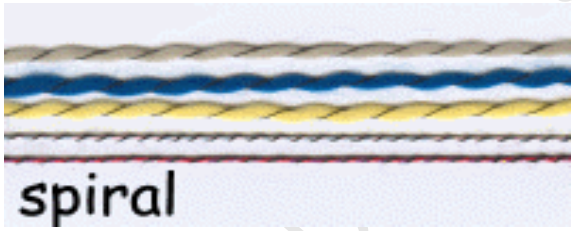
   d) **Double Yarns:** Double yarn consists of 2 or more single strand without twist treated as one in the weaving process.



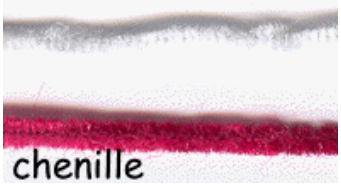
2. **Fancy Yarns:** Fancy yarns have unlike portions that are irregular at regular intervals. It has three basic parts such as foundation or core yarn, the effect or fancy yarn and the binder yarn. Different types of novelty yarns are:

a. **Slub Yarns:** In this yarns, some portions are left untwisted to vary the diameter. These yarns consist of irregularities and varying thickness of soft, untwisted areas at frequent interval throughout the length of the yarn.
b. **Flake Yarns:** It is variation of slub yarns. The slub effect is made by inserting the soft, thick, elongated tufts of fibre into the yarn at regular intervals.
c. **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.





Spiral yarn **Ratine yarn**



Knot Yarn

d. **Ratine Yarns –** This yarn is the variation of spiral yarn. 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 kicks back on itself. This structure of core yarn is effect yarn is held in place with the binder yarn.

e. **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.

f. **Chenille Yarns –** These yarns have soft, fuzzy and lofty surface. The construction of the yarn consist of two yarn plied together which hold short tufts of soft untwisted yarn between the twist along the core length.

3. **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.

- These yarns are more opaque, have improved appearance and texture, and have increased warmth and absorbency.
- There are two different types of textured yarns:

a. **Stretch Yarns:** These yarns are frequently continuous-filament, man-made yarns that are very tightly twisted, heat-set, then untwisted, producing a spiral crimp giving a springy character. The different ways of manufacturing the stretch yarns are:
   i. By mechanical heat setting the thermoplastic filament fibres.
   ii. From elastomeric fibres
   iii. From bicomponent fibres
   iv. From biconstituent fibres

v. By chemically treating the natural fibres

i. **By mechanical heat setting the thermoplastic filament fibres:** Thermoplastic yarns are one which can be put into any shape or form desired by subjecting to a predetermined heat for a specific period of time. There are different methods by which the heat setting treatment can be applied onto the thermoplastic yarns.

- **Coil type – False twist method –** The steps in producing coil type yarns are;

  A yarn is held by nip roller on either end. A high amount of twist is inserted into the yarn in opposite direction on each side of yarn. These are then passed through a heat-setting zone wherein the predetermined heat is applied to the yarns in a coiled condition. The twist in the yarns is removed by a false twist spindle. On emerging from false-twist spindle, the yarn has a built in twist either in S or Z direction.

- **Curl type – Stress curled method –** This is making the stretch yarn based on the method obtaining random curl in paper ribbon by pulling between one's thumb and edge of a dull blade.

  The yarn is first supplied to a two-stage delivery machine which supplies the yarn to the delivery rollers. The yarn from the heat delivery roller, is passed on the blade edge, which curl and then pass to cold delivery roller. From cold delivery roller it is passed to the two-stage delivery mechanism and then twisted onto the spindle.

ii. **From Elastomeric yarn -** Spandex has distinctive property of stretching about 4 to 7 times its relaxed state.

Spandex fibres such as Lycra are produced as core-spun yarns. These yarns have spandex core, it would be as little as 5 to 15 percent of the entire yarn with a layer of any staple fibre. This fibre would be spun around the core. When it is relaxed after spinning, the spandex core returns to its normal length, which pulls the outer layer of spun fibres into a more compact formation. Since the core yarn is encased in a layer of staple fibres, the yarn takes on hand and appearance.

iii. **From Bicomponent Yarns –** It is made of two different types of same polymer extruded simultaneously from the spinneret opening. In processing of yarn, one type of polymer which shrinks more than the other, causes the crimped.

iv. **From Bicomposite Yarns –** It is made of two different types of polymers extruded simultaneously from spinneret opening. The polymer adhere together to form a single filament.

v. **By chemically treating the natural fibres –** This involves treating the cotton with polymeric chemicals giving heat thermoplastic properties.

b. **Bulk Yarn:** 'Bulk yarns' as the name signifies are bulky in nature. These yarns have lower elastic stretch than stretch yarns. The bulk yarns are relatively thick and soft. High bulk yarns have the soft hand of the cashmere. One of the method of producing the bulk yarn is given below:

- **Loop Bulk or Air Jet Yarns –** Loopy yarns have relatively larger number of randomly placed and randomly sized loops along the fibre or filament structure.

  These yarns are generally made of air jet texturizing method. These yarns are made of the continuous filament fibres such as rayon, acetate nylon or polyester.

The process involves the passing of smooth filament yarn across high pressure air jet that causes the individual filaments to loop up and become tangled so that permanently textured surface of randomly situated tiny loops develop along the yarn.

Summary

- There are different types of yarns which can be broadly classified as simple yarns, fancy yarns and texturized yarns.
- Texturized yarns are again classified as stretch yarns and bulk yarns.
- Simple yarns like ply, cabled yarns etc., are used in construction where the strength is of main concern.
- Novelty yarns like flake yarn, spiral yarn etc., are used for decoration purpose.
- The stretch yarns are produced by different methods like heat setting the thermoplastic yarns, by chemically treating the natural fibres, from elastomeric filament etc.
- The bulky yarns have soft and lofty surface and has soft hand of Cashmere.

Self Assessment Question

1. Ply yarns are composed of two or more single yarns twisted together. (True / False)
2. Double yarns are stronger than the ply yarns. (True / False)
3. Cable yarn is an example for fancy yarn. (True / False)
4. Explain various types of twists in the yarn.
5. Explain the simple Yarns with its types in detail.

Unit 16

Weaving

Objectives

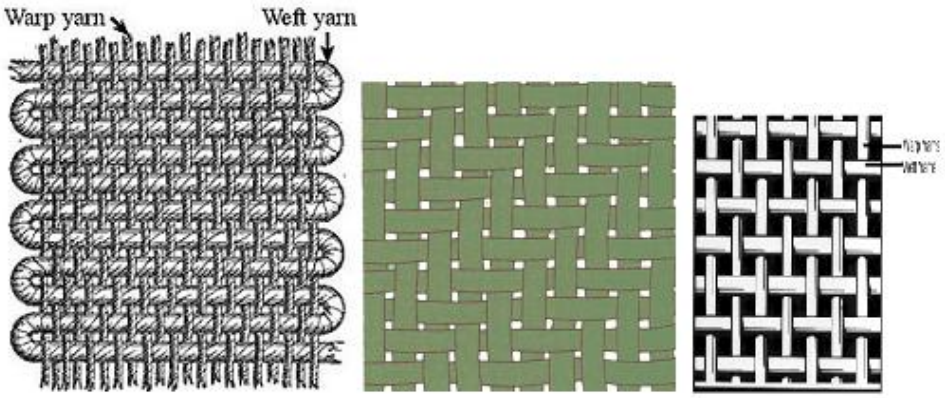
- Understand the Basic terminologies related to weaving
- To understand the process of weaving, structure of looms and fabric
- Describe the different types of weaves

Introduction

Weaving: This is the method of fabric formation by **interlacing** the **warp** and **weft** yarn at right angles to each other.

- The yarns, which **run parallel** to the selvage on the woven fabrics, are called **warp yarns**.
- The yarns, which **run cross wise across** the loom intersecting the warp, are referred as **weft yarns**. In other words, the yarns perpendicular to the selvage are called weft yarns

  There are a number of ways by which the warp and weft yarns could be interlaced, thus producing different designs of the woven fabric.



The Structure formed by interlacing of Warps and Weft is called as **Weaves**.

Terms Commonly Used with Weaving

- **Balanced weave:** A balanced weave has an equal distribution of warp and weft yarns in the fabric surface.
- **Beating up (Battening)**: Beating is the stage of pushing filling yarns firmly in place by means of the reed.
- **Pick:** A single crossing of the filling yarn from one side of the loom to the other is known as a pick.
- **Selvages (Selvedges):** As the shuttle moves back and forth across the width of the shed, it weaves a self edge called the selvage, or selvedge, on each side of the fabric.
- **Shed:** The raising of alternative warp yarns forms an inverted V opening through which the weft yarns are passed. This V opening is called a shed.
- **Shedding:** Shedding is a process of raising specific warp yarns by means of the harness or heddle frame.
- **The pick count:** The number of weft yarns per inch in a woven fabric is referred to as the pick count.

Taking up and letting off small

The stage of weaving where winding the manufactured fabric on the cloth beam and releasing more of the warp from the warp beam takes place

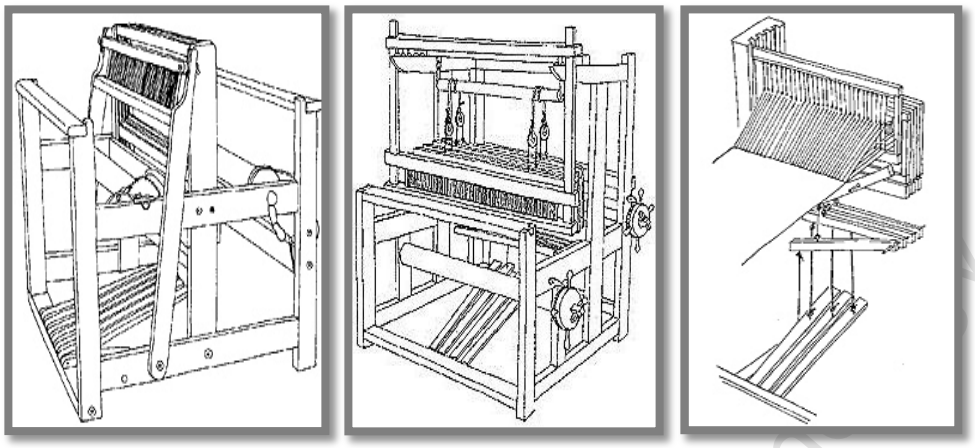
- **Thread count**: Thread count also known as cloth count, is determined by counting the number of warp yarns and filling yarns in a square inch of fabric.

- **Warp-face fabric:** A web in which the warp yarns predominate is called a warp-face fabric.
- **Weft-face fabric:** A web in which the weft yarns dominate the surface of the cloth or completely hide the warp is referred to as weft faced fabric.
- **Warp yarns:** The yarns, which run lengthwise on the loom are called warp yarns. In other words, the yarns, which run parallel to the selvage on the woven fabrics are warp yarns.
- **Weft yarns:** The yarns, which run cross wise across the loom intersecting the warp are referred as weft yarns. In other words, the yarns which are perpendicular to the selvage are called weft yarns.
- **Unbalanced weave:** An unbalanced weave has an unequal distribution of warp and weft yarns, with one or the other predominating.

Loom & Its Parts

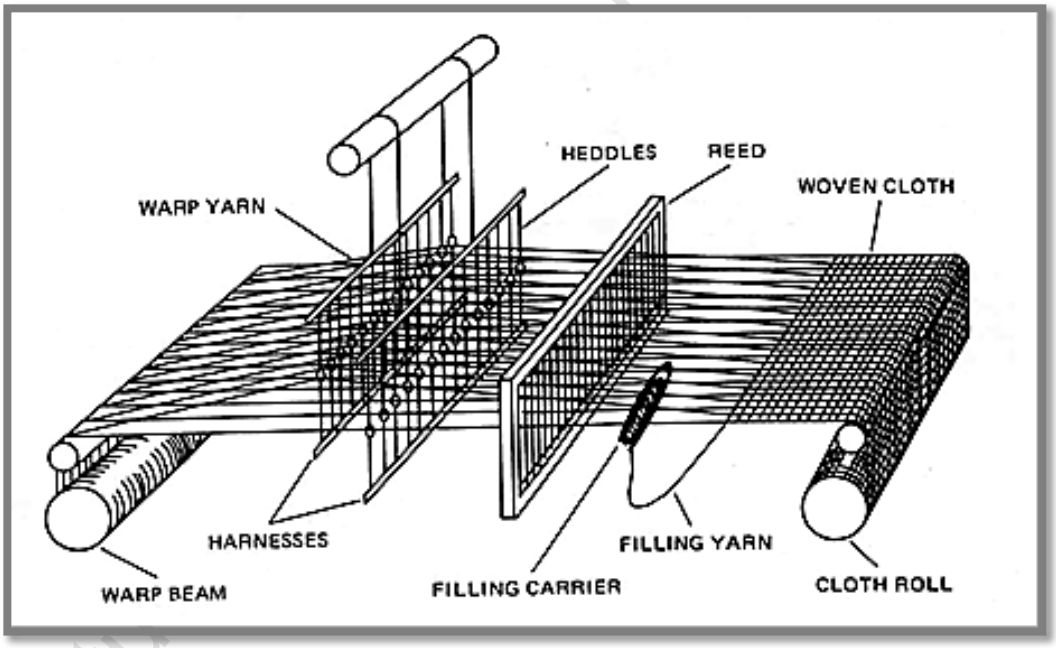
Loom, in simple words could be said as a device used to weave clothes." There are different definitions associated with the loom used for weaving the fabrics. They are;

- Webster defines a loom as "a frame or machine for interweaving yarn or threads into a fabric, the operation being performed by laying lengthwise a series called the warp and weaving in across this other threads called the weft, woof, or filling."
- Another definition, which is quite to the point: "A loom is the framework across which threads are stretched for the weaving of cloth."



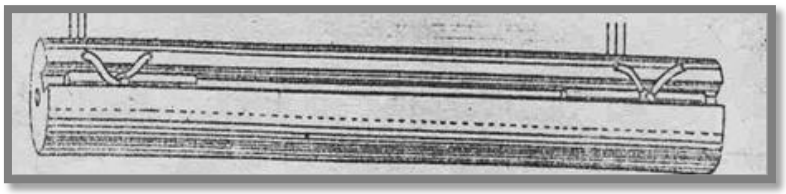
Different types of Looms

Loom & Its Parts



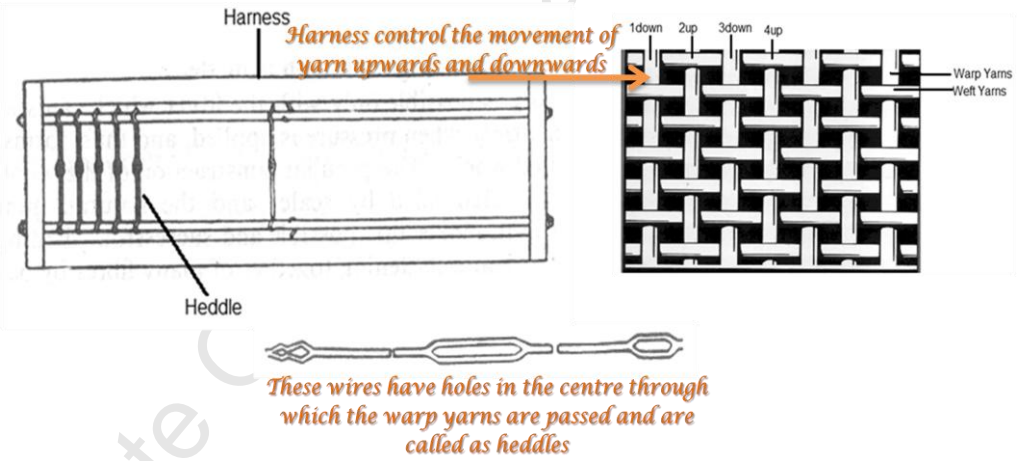
1. **Warp & the cloth rollers:** Wrap roller supply the warp at the back of the loom. The cloth rollers also called breast beams consist of the manufactured cloth. Back beam and the cloth beam are built width

wise of the loom and provide a firm, even foundation and tension of the warp threads stretched across them.



2. **Harness:** The harness is like a wooden frame work, which contains a number of wires.

   - Harness is used to pass the warp yarns. It is a frame which holds the heddles.
   - Harness helps in lifting the warp yarns up and down to facilitate the movement of the weft yarns in forming the interlaced pattern.

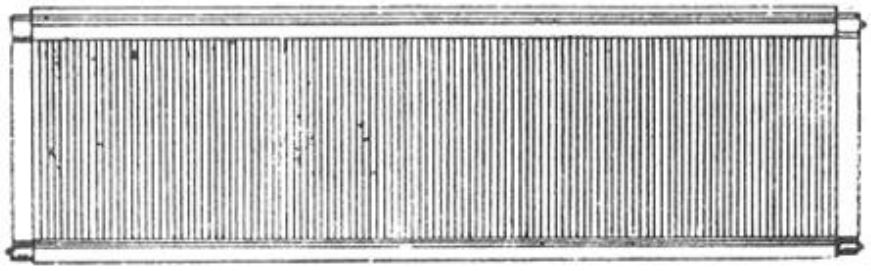


3. **Shuttle:** Warp yarns in loom should be interlaced by the weft yarn in the width wise direction. The device, which holds the weft yarns and carries it across the loom for interlacing is known as shuttle. The shuttle passes backwards and forwards across the loom to form the

woven fabric. The shuttle consists of a bobbin which holds the weft yarns. The weft yarns are wound on these bobbins and are placed inside the shuttle.

shuttle

4. **Reed**: Reed is a frame which is located directly in the front of the harness. This is used to push the interlaced pattern forward each time the shuttle in between the warp yarns, and presses back the filling thread in position. It is similar to the comb we use in combing our hair. The narrow spaces between the reed is known as dent.



Different Operations on Loom

Stages in Preparation of Yarn

1. **Winding:** The objectives of the winding process are to inspect the yarns as obtained from spinning, inspecting the thick and thin spots of the yarn and to wind it on the packages.

2. **Warping:** The yarns are removed from winding packages and the desired number of yarns is arranged on the cylinders called beams. Care is taken to arrange the yarns parallel and under uniform tension.
3. **Slashing or Warp Sizing**: This process is applicable for warp yarns to withstand the rigor in the weaving process. The main objective is to increase the strength of the warp yarns and lubricate the yarn by treatment of starch.

Drawing-in and Tying-in

The slashed yarns are passed through the harness and reed; the process of which is known as drawing in. When mass of warp yarns are used in producing lengths of fabrics, the yarns from the new beam are tied to the corresponding end of yarns of the old beam thus replacing the same

1. **Primary Motions:** Every loom requires three primary motions to produce woven fabric:

   a) **Shedding**: Shedding is the process by which the harness frames are moved up and down in order to separate the warp sheet into two layers. This process of drawing each warp yarn through the eye of the heddle eye is known as drawing in. There are different types of shedding, which such as cam system of shedding, dobby system of shedding and jacquard system of shedding.

   b) **Picking or Filling Insertion:** This is the means by which the weft is projected through the shed. Looms using a filing carrier other than a shuttle are grouped under the general heading of shuttleless looms The common filling insertion methods in use

today include the conventional shuttle, rapiers, gripper projectiles, air jets and water jets, the last four being shuttleless systems.

c) **Beating-up**: Beating-up is where the reed pushes the weft into the fell of the cloth to form fabric. Beating-up is accomplished by the use of the wire grate called a reed. At the beginning of the weaving cycle, the reed is moved backwards to allow for filling insertion. After the filling is inserted, the reed moves forward and the wires engage the filling yarns driving it into the fell of the cloth, the position in the warp shed where each pick is beaten

2. **Secondary Motions:** There are two secondary motions in weaving that assist in continuous weaving.

   a) **Let-off**: This process delivers the warp yarns from the warp beam to the weaving area of the loom at the constant tension.
   b) **Take-up**: The cloth take-up motion withdraws cloth from the fell and then stores it at the front of the loom.

Weaves

A **weave i**s formed on a loom by interlacing of the warp yarns with the weft yarns". It denotes the fabric **structure** formed by **interlacing** of **warp** yarns and **weft** yarns in a **woven fabric**.

- The manner in which the warp yarns are interlaced by the filling yarns determines the pattern of the weave.
- In a simple weave construction, the filling yarns go under one warp yarn and over the next as shown in this figure.
- The weaves could be broadly classified as:

a. **Simple weaves:** These include weaves such as plain, rib, twill, satin and basket weave. These are also called fundamental weaves.
b. **Decorative weaves**: These weaves include pile, double cloth, gauze, dobby, and Jacquard weave.
c. **Surface Figured Weaves**: These have any surface embellishment using extra warp or weft figuring- swivel, lappet, Spot, Leno, Pile, Double Cloth,

Plain Weave

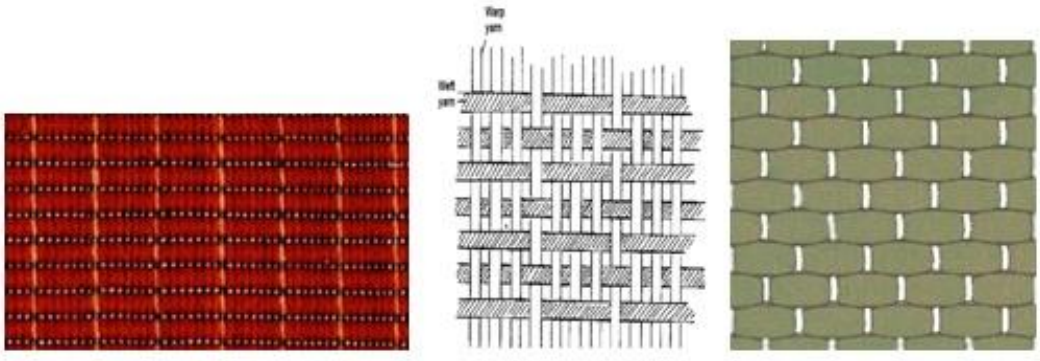
Plain weave consists of each filling yarn going alternately under and over the warp yarns across the width of the fabric. It is sometimes referred to as **tabby**, **homespun**, or **taffeta weave**. It requires only two harnesses for the weaving process. On its return, the yarn alternates the pattern of interlacing.

The plain woven fabrics are used for different purposes as listed below:

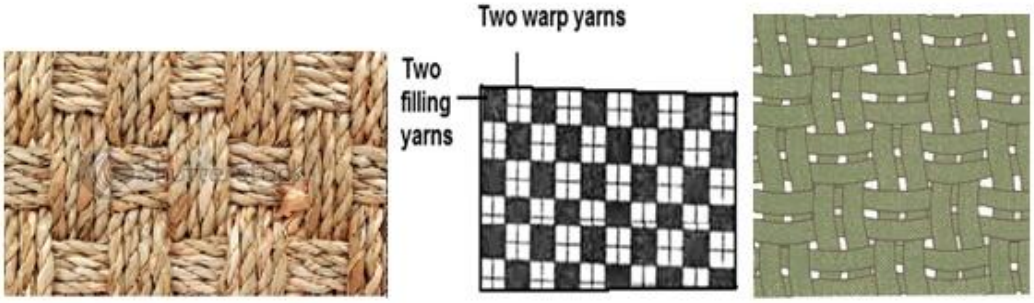
- They are used extensively for cotton fabrics and for fabrics that are to be decorated with printed designs
- They are more serviceable of all weaves, as fabrics with these weaves are easy to maintain and care.
- They are used for such purposes as blouses, dresses, shirts, and for such home furnishings as curtains.

There are two variations of Plain weaves

a. **Basket Weave**: Basket weave is a variation of plain weave construction where double yarns are used to produce the design. As the weave resembles the pattern of the basket, it is called basket weave. Basket weave fabrics are used for suiting, outerwear and home furnishings such as drapery.

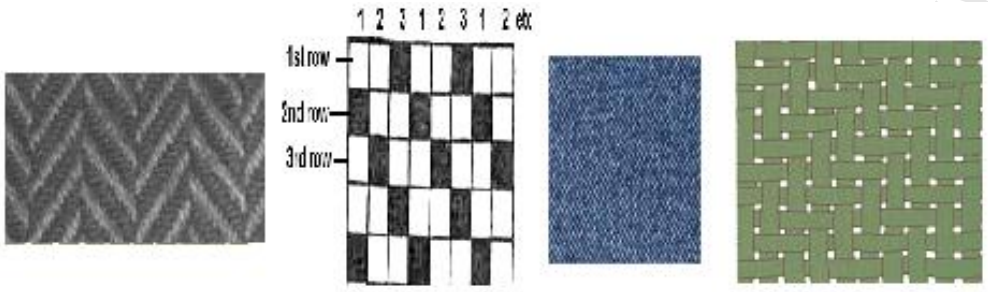


b. **Ribbed Weave** – A raised effect called a ribbed effect is produced in the warp or in the filling by alternating fine yarns with coarse yarns, or single yarns with doubled yarns. The **ribbed fabrics** are used for blouses, curtains, dresses and a variety of apparel depending on their construction.



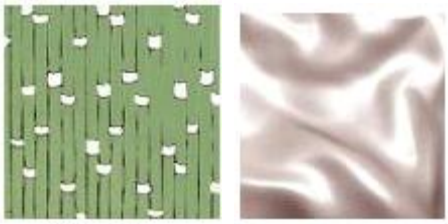
Twill Weave

You can easily identify a twill woven fabric through the **diagonal lines** which is the characteristic feature of the twill weaves. The method of interlacing of the yarns follows the below given pattern



Satin Weave

A satin fabric is distinguished from fabrics by its **lustrous** or **silky appearance**. Satin weaves generally use from five to as many as twelve harnesses in the construction of the fabrics. But they have greater drapability.



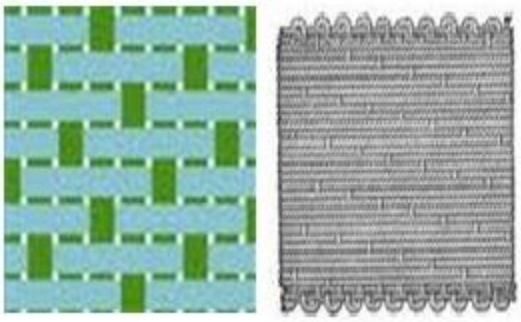
Satin Weave Satin fabric

Reflection of light on the floats gives satin fabric its primary characteristic of luster, which appears in the direction of the warp. The **long floats** found in the satin weave might be considered a disadvantage because they represent a **minimum of interlacing**, and therefore a potential weakness in the fabric. In its construction, the warp yarns are made to pass over four filling yarns and under one. This type

of construction is called a five shaft construction, since the warp interlaces every fifth filling yarn.

Sateen Weave

A **weft faced satin** weave is called **sateen weave**. The distinction feature is that the weft or filling yarns lay on the surface of the fabric. The floats in this construction are made of the filling yarns and the luster appears in the filling direction.



Sateen Weave

Sateen fabric

Novelty Weaves/Decorative Weaves

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

Dobby Weave

The dobby weave is created on a plain loom by means of a mechanical attachment, called a dobby or cam, which raises or lowers as many as twenty-four to forty harnesses containing the series of warp yarns that form the pattern. The designs made by dobby weaves are simple, limited in size, and usually geometric in form & generally found on shirtings and tie fabrics. The most familiar type of dobby weave is

bird's eye, the small diamond pattern made with short floats that give the impression of an eye.


Jacquard Weave

Fabrics with elaborate designs are woven using the Jacquard loom. The Jacquard mechanism has the ability to control every warp yarn instead of a series as in regular harness looms. The machine is very big and very expensive. The pattern for the Jacquard loom is transferred to a series of perforated cards, one for each filling pick in the pattern. The card is punched so as to permit the needles on the machine to be raised to pass through the card. A special mechanism called Jacquard mechanism is used which controls thousands of heddles,



which lift one or more warp yarns independently of others without the use of harnesses.

This type of weave is used when large sized figures are desirable. The jacquard woven fabrics are used for a variety of apparels such as jackets and evening gowns and for such home furnishings as table cloths, drapery, and upholstery.

Surface Figure Weaves

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

Pile Fabric

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

Pile fabric-Cut Pile

Toweling Material- Uncut pile

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

Spot Weave

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

Double – Cloth Weave

They are composed of five sets of yarns. Filling and warp yarns are both two sets, and one set is responsible to join the two layers by interlacing between them. Fabrics have two layers and they may be identical.

The type of weave used for both the fabrics range from plain weave on each side or plain weave on one side and a twill weave on the other side. The two layers of the fabrics being woven are combined by means of a separate set of yarns called tying yarns or by interlacing some of the warp and weft yarns. Double cloth fabrics are by their very nature heavier weight materials. Depending upon their composition and

construction, they can be used for robes, blankets, coat materials, and a variety of upholstery fabrics.

Double Cloth

Swivel Weave

Swivel Weave

This method of weaving is used to produce fabrics with decorative effects such as dots, circles etc., in the fabric construction. The fabric looks like an embroidered one.

The weaving of the design requires an extra filling yarn and additional small shuttles or insertion devices. While the fabric is being constructed, the row of small shuttles drops across the width of the loom, and each interweaves its separate design with a circular motion on a small area of the warp. A long thread is carried on the under surface of the fabric from one design to the next. Different colours may be used in each of the designs because each figure is woven with its own specific bobbin. The decoration produced by the swivel weave is not considered durable, because the swivel yarns are cut when the fabric is completed and cannot be securely fastened. The cut ends roughen the under surface of the fabric and may pull out if it is handled roughly, as may happen in laundering.

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

Summary

- Loom also called as weaving machine, is the device used in weaving.
- The different parts of the loom, which assist in the process of weaving include the reed, harness, heddle, shuttle and the beams.
- The yarns as obtained from the spinning process are put through different process such as winding, warping slashing etc., to make them suitable to withstand the pressure of weaving process.
- The process of weaving on the loom could be put into three motions such as primary, secondary and ancillary motions.
- There are three primary motions needed to produce a woven fabric: shedding, picking and beating-up.
- Let-off and take-up are secondary motions for weaving.
- Ancillary motions used on modern weaving machines are weft stop motions, warp stop motions, warp protectors
- Weaving is a process of fabric formation wherein the warp yarns (lengthwise) on the loom are interlaced by the weft yarns, passed across the loom with the aid of shuttle.
- The selvages are produced by the shuttle that moves back and forth across the width of the shed weaving a self edge called selvage.

- The weaves are generally classified as basic weaves and fancy weaves.
- There are different variations of the plain weave namely basket weave and ribbed weave.
- The twill weave is characterized by the diagonal lines running on the face of the fabric, which may be due to the warp or weft yarn.
- The ribbed weave has the ribbed surface on the face of the fabric.
- The satin weave is characterized by the floats on the surface of the fabric.
- The different types of fancy weaves include the swivel, lappet, double cloth and pile weave constructions

Self Assessment Questions

1. _____ on the loom has heddles.
2. The narrow spaces on the reed are called _____.
3. Explain the different parts of the loom.
4. The manner in which warp yarn interlaces with weft yarn the resultant structure is called as _____.

Unit 17

Non-Woven Fabrics

Objectives:

- Describe the meaning of nonwoven fabrics
- Explain the method of making nonwoven fabrics

Introduction

The textile fibres are converted to yarns, which are processed through different methods of fabric formation. The different methods of a fabric manufacture could be broadly classified as follows:

- **Conventional methods**
- **Non-conventional methods**

Conventional methods

Conventional methods means the common methods of manufacturing the fabrics include weaving, knitting, braiding, lace and felt making.

Non-conventional methods

This involves any other method then the usual weaving and mainly non-wovens.

Non Woven Fabrics

Non-woven fabrics are obtained by bonding or interlocking of the fibres. Non-woven are defined by the American Society for Testing and Materials (ASTM) as fabrics constructed of fibers held together “by bonding or the interlocking of fibers or both, accomplished by mechanical, chemical, thermal, or solvent means and the combinations

thereof". Another definition for nonwoven is that they are sheets or web structures bonded together by entangling fiber or filaments (and by perforating films) mechanically, thermally or chemically. They are not made by weaving or knitting and do not require converting the fibers to yarn

a) **Braiding**: It is a method of forming a narrow fabric, which is generally used for decorative purpose. In this process the strands of yarns are plaited together by crisscrossing them diagonally and lengthwise.
b) **Felting:** It is the massing and flattening or matting together (Interlocking) of many fibres by application of heat, pressure, steam or chemicals.

Felting is possible only with the fibres moisture and stick to one another firmly when pressure is applied and thus, forming the fabric.

Types of felts

There are two basic types of felt such as:

1. **Wool Felt:** The characteristics of the wool felt are given below:

   a. In most satisfactory grades of wool felt, at least one-half of the fiber composes wool, as the wool fiber surpasses all others in the physical quality of cohesiveness that makes this type of fabric construction possible.
   b. **Short**: Staple wool fiber, or noils, is used for felt; but the finer the grade of staple used, the stronger the felt.

c. **Some lower** priced grades of felt are also made chiefly from wool. Other felts are made by combining cotton, kapok, or rayon with woo

These felts may be distinguished from fur felt by the dull appearance, harder feel, and comparatively rough texture. Acetate, nylon, and acrylic fibers are also blended with wool. They improve the fabric's drapability. These blends also reduce the finished felt's tendency to shrink.

2. **Fur felt:** The characteristics of the fur felt are:

The short fibers of some furbearing animals like rabbit, musk rat are important in the manufacture of felt for hats. Fur felt is usually made from a mixture of fibers, and the better grade contains beaver. Fur contributes softness, smoothness resilience, and water repellency.

Properties of felt

The properties of felt are given below:

- Felt has no warp, filling or selvage, which simplifies its use in garment construction. Because it does not have a system of threads, it will not fray or ravel.
- On the other hand, its structure makes sewing difficult; hidden mending of tears and holes is impossible.
- As it is made without twisted yarns and without interlacing, felt has little tensile strength and, when it retards, it does so in a ragged, fuzzy manner.
- It has practically no elasticity or draping quality.

- However, felt can be cut or blocked into any shape. It has good resilience and will retain its shape unless subjected to undue tension.
- Wool felt has high thermal insulating properties, and it provides warmth.
- It absorbs sound and shock, and is more impervious to water than untreated woven or knitted fabrics. Since wool felt shrinks, it should
- Be laundered carefully.

Uses of felt

The uses of felt are listed below:

- The properties of felt affect its application. Lack of tensile strength and drapability limit the use of felt as a general clothing fabric, but it is especially adaptable for blocking into hats.
- Felt is also suitable for such articles as slippers, shoe insoles, earmuffs, pennants and table padding. Because of its insulative and noise absorptive properties, felt has various industrial uses

Bonded Fabrics

There are several methods of bonding the fibers in the web to form fabrics. The broad classification involves the following:

a. **Chemical bonding** with includes methods such as resin bonding, gelatin bonding etc.
b. **Mechanical bonding** such as stitch through bonding.
c. **Thermal bonding**

This method of bonding is used for thermoplastic fiber webs, which are fused with the help of thermoplastic threads. Here, layers of thermoplastic fibres are stitched using thermoplastic thread. The

application of heat causes the thread to soften, shrink, and bond to the web structure, making it more compact. These are some of the methods used to bond the webs of fibres, thus forming non-woven fabrics such as thermoplastic bonding. Other bonding methods are Resin Bonding, Gelatin Bonding, Thermoplastic Bonding, Spun Radiation Bonding and Stitch Bonding.

Laminated Fabrics

Laminated are fabrics in which two layers of fabrics are combined into one with adhesive or foam .This is a process of producing laminated fabrics.

Laminating is the permanent jointing of two or more prefabricated fabrics. Unless one or other of the fabrics develops adhesive properties in certain conditions, an additional medium is necessary to secure bonding.

- **Wet laminating**: Adhesives used in the wet process are dissolved or dispersed in a suitable solvent. The simplest form of wet laminating consists of applying the adhesive to one of the lengths of material that is to be joined, and to put the second length on it with the required amount of pressure. Then drying, hardening or condensing the material that has been joined together is carried out. The solvents can be macromolecular natural or synthetic substances and water.
- **Dry laminating**: All Kinds of thermoplastics are used for dry laminating. These include powders, plastisols, or melt adhesives, and are applied to the substrates that are to be joined together using suitable machinery. Dry laminated non-woven fabrics have a soft feel.

Pile Weave

This type of weave is considered as fancy weave as well as functional weave. It has got loops called piles on the surface of the fabric which could be cut or uncut making it a cut pile fabrics and uncut pile fabrics respectively.

Pile weave construction is especially desirable when softness, warmth and absorbency are desired. The weave construction used for pile weave is a twill or plain weave construction.

The simple description of the pile weave construction is as follows:

- In the weaving process an extra set of yarn is woven where the extra set is woven as floats.
- After weaving, a machine is used to raise the float. These form the uncut pile construction.
- If the piles are left as loops on the ground construction, then the weave is called uncut pile construction.
- If the piles are cut using the blades at the centre, then the weave is called cut pile construction.

Lace

Lace is the most common trimming used in decorating the garment. The techniques of lace making involve **looping**, **knotting**,

braiding, **twisting**, or **stitching** thread into decorative, open – work patterns.

Types of Lace

Handmade laces have always been highly prized as trimming for apparel and as decorative pieces for the home. The techniques of lace making involve looping, knotting, braiding, twisting, or stitching thread into decorative, open – work patterns.

- The fabric made as lace is a pattern with open holes in the work, which could be made by machine or hand.

The general handmade laces include the following:

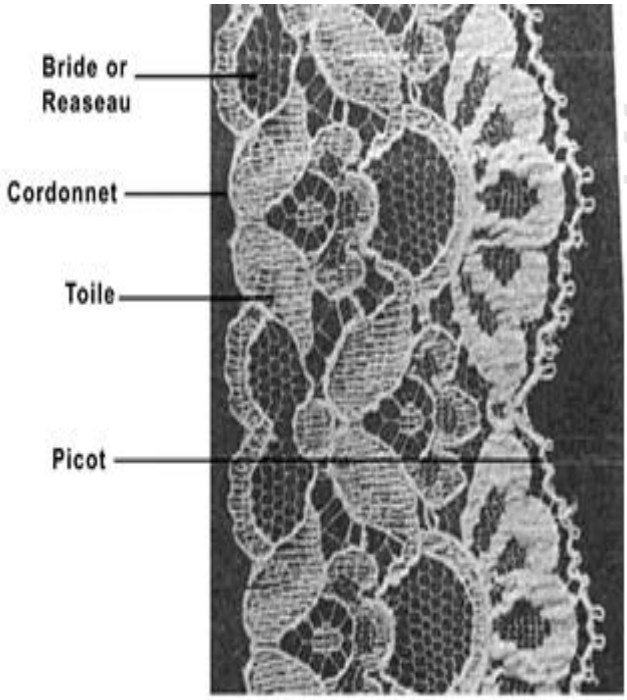
a. Bobbin (Pillow) Lace
b. Crocheted Lace
c. Darned Lace
d. Needle point Lace
e. Tatting Lace
f. Macramé Lace

Parts of Lace

Laces are constructed of different parts, each having a particular designation.

- **Bride, or reseau**, is the fine yarn that forms the mesh, which provides the sheer ground (background) between the prominent parts of the pattern.
- **Cordonnet** is the heavy yarn that outlines the pattern.

- **Picot** is a decorative loop used both in the pattern and on the edge of the lace.
- **Toile** represents the predominate parts of the pattern made by braiding, knotting, looping, or twisting the yarn.



Uses of Lace

- The fabric can be produced in widths of over one yard (1 m) that are devoid of scallops. The fabric comes in bolt form and is used for blouses, dresses, and evenings wear.
- Flouncing comes in 12” to 36” widths and is used for ruffles.
- Gallon has scalloped edges on top and bottom & comes in widths of 18” and is used either as a banded appliqué on a fabric or as an insertion between two pieces of fabric.

- Edging comes in widths of 18" or less and has a straight top edge and a scalloped bottom. It is used to trim such garments as dresses, blouses and lingerie.
- Medallion is a single-lace design that is used as an appliqué on a ground fabric for dresses, blouses, lingerie, and napkins.

Quality & Care of Lace

- If lace is made by hand, it is considered better than machine – made.
- Lace should either be laundered by hand or dry cleaned, depending upon its nature.
- If it is to be laundered, lace should be either washed by hand squeezing suds through it without rubbing or by putting it into a mesh or cloth bag and machine washing at a gentle cycle.
- Ironing or pressing should be done carefully by placing a cloth over the lace to avoid tearing.

Summary

Let us summon the important points discussed with reference to nonwoven materials. Nonwoven are defined as fabrics constructed of fibers held together "by bonding or the interlocking of fibers or both, accomplished by mechanical, chemical, thermal, or solvent means and the combinations thereof". The sequence in the manufacture of these fabrics involve preparing the fibres called web formation, laying the fibers for forming webs and bonding the webs to form the fabric structure. The fibers obtained are put through cleaning and blending before they are used for nonwoven fabrics. The fibers thus formed are converted to layers of web through the process such as parallel-laid web, random laid web etc. The layers of web are then bonded by

methods such as resin bonding, needle-punched, spun laced bonding etc. The nonwoven fabrics in apparel construction are used as interlinings and interfacings. They are mainly used for surgical and industrial purposes.

Self Assessment Questions

1) Explain Non-woven method of fabric construction
2) Explain the following fabric structures
   - Lace
   - Pile
3) Explain the properties of felt fabrics

Unit 18

Knitting

Objectives:

After studying this unit, you should be able to:

- Differentiate between weaving and knitting
- Describe the needles used for knitting fabrics
- Explain the warp knits and weft knits.

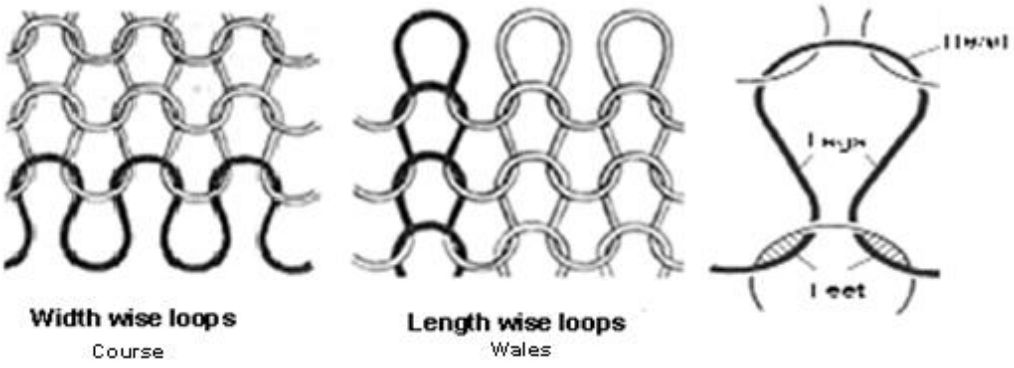
Introduction

Knitting is the second most frequently used method of fabric construction after weaving. Knitted fabrics may be constructed with a single yarn that is formed into interlocking loops by the use of hooked needles. The growth in consumer demand for wrinkle–resist, stretchable, snug–fitting fabrics, particularly in the greatly expanding areas of sport wear and other causal wearing apparel has made knitted fabrics more popular for different fashion products. Today, the usage of knitted fabrics ranges from hosiery, underwear, sweaters, slacks, suits, and coats, to rugs and other home furnishings. When the interlocking loops run lengthwise, each row is called a wale. When the loops run across the fabric, each row is called course.

Basic Structure of Knits

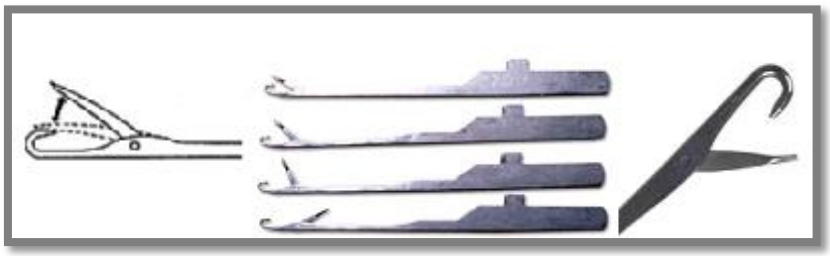
- With reference to knitting, you need to understand two terms – yarn loop and knitted loop.
- In knitting each stitch is made by the knitted loop coming from the yarn loop. Essentially, the loop made on the needle is interloped with the already formed loop.

- Each stitch - a knitted loop and yarn loop consist of the following parts:
- Top arc (head),
- Two legs stitch that is bound at the end and
- Two bottom half-arcs (feet), at upper and lower ends, i.e. at the head and at the feet.
- The first loops (yarn loops) are bound only at the head with loosely hanging feet.
- The knitted loops are bound only at the feet to the heads of the previous stitches.
- At the place where the legs transform into feet, there are two points of contact with the previous stitch. These are defined as the binding points.

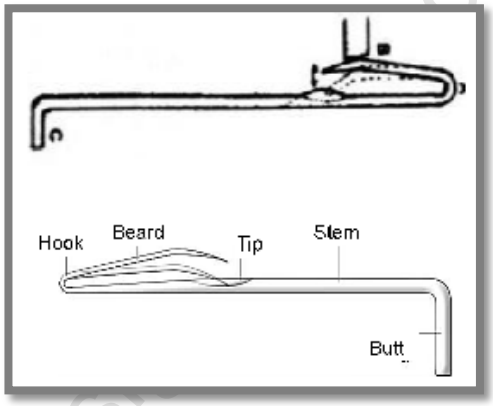


Types of knitting Needles

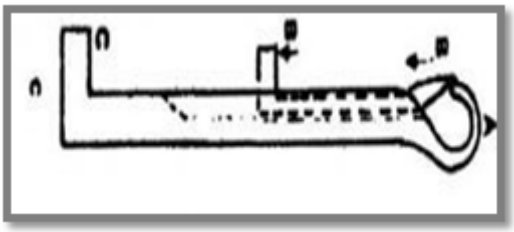
1. **Latch Needle**: It has a latch or swinging finger that closes onto the hook of the needle as it pulls the yarn through loop to form a new loop.

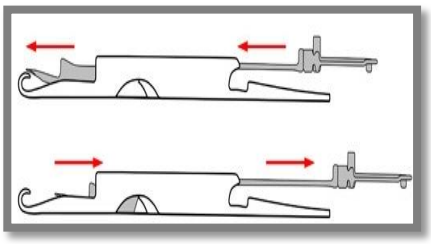


2. **Spring-beard Needle** – A spring – beard needle has a fine, sparingly hood slightly resembling a beard. This type of hook must be used with a sinker to hold the fabric down and a presser to close the hook as it forms the loop.



3. **Compound Needle** – A compound needle is composed of a hook and a sliding closing element.





The knitted fabric can be divided into two types based on its construction as follows:

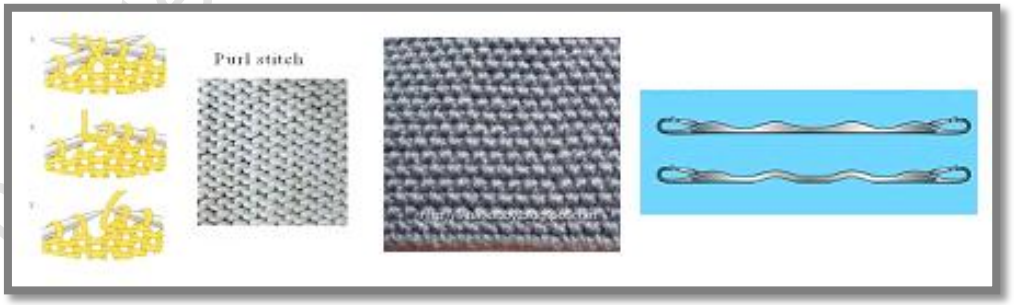
1. **Weft Knits**
2. **Warp Knits**

1. **Weft Knits:** This is formed when one continues yarn forms courses across the fabric. There are three fundamental stitches in weft knitting

   a) **Plain Stitch**: The plain knit is made by needles intermeshing loops drawn to one side of the fabric. It can be produced in flat – knit or in tubular form otherwise called circular form.

   Loops form distinctive vertical herringbone like ribs or wales on the right side of the fabric. On the reverse side the courses can be readily seen as interlocking rows of opposed half circles.

   b) **Purl Stitch:** This construction is also referred to as the links and links stitch. It is made on flat bed and circular machines by needles using hooks on both ends to alternately draw loops to the front of the fabric in one course and to the back in the next course. **A purl stitch** has crosswise stretch and excellent lengthwise stretch and hence, it is widely used in infant and children's wear.



c) **Rib Stitch**: Rib-knit fabrics have alternating length wise rows of plain and purl stitches constructed so that the face and back of the fabric appear alike.

2. **Warp Knitting:** The needles produce parallel rows of loops simultaneously that are interlocked in a zigzag pattern.

- The stitches on the face of the fabric appear vertically, but at a slight angle, and the stitches on the back appear horizontally as flats at a slight angle.
- These flats called laps, or under laps, are distinguishing identification of warp knits.
- There are seven types of warp knitting, which are as follows:
  a. **Tricot**
  b. **Milanese**
  c. **Simplex**
  d. **Raschel**
  e. **Kitten Raschel**
  f. **Crochet**
  g. **Weft – insertion**

  a. **Tricot Knit**: The machine has one or more warp beams mounted above it. Each set of yarns from a warp beam is fed to a row of needles arranged across the width of the machine

and is controlled by yarn guides set in a guide bar that is also laid across the machine.

Typical uses of tricot fabrics are lingerie, loungewear, sleepwear, blouses, shirts, dresses, slacks, uniforms for nurses, bonded fabric material, outerwear, and automobile upholstery.

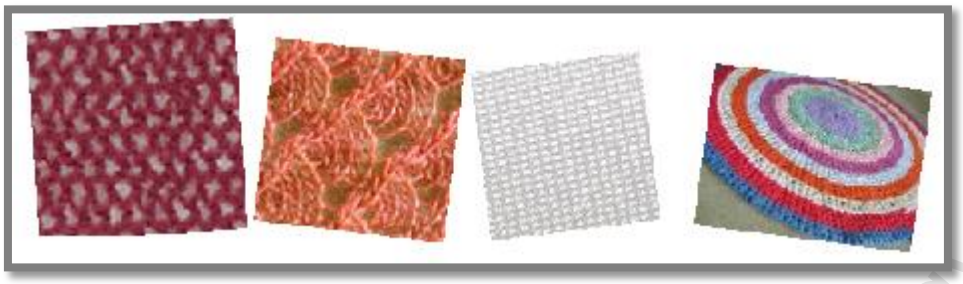
b. **Milanese Knit:** It can be identified by the fine rib on the face and a diagonal pattern on the back. Milanese is knitted on the flat bed machine with spring – beard needles and on the circular machine with latch needles.

c. **Simplex Knit** – Simplex fabrics are produced with spring – beard needles on a machine that is essentially two tricot machines arranged back to back. They are used for such purposes as gloves, handbags, and sportswear and slip covers.

d. **Rasche**l: Raschel constructions are made with heavy yarns and usually have an intricate, lacelike pattern. The raschel knit ranks in importance of production with tricot, but it surpasses it in variety of products, which range from veiling and laces to power nets for foundation garments to such pile fabrics as carpets.

e. **Ketten Raschel:** This knit is also called the chain raschel. The machine can be equipped to produce raised pattern effects in one or more colors by a shell stitch construction.

f. **Crochet**: This basic stitch is used in hand – crochet work employing a pillar chain. Using either latch or beard, needles, this construction is used in a wide variety of fabrics ranging from nets and laces to bedspreads and carpets.



Weaving	Knitting
• Weaving is formed by two sets of parallel yarns interconnected by interlacing them at right angles • The term, 'interlacing' is used • Two sets of yarns are used in the construction, which are interlaced at right angles • The vertical yarns are termed as warp and the horizontal yarns as weft yarns • Woven fabrics are constructed by the interlacing of two or more sets of yarns, which do not allow the fabric to stretch to any marked degree • The fabrics formed are firm, smooth, stable and are stiff	• Knitting is formed loops which are interconnected in order to produce a textile structure • The term, 'inter-looping' is used • A single or one set of yarn is used which is interloped in the construction of the fabric • A horizontal set of yarns could be inter looped to produce a weft knitted fabric, and a vertical set of yarns could be used to produce a warp knitted fabric • The advantage of stretchability in knitted fabrics is an important consideration where fit and comfort are concerned – they fit the figure but do not bind it • The fabrics are wrinkle resistant, stretchable and fit to the body

Summary

We have learnt the different methods of producing the knitted fabrics in this unit. We have started with the definition of knitting, which is a process of constructing the fabric by interlocking the loops of the single yarn. Knitted fabrics give warmth, elasticity and are very porous. There are different types of needles used for machine knitting which may be listed as latch needle, spring beard needle and compound needle. The two major types of knitting machines used may be listed as flat bed machine and circular bed machine. There are two different varieties of stitches produced such as warp knits and the weft knits. Warp knitting differs from weft knitting, basically, in that warp knitting has each needle looping its own thread; whereas in the weft knitting a single thread is used which resembles the hand knitting. Three basic weft knitted stitches include plain stitch, purl and rib stitches. Similarly, there are different warp knitted stitches such as the tricot, milanese, simplex etc.

Self Assessments Question

1. Knitted fabrics are formed by interloping of the yarns. (True / False).
2. _____ of the knitted fabric corresponds to the warp of the woven fabric.
3. The top arc of the knitted stitch is called _____.
4. List the different types of weft knits.
5. Explain the different types of needles used for knitting.
6. Discuss the difference between knitting and weaving

Glossary

A

Abrasion Resistance: The degree by which a fabric is able to withstand loss of appearance through surface wear, rubbing, chafing, and other frictional actions.

Absorbency: The ability of a fabric to take in moisture. Absorbency is a very important property, which affects many other characteristics such as skin comfort, static build-up, shrinkage, stain removal, water repellency, and wrinkle recovery.

Acetate: A manufactured fiber formed by a compound of cellulose, refined from cotton linters and/or the wood pulp of the mulberry trees. This material is then combined with acedic acid and is extruded through a spinneret and then hardened.

Acetylation: The Process of Introducing an Ethanoyl (acetyl) Radical into an Organic Molecule.

Acrylic: A manufactured fiber derived from polyacrylonitrile. Its major properties include a soft, wool-like hand, machine washable and dryable, excellent color retention. Solution-dyed versions have excellent resistance to sunlight and chlorine degradation.

Ahimsa silk: An alternative, non-harmful method of producing silk. Silk is woven by making use of empty cocoons rather than harvesting live moth pupae. Cultivated on forest trees, the silk is spun after the silkworm metamorphoses into a moth and flies away leaving its cocoon.

This type of silk derives its name from the Hindu, Buddhist and Jain doctrine of peace and non-violence.

B

Bast Fibre: Fibre Obtained From The Stems Of Various Plants.

Blend: A blend is a fabric or yarn made up of more than one type of fiber

Bleaching Agent: A chemical reagent capable of destroying partly or completely the natural coloring matter of textile fibres, yarns and fabrics, and leaving them white or considerably lighter in colour. Examples are oxidizing and reducing agents. Amongst the former, hydrogen peroxide is widely used.

Braid: To braids is to interweave or twine three or more separate strands of one or more materials in a diagonally overlapping pattern.

Bonded: A Fabric Composed of 2 or More Layers Joined Together With an Adhesive, resin, Foam, Or Fusible Membrane.

Brocade: A heavy jacquard-type fabric with an all-over raised pattern or floral design. Appropriate for upholstery, draperies, handbags and eveningwear.

Burlap: A loosely constructed, heavy weight, plain weave fabric. It has a rough hand. Appropriate for draperies and decorative items.

C

Cambric: A fine thin white linen fabric.

Canvas: A strong, durable, closely woven cotton fabric.

Cheesecloth: A lightweight, sheer, plain-woven fabric with a very soft texture. It may be natural colored, bleached, or dyed. It usually has a very low count. If dyed, it may be called bunting and could be used for flags or banners.

Chiffon: Lightweight, extremely sheer and airy fabric, containing highly twisted fibers. Suitable for full pants, loose tops or dresses.

Crimp: The waviness or curvature of a fiber or yarn. Can be found naturally, as with wool, or can be mechanically produced.

Cotton: A white vegetable fiber grown in warmer climates in many parts of the world has been used to produce many types of fabric for hundreds of years. Cotton fabric feels good against the skin regardless of the temperature or the humidity and is therefore in great demand by the consumer.

Crepe: Used to describe all kinds of fabrics--wool, cotton, silk, rayon, synthetics and blends-that have a crinkle, crimped or grained surface.

Combed Yarn: The process following carding, combing straightens fibers into parallel strands and removed any remaining impurities or short pieces, in order to further soften cotton yarns.

D

Dyes: Dye is used to color fabric. There are two main types natural and synthetic the process is called dyeing.

Denim: A twill weave cotton fabric made with different colored yarns in the warp and the weft. Due to the twill construction, one color predominates on the fabric surface. Suitable for pants, jackets and skirts. Pre-wash and dry 100% cotton denim at least twice to eliminate shrinkage and color bleeding

Dobby: A decorative weave, characterized by small figures, usually geometric, that are woven into the fabric structure

Dotted Swiss: A lightweight, sheer cotton or cotton blend fabric with a small dot flock-like pattern either printed on the surface of the fabric, or woven into the fabric. End-uses for this fabric include blouses, dresses, baby clothes, and curtains.

Double Cloth: A fabric construction, in which two fabrics are woven on the loom at the same time, one on top of the other. In the weaving process, the two layers of woven fabric are held together using binder threads. The woven patterns in each layer of fabric can be similar or completely different.

Drill: Strong, medium- to heavyweight, warp-faced, twill-weave fabric. It is usually a 2/1 left-handed twill and piece dyed.

Duck: A tightly woven, heavy, plain-weave, bottom-weight fabric with a hard, durable finish. The fabric is usually made of cotton, and is widely used in men's and women's slacks, and children's play clothes.

Dupioni Silk: A crisp fabric with irregular slubs. It is perfect for tailored slimmer silhouettes like flat-front trousers, jackets and fitted blouses and

dresses. Silk Dupioni can be machine washed in the gentle cycle and drip-dried.

E

Elasticity: The ability of a fiber or fabric to return to its original length, shape, or size immediately after the removal of stress.

Embossing: A calendering process in which fabrics are engraved with the use of heated rollers under pressure to produce a raised design on the fabric surface.

Embroidery: An embellishment of a fabric or garment in which colored threads are sewn on to the fabric to create a design. Embroidery may be done either by hand or machine.

F

Felt: A non-woven fabric made from wool, hair, or fur, and sometimes in combination with certain manufactured fibers, where the fibers are locked together in a process utilizing heat, moisture, and pressures to form a compact material. Ideal for most craft projects.

Flannel: Usually a 100% cotton fabric that has been brushed on one or both sides for softness. Typically used for shirts and sleepwear.

Flax: The plant from which cellulosic linen fiber is obtained. Linen is used in apparel, accessories, draperies, upholstery, tablecloths, and towels.

Fleece: Synthetic knit fabric that stretches across the grain. Suitable for vests, jackets and top **Fiber**

Fiber: Fiber is a class of materials that are continuous filaments or are in discrete elongated pieces, similar to pieces of thread. Fibers are often used in the manufacture of other materials. They can be spun into filaments, thread, or rope. They can be used as a component of composite materials. They can also be matted into sheets to make products such as Paper or felt.

G

Gabardine: A worsted twill weave that is wrinkle resistant. Wool gabardine is the most common and is considered year-round fabric for suits.

Gauze: A sheer, open-weave fabric usually cotton or silk. It is suitable for blouses, dresses and curtains.

Georgette: A drapey woven fabric created from highly twisted yarns creating a pebbly texture. It is semi-sheer and suitable for blouses, full pants and flowing dresses.

Gingham: A medium weight, plain weave fabric with a plaid or check pattern. End-use include dresses, shirts, and curtains

J

Jacquard: Woven fabrics manufactured by using the Jacquard attachment on the loom. This attachment provides versatility in designs

and permits individual control of each of the warp yarns. Thus, fabrics of almost any type or complexity can be made. Brocade and damask are types of jacquard woven fabrics.

Jersey Fabric: Usually thinner or lighter-weight than interlock knit with less stretch. It's appropriate for tops and fuller dresses.

Jute: A bast fiber, chiefly from India, used primarily for gunny sacks, bags, cordage, and binding threads in carpets and rugs

K

Kapok: A short, lightweight, cotton-like, vegetable fiber found in the seed pods of the Bombocaceae tree. Because of its brittle quality, it is generally not spun. However, its buoyancy and moisture resistance makes it ideal for use in cushions, mattresses, and life jackets

Khaki: A tan or dusty colored warp face twill, softer and finer than drill. Name derived from East India word meaning "earth color." Fabric made of cotton, linen, wool, worsted, or manmade fibers and blends.

Knit Fabrics: Fabrics made from only one set of yarns, all running in the same direction. Some knits have their yarns running along the length of the fabric, while others have their yarns running across the width of the fabric. Knit fabrics are held together by looping the yarns around each other. Knitting creates ridges in the resulting fabric. Wales are the ridges that run lengthwise in the fabric; courses run crosswise.

L

Leather: Animal skin dressed for use in clothing.

Linen: A natural plant fiber, linen fibers are stronger and more lustrous than cotton. Depending on the weight, it's appropriate for anything from heirloom sewing and blouses to slacks and jackets.

Lawn: A light, fine cloth made using carded or combed, linen or cotton yarns. The fabric has a crease-resistant, crisp finish. Linen lawn is synonymous with handkerchief linen. Cotton lawn is a similar type of fabric, which can be white, solid colored, or printed.

Loom: Yarns affixes to two ends of the frame, while the horizontal weft yarns were manually woven through. Today there are many different types of looms, from the hand looms still in use A machine or frame used to weave cloth. The earliest looms featured vertical warp in developing countries to computer-controlled Jacquard looms that are able to control minute movements in the weaving process with speed and efficiency.

Lycra: The trademark name for DuPont's brand of Spandex fiber.

M

Madras: A lightweight plain weave cotton fabric with a striped, plaid, or checked pattern. True madras will bleed when washed. This type of fabric is usually imported from India. End-uses are men's and women's

shirts and dresses. **Madras** Fine cotton, hand loomed in the Madras region of India. Dyed with natural dyes.

Muslin: An inexpensive, medium weight, plain weave, low count (less than 160 threads per square inch) cotton sheeting fabric. In its unfinished form, it is commonly used in fashion design to make trial garments for preliminary fit.

N

Net: Refers to any open-construction fabric whether it is created by weaving, knitting, knotting, or another method.

Nylon: Produced in 1938, the first completely synthetic fiber developed. Known for its high strength and excellent resilience, nylon has superior abrasion resistance and high flexibility.

Nap: The nap of a fabric is the direction in which the sheared pile faces, and can be manipulated with combing or brushing.

O

Organdy: A stiffened, sheer, lightweight plain weave fabric, usually cotton or polyester.

Organza: A crisp, sheer, lightweight plain weave fabric, with a medium to high yarn count, made of silk, rayon, nylon, or polyester.

P

Polyester: A manufactured fiber introduced in the early 1950s, and is second only to cotton in worldwide use. Polyester has high strength (although somewhat lower than nylon), excellent resiliency, and high abrasion resistance. Low absorbency allows the fiber to dry quickly.

Poplin: A fabric made using a rib variation of the plain weave. The construction is characterized by having a slight ridge effect in one direction, usually the filling. Poplin used to be associated with casual clothing, but as the "world of work" has become more relaxed, this fabric has developed into a staple of men's wardrobes, being used frequently in casual trousers.

Pile: From the Latin word for hair, pile is the extra yarn that protrudes from the surface of a fabric. Pile can be shaved and shaped, as with velvet and corduroy, or can be left uncut as with terry cloth

Plush: Velvet with a deep, soft pile, plush is easily found in childrens' stuffed animals. From the French word peluche meaning hairy, plush fabric can also be knitted for a bit of stretch.

Ply: When two or more threads are twisted together before weaving, increasing yarn density and weight.

Q

Quilting: A fabric construction in which a layer of down or fiberfill is placed between two layers of fabric, and then held in place by stitching or sealing in a regular, consistent, all-over pattern on the goods.

S

Sateen Fabric: A fabric made from yarns with low luster, such as cotton or other staple length fibers. The fabric has a soft, smooth hand and a gentle, subtle luster. Sateen fabrics are often used for draperies and upholstery.

Satin: With a lustrous, shiny surface, drapability depends on fiber content. Silk and rayon satins have the best stitch results.

Seersucker: A fabric with a woven pucker, this fabric is traditionally cotton, but can be polyester. Suitable for shirts, casual slacks and children's clothing.

Spandex: Made with elastic fibers that can be stretched up to five times its original length without damage. When blended with natural fibers, it creates a lightweight and flexible fabric with great shape retention.

Suede: Leather that has been given a velvety nap.
Silk: The fabric is woven using the natural filament fiber produced by the silkworm in the construction of its cocoon. Silk is a naturally strong, lustrous, and fine fiber that produces long-lasting, versatile, and high-quality multi-purpose fabrics.

T

Taffeta: With a crisp hand, taffeta is typically used for formal wear like gowns and fuller skirts. Underlining prevents some of the wrinkling it has a tendency to have.

Tapestry: A heavy, often hand-woven, ribbed fabric, featuring an elaborate design depicting a historical or current pictorial display. The weft-faced fabric design is made by using colored filling yarns, only in areas where needed, that are worked back and forth over spun warp yarns, which are visible on the back. End-uses include wall hangings and upholstery.

V

Velvet: Velvet is one of the most luxurious fabrics because of its evenly cut, thick, soft pile. Traditionally made from silk, velvet comes in a variety of blends like rayon/silk, cotton, or nylon, and some velvets, such as stretch velvet, has some lycra blended in as well.

Velveteen: A lightweight fabric made from cotton with a very short, dense pile. Developed in Manchester, England in the 18th century, velveteen lacks the sheen and drape of velvet, is woven with an extra filling yarn, and can have a plain or a twill back.

Vinyl: A synthetic fabric made from PVC which resembles leather.

Viscose: A man made synthetic fiber, typically referred to as rayon. Viscose has a silken, smooth feel and a terrific drape, and is often used for linings and bridal garments.

Voile: Usually made with cylindrical combed yarns, this plain, loosely woven fabric has an extremely clear surface because the excess fuzzy yarns are singed away. It is thin, semi-transparent, and very lightweight, resembling an organdy or organza in appearance.

Woven Fabric: Fabrics composed of two sets of yarns. One set of yarns, the warp, runs along the length of the fabric. The other set of yarns, the fill or weft, is perpendicular to the warp. Woven fabrics are held together by weaving the warp and the fill yarns over and under each other

Warp: The vertical threads in a particular fabric or on a loom.

Weave: The manner in which a fabric is produced, utilizing methods of combining the warp and weft threads. The type of weave affects the strength, stretch, sheen and weight of a fabric. The basic types of weaves are plain, twill and satin.

Weft: The horizontal threads in a particular fabric or on a loom.

Wool: This textile is made using the fibers from the hair of animals, such as goats, sheep, camels, or llamas, and it comes in several different forms from crepe, to gabardine, to worsted. Wool is moisture absorbing and known for its warmth, and is also naturally stain and wrinkle resistant.

Worsted: A wool fabric woven from firmly twisted yarns, which are spun from combed long-staple wool, creating a solid smooth surface with no nap.

Y

Yarn: Also referred to as thread, yarn is the basic component of all fabrics. Yarn can be composed of twisted natural or synthetic fibers, or a longer single fiber.

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