Reading Material for Diploma Course in Haryana

Branch Textile Technology
Semester I

SUBJECT
TEXTILE FIBRES
2022

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Subject -1.5 TEXTILE FIBRES

Unit-I INTRODUCTION

Syllabus - General concept of Textile, fiber, yarn, fabrics and wet processing. Definition of Textile fiber and filament. Classification of Textile fibers according to nature and origin. General physical properties of Textile Fibers. General chemical properties of Textile Fibers.

READING MATERIAL unit I -

Definitions:

Textiles

Textile denotes fibres that can be spun into a yarn by various spinning processes and then into a fabric by the process of weaving or knitiing Or directly fibres to nonwoven fabrics.

Textile Technology

Textile Technology denotes the arts and science of fibres and fabrics, including the processes of spinning, weaving, knitiing, felting, bonding, braiding, technical use, dyeing etc., their mechanism, construction, description and practice.

Fibre

A fibre is something that is several hundred times longer than its width. To be spun into a yarn it should have minimum 5mm length, pliability, cohesivneness, and sufficient strength. Other desirable properties include elasticity, fineness, uniformity, durability and lusture. A textile fibre/ material is, which is spinable.

Yarn

It is the term used for a continuous thread which is made by twisting a group of fibres together. It is the base for weaving a cloth.

Fabric

It is the term used for cloth produced by knitting, weaving, or felting threads, the thread which is made by twisting together a group of fine filament or fibres.

Wet Processing

Wet processing covers all the process which requires involvement of some type of wet or chemical treatment like Desizing, Scouring, Bleaching, Mercerizing, Dying, printing, and Finishing.

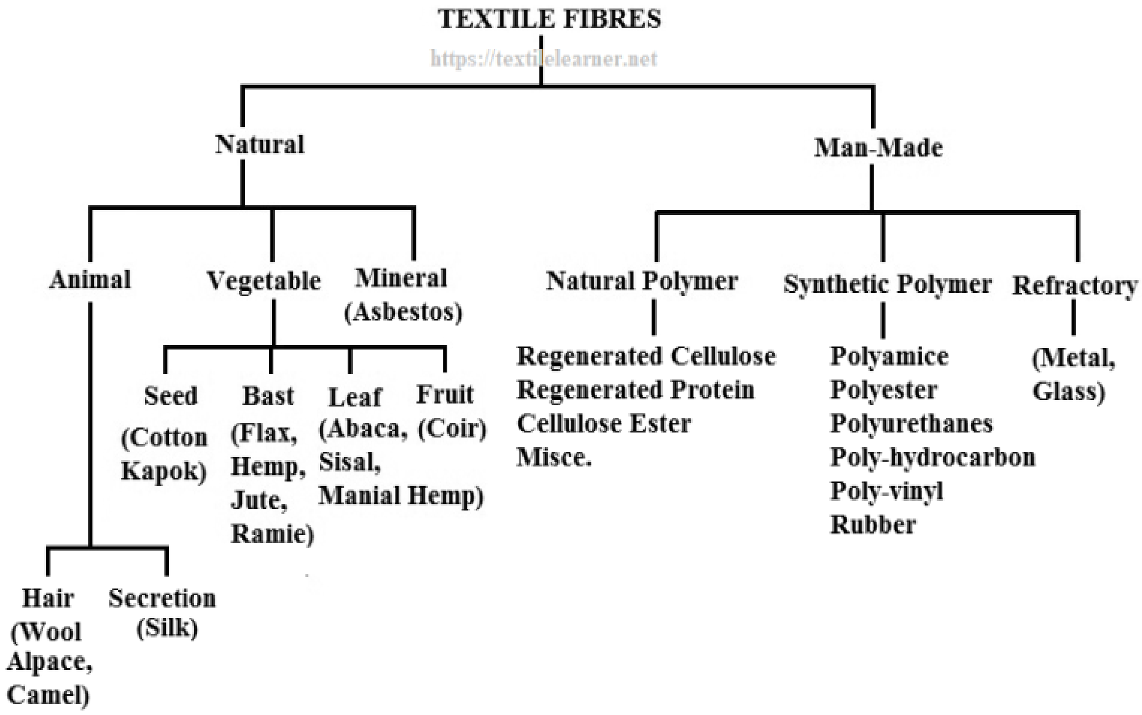
Filament

It is the continuous length in several thousand meters is called filament. Ex = natural filament : Silk , Manmade= Rayon, Viscose.

CLASSIFICATION OF TEXTILE FIBERS

Classification means organizing a number of objects into several groups according to a rule for their easy understanding. Based upon the source of their origin, the textile fibres can be classified as:

1. NATURAL FIBERS
2. MAN – MADE FIBERS



NATURAL FIBERS:

1. Vegetable Fibers – Cotton, Jute, Flax, Coir, Hemp, Ramie etc.
2. Animal Fibers - Wool, Silk, Mohair etc.
3. Mineral Fiber – Asbestos etc.

MAN – MADE FIBERS:

1. Regenerated Fibers – Viscose Rayon, Diacatate, Triacetate etc.
2. Synthetic Fibers – Nylon, Polyester, Acrylic, Polypropylene, Polyethylene etc.
3. Mineral Fibers – Glass, Steel, Carbon, Ceram etc.

General Physical Properties of Textile Fibres

1. Strength: Tensile strength of a textile fiber is the ability to resist the breakage when it is stretched or pulled along its axis.
2. Elongation: It is the maximum stretch ability of the fiber before it breaks. It is also known as elongation at break. It is represented in percentage.
3. Elasticity: It is the ability of stretchable fiber to come back to their original shape and position after the release of applied force. It is always represented in percentage.
4. Shrinkage: It is the linear amount of fiber which will contract lengthwise when washed. It is measured as percentage of its original measurement.
5. Moisture Regain: It is the ability of fiber to absorb moisture from the atmosphere. The amount of moisture regain will depends on the chemical composition of fiber, temperature, Relative humidity. Standard atmospheric temperature is 27 and relative humidity is 65 percent.
6. Hydrophilic Fiber: The fiber which has affinity towards water are known as hydrophilic fibers.
7. Hydrophobic Fibers: The fibers which do not have affinity towards water is known as

hydrophobic fibers.

8. Thermoplastic Fibers: The fibers which gets soften and melts when subjected to heat are called thermoplastic fibers. All synthetic fibers are thermoplastic fibers.

9. Non- Thermoplastic Fibers: The fibers which neither soften nor melts when subjected to heat are called non thermoplastic fibers.

10. Spinnability: It is the spinning property which enables the fibres to be spun easily.

General Chemical Properties of Textile Fibres

1. Effect of Light: When we wear cloth or fabric it comes into the touch of sunlight. It is very familiar to us. Effect of sunlight should be kept in mind for general people. Sunlight reduces the strength of cotton and it becomes yellow. Linen is better than cotton in sunlight. But cotton is better than silk.

2. Effect of Heat: Effect of heat si a vital point during dyeing, ironing, steaming and some other operations. Different fibers behave differently under heat. Some fibers burn where some scorch when heat is applied. Some fibers are not combustible e.g. mineral fiber, glass fiber etc. Cotton is easily flammable, wool is hardly flammable fiber.

3. Effect of Weather: Rain and wind have a significant influence on the persistence of fibres. Fibre loss was less predictable in outdoor tests than in laboratory tests. Fibre loss on static textiles in outdoor conditions was generally linear with time. Extreme meteorological conditions cause exponential fibre losses on static textiles.

4. Effect of Acid and Alkali: Acid or alkali is harmful for cellulose and protein fibers. Therefore, the effect of acid and alkali must be known during bleaching, dyeing and finishing. Different fibers react differently with acid and alkali. For example, Cotton and Linen damaged when they are subjected to conc. Hydrochloric, Sulphuric and Nitric acids. Also dilute solution of those acids can make harm to the fibers. On the other hand, conc. alkaline solution is not harmful to Cotton and Linen. Wool is not affected by dilute solution of acid. But conc. acid and alkali damage wool easily. So acid or alkali must be chosen properly to use in different purpose and processing.

5. Effect of Mildew: Textiles are susceptible to mould growth, which can cause staining, weakening, or complete destruction of fibres. Moulds feed by digesting the substrate on which they grow. Cellulosic fibres such as cotton, linen, and rayon are particularly vulnerable, but proteins such as wool and silk can also be affected.

6. Effect of Bleaches: The purpose of bleaching is to remove this colouring material and to confer a white appearance to the fibre. Repeated bleaching on textile fibres results in its weakening

After completing this unit the student will be able to tell :

Q. Which of following fibre is natural fibre of animal origin?

A Cotton B Wool C Nylon D Jute

Q. ....is the basic unit of Textile

A Fabric B Yarn C Fibre D Cloth

Q. Strength of fiber is measured in.

A newton B decimal C gm / denier D Pascal

Q. which is regenerated fiber?

A Cotton B Wool C Nylon D Rayon

Q. Which of following fibres synthetic fiber?

A Cotton B Wool C Nylon D Jute

Q. Define Fibre.

Q. Write any two Physical Properties of Textile fibre.

Q. Write name of two types of natural fibres.

Q. Define moisture regain.

Q. What are moisture regain and moisture contents?

Q. What is filament?

Q. What is Textile?

Q. Write definition of Textile filament with example.

Q. How are fibres classified? Give one example of each type.

Q. Write about classification of Textile fibres according to nature and origin

Q. What are general properties of Textile fibres. Explain with importance.

Unit-II Natural Fibre -COTTON

Syllabus - Origin and nature of Cotton fibres. Appearance, Longitudinal and cross sectional view of cotton fibres (structure). Chemical structure of cotton fibre. Impurities in cotton. Physical & chemical properties of Cotton fibres. End use of Cotton Fibre.

READING MATERIAL -

Origin and Nature of Cotton Fiber

The cotton fibre is obtained from the cotton plant by the following processes:

1. Cultivation: Cotton is the oldest fiber and grown in warm and hot climate. The bowing season of cotton in India is in the month of April and May. The seed of cotton is takes about 3 months to develop in a young plant. The flowers are converted into fruits which are known as cotton balls. The cotton fibers are grown from skin of seed present in cotton balls. Finally the cotton balls splits and the fibers are ready for harvesting by the month of September and October.

2. Harvesting: Harvesting of cotton fiber is done manually by hand picking in India whereas in developed countries harvesting is done by machines. The harvested cotton fibers are then send to ginning mills.

3. Ginning And Bailing: In ginning mills cotton fibers are separated from seeds. This process is called ginning and it is carried out ginning machines. The cotton fibers are so obtained and then packed in the forms of bales. This process is called bailing and it is done in bailing press. The average bale weight is kept from 150 to 200 kg aprox.

Nature of Cotton Fibre:

The cotton is the most important textile fibre due to its comfort ability. It comes from the vegetable fibres family.

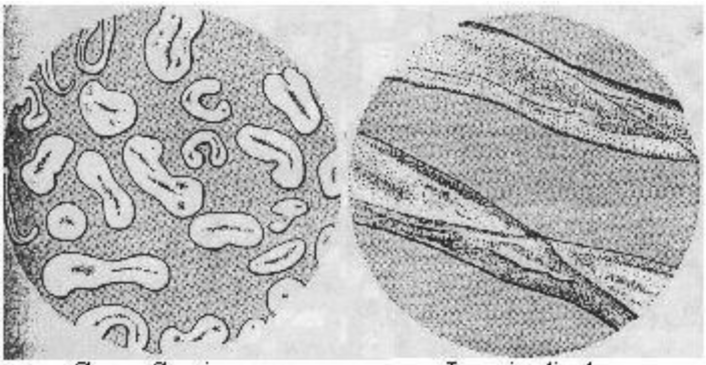
Appearance and Microscopic Structure

Microscopic view of cotton fibre: The cotton fibre is a single plant cell. When weobserve the cotton fibre under a microscope it like as shown below:

i. **Longitudinal view:** it looks like twisted ribbon or a collapsed and spirally twistedtube with a rough surface. A large number of convolutions are usually found.

ii. **Cross sectional view:** it is a flat, elongated or bean shaped with lumer parallel to the larger direction cross - section is oval shape.

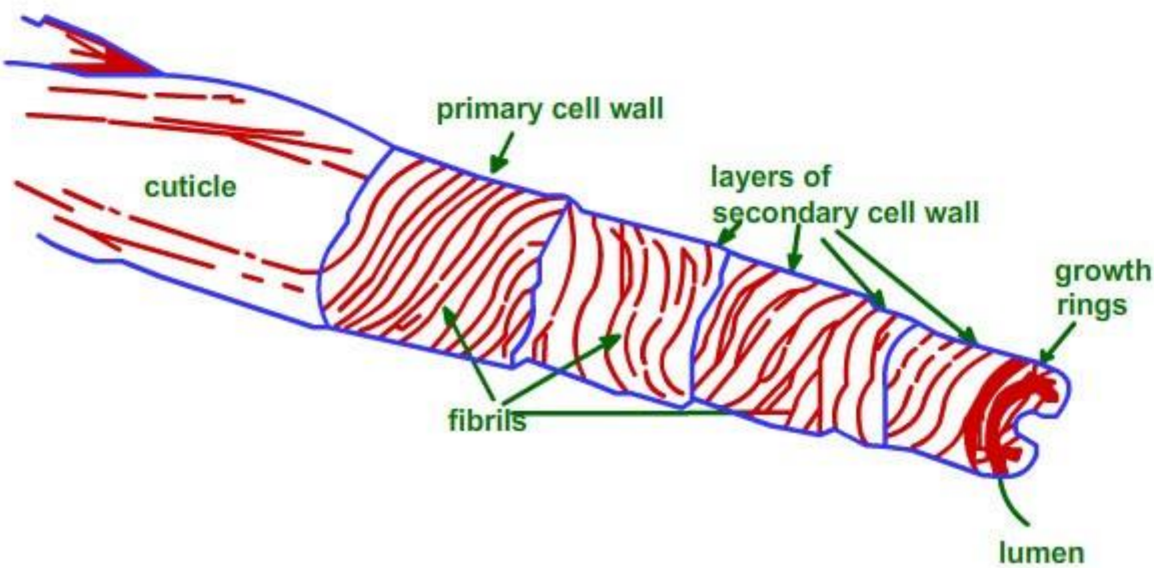
Mature cotton has Bean or Kidney shaped cross section, and a small lumen. Immature cotton also has a bean shaped cross section but a larger lumen. Mercerised cotton looksalmost round to oval, a small point at or near the centre representing the lumen

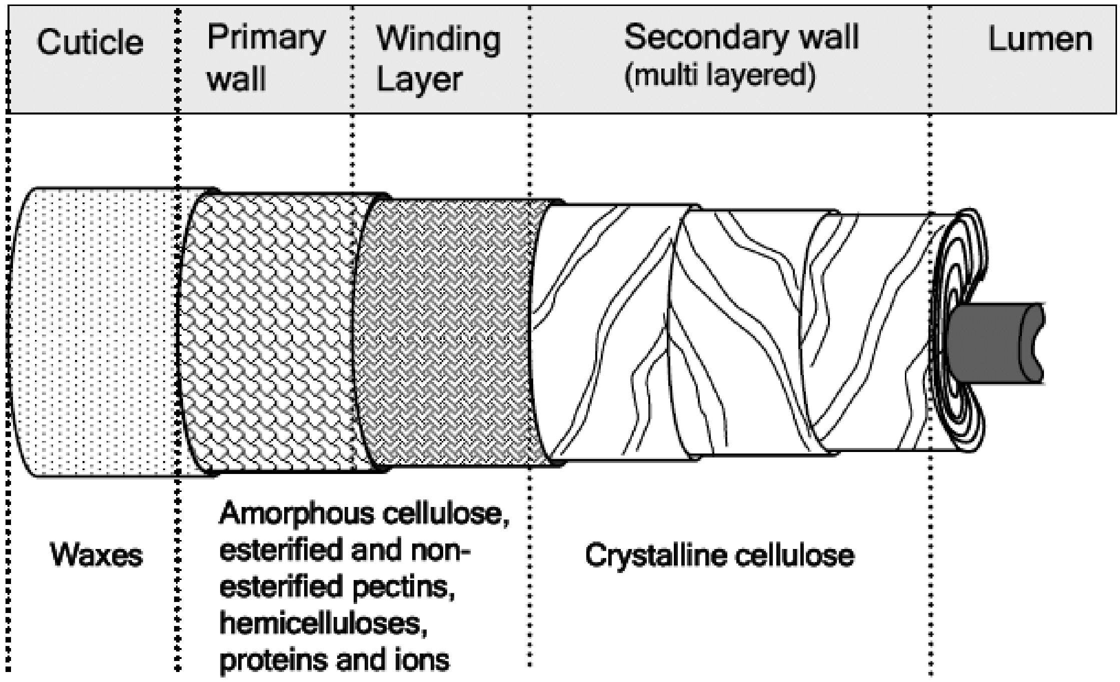


Cross Section Longitudinal

i. Morphological or micro- structure of cotton fiber

Like other plant cells, cotton also has a distinct cuticle, primary wall, secondary wall anda cuticle.





a. ***Cuticle* :** Cuticle is the very outside or skin of cotton fibre . It is composed of wax. It is few molecules thick. It protects the fibre against chemicals and other degrading agencies.

(Kier boiling) Scouring and bleaching removes this layer of wax and increase absorbency. However, as the cuticle or outer layer decreases in further washing and deterioration of cotton material increases. Subsequent laundering will gradually remove most of the remaining cuticle. As the extent of the cuticle is decreased further, deterioration of the cotton textile material increased.

b. ***Primary cell wall*:** It is under the cuticle layer and is approx 200 nm (nano- meter) thick . It is made of fine threads of cellulose, called fibrils . These fibril are 20 nm thick and at an angle 70 (degree) to the fibre axis . These fibrils impart strength to theprimary cell wall and thus to fibre.

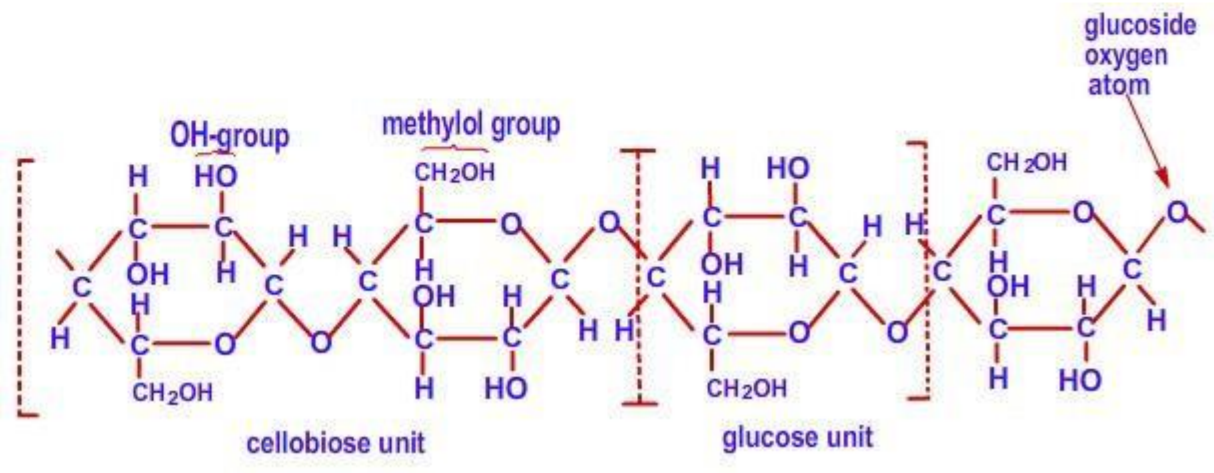
c. ***Secondary cell* wall:** It lives under the primary cell wall. It forms the bulk of fibre. It is about 10 nm (nano meter) thick. Fibril forms an angle of 20-45 (degree) with the fibre axis. Much of the strength of the fibre and yarn comes from it.

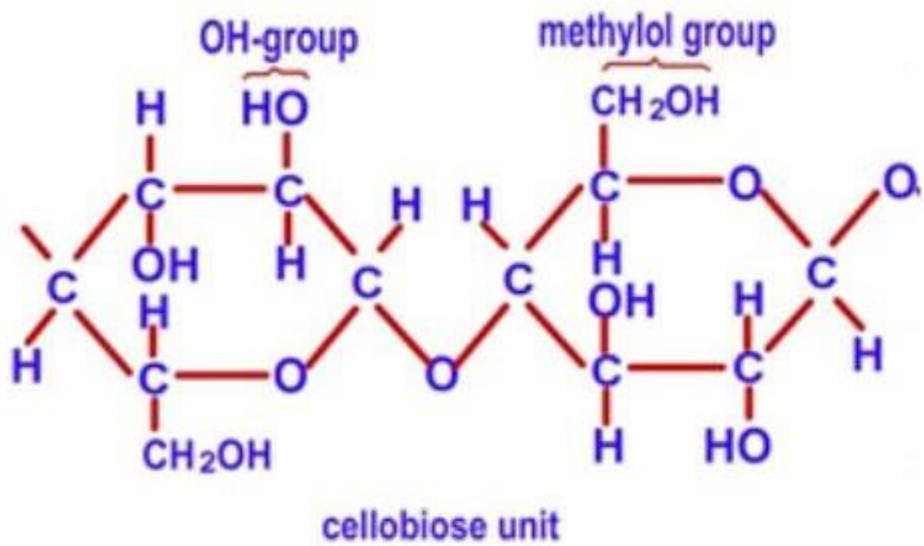
d. ***Lumen:*** The hollow canal running the length of the fibre is called lumen. It is present in the form of concentric layer of spiral secondary cell wall. It is innermost wall and main part of fiber. It covers three-fourth to fifteen-sixteenth of its length. It is quite regular. Due to the evaporation of cell sap (liquid of sugar, protein, minerals) fiber dries inside and takes the shape of bean or kidney.

Chemical Structure of Cotton Fibre

Cotton fibre is made of a linear cellulose polymer. Repeating units in cottonpolymer is cellobiose which contains two glucose units.

Cotton is a linear, cellulose polymer. The repeating unit in the cotton has two glucoseunits, called cellobiose. Cotton consists of about 5000 cellobiose units. Its degree of polymerization is thus 5000. Hence it is a very long, linear polymer, about 5000 nm inlength and about 0.8 nm thick.





Cotton Polymer contains 5000 cellobiose unit so its degree of polymerization is 5000. Polymer length is about 5000 nm and thickness about 0.8 nm. It is 70% crystalline and 30% amorphous. In crystalline region cotton polymers are well oriented and probably maximum 0.5 nm apart.

These are two main groups present in cotton polymer.

-OH - Hydroxyl group. It makes Hydrogen bond with adjacent cotton polymer.

-CH2OH -methylol Groups

Varieties of Cotton

1. Sea Island Cotton: It is the highest quality and also very costly cotton. It grows on the cost of the gulf of Florida. The average length of this cotton is 2 inch and diameter is 1/1500 inch. This cotton is used to making yarn up to 300 count.

2. Egyptian Cotton: There are two types of Egyptian cotton white cotton and brown cotton. Average length is 1.5 inch and diameter is 1/1500 inch. It is suitable for up to 200 count.

3. **South American Cotton:** The average length of cotton is 1- 1.5 inch and diameter is 1/1300 inch. It is suitable for making yarn up to 150 count.

4. **North American Cotton:** Its average length is 1- 2.5 inch and diameter is 1/1200 inch. It is suitable for yarn 70 count.

5. **Indian Cotton:** The average length of Indian cotton is 0.6 to 0.8 inch and diameter is 1/1200 inch. It is suitable for yarn up to 20.50 count.

6. **China Cotton:** The average length of cotton is 0.5 to 0.7 inch and average diameter is 1/1200 inch. It is suitable for yarn up to 20.50 count.

Physical Properties of Cotton Fiber

1. **Microscopic Appearance:** When viewed under microscope cotton fiber appears like flat tube with spiral twists.
2. **Length:** The length of cotton fiber range from 0.5 to 2 inches.
3. **Diameter:** Its range is from 0.0005 inch to 0.0009 inch.
4. **Color:** Its color may be yellowish, creamy and white.
5. **Luster:** Cotton fiber is not lustrous.
6. **Strength:** Cotton fiber has good strength. The strength of cotton fiber range is 2 to 5 grams per denier. The wetting strength of cotton fiber ‘s range up to 30 percentage.
7. **Elasticity:** Cotton fiber has very little natural elasticity. This property can be altered by twisting hard the fiber.
8. **Conductivity of Heat:** It is a fair conductor.
9. **Moisture Regain:** Cotton has good moisture regain capacity. It absorb water well but it does not dry quickly. Moisture regain cotton is 8.5 percent.

Chemical Properties of Cotton Fiber

1. Effect of Light: Effect of light is weaken.
2. Effect of Heat: It can be heated up to 150 degree centigrade with no damage. The cotton starts damaging at 240 degree centigrade and burns.
3. Effect of Acid: The dilute acid do not injure the cotton fiber but the concentrated acid destroys the cotton.
4. Effect of Alkali: The weak alkali have no effect but the strong akalies have effect.
5. Effect of Bleaching: Cotton can be safely bleached by using ordinary bleaching agent.
6. Affinity for Dyes**:** It has good affinity for dyes.

Uses of Cotton Fiber

1. Cotton is used for apparels, undergarments and also used in home furnishing like bed cover, pillow cover, curtain e.t.c.
2. It is particularly used for making summer dresses, for towels and filling material.

Composition of Cotton

94% Cellulose, 1.3% Protein , 1.2% Ash, 0.6% wax, 0.3%sugar and 2.6% traces of pigments etc.

Impurities in Cotton

Leaf Particles, Seed Particles, Sand, Dust, Dirt, Some metallic parts, Oily/ Greasy Material, Hairs, Some packaging material pieces such as sutli etc.

<u>After completing this unit the student will be able to tell :</u>

Q. Cotton fibre are example of ....

A Plant B Animal C Synthetic D Regenerated

Q. Which plant known as golden fibre?

A Cotton B Wool C Jute D Viscose

Q. Cotton is a .... fiber.

A Protein B Cellulosic C Polythene D polypropylene

Q. Moisture regain of cotton fiber is ….

A 5% B 8% C 10% D 12%

Q. Specific gravity of Cotton fibre is .... gm/ cc.

A 1.32 B 1.54 C 1.65 D 1.72

Q. What is the specific gravity of cotton fiber?

Q. Write three end use of cotton.

Q. Write about Appearance of Cotton.

Q. Write about physical properties of Cotton.

Q. What is the range of degree of polymerizations of cotton fiber.

Q. Give microscopic view of Cotton fibre?

Q. Explain the morphological structure of cotton fibre.

Q. Draw the chemical structure of cotton fibre.

Q. Explain chemical properties of Cotton fibre.

Q. Give places where Cotton fibre is grown?

Q. Give impurities of cotton fibre

Q. Write and draw diagram of cotton fibre. Write about various end use of it.

Q. What are the specific gravities of cotton

Q. Mention the chemical formula of Cellulose.

UNIT-III Natural Fibres- WOOL, SILK and JUTE

Syllabus - Origin, nature and appearance of Wool Fibre. Impurities in wool. Physical & chemical properties of Wool Fibre. End use of Wool.

Origin, nature and appearance of Silk Fibre. Impurities in Silk. Physical & chemical properties of Silk Fibre. End use of Silk

Origin, nature and appearance of Jute Fibre. Impurities in Jute. Physical & chemical properties of Jute Fibre. End use of Jute

READING MATERIAL -

WOOL FIBER

Origin and Nature of Wool Fibre:

Wool is natural fibre obtained from animals like Sheep, Goat, Rabbit and Camel. It has protein init. Wool is formed by 18 aminoacids, distributed in a particular order. A polyamide is formed bythis which is called ‘keratein’ used for actual fiber forming material of Wool.

The wool fibre is obtained by the following processes:

1. Shearing – It is the process of taking the wool from the body of sheep by using hand operated or machine operated cutters.

2. Sorting And Grading – Shorting and grading of wool is done before selling it to market by skilled workers depending on the type, staple length, fineness and part of sheep body e.t.c. and priced accordingly. The grading of wool is done according to the British numbering system depending upon the yarn, which can be made from it. The grading of wool in United State is based upon the superior quality obtained from Merino sheep e.g. Half-blood, Three-eigth-blood, Quartered-blood, Low-quarter-blood, Common and Braid.

3. Scouring – The wool fiber contain a lot of impurities like grease, dust and dirt because the sheep remains mostly in fields. So these impurities are removed in scouring process by treating with mild alkaline solution. In scouring the wool fibers are passed through warm water, soap solution and mild solution of soda ash. If wool fibers contain more impurities then they are passed through a dilute solution of Hydrochloric acid.

4. Drying – After souring wool fibers are dried in sun light or with driers to eliminate moisture present in fibers.

5. Oiling – In order to improve spinning performance the wool fibers are treated with some oils, this process is known as oiling.

6. Dyeing – The wool fibers are dyed in the required shade if fiber dyed yarn is to be made.

7. Blending – The wool fibers may be blended with other fibers like cotton, polyester, acrylic as required and then subjected to further spinning processe.

Nature of Wool Fibre:

Wool is grown year-round and it is famous for its warmth quality, and hence pure wool or its blends are used in winter wear fabrics.

Being Odour resistant in contrast to synthetics, wool can absorb moisture, which means less sweat on your body. They can also absorb and locks away the odours from sweat.

Appearance of Wool

Microscopic view

i. **Longitudinal view:**

In longitudinal view wool is irregular and roughly cylindrical. Scales are present on thesurface.

ii. **Cross sectional view**

It is oval shaped or circular shaped with variation in diameter.

(a) Raw wool fibers (b) Stretched wool fibers

FIGURE 8. Microscope photos showing change in fiber morphology after stretching & slenderization

iii. Morphological/ Structural view:

Physical structure of wool appears to be circular cylindrical that tapers from root to tip.From microscopic or morphological point it has 4 parts.

a. Epicuticle, or Outer sheath: It is the outer most non-protein, thin and water repellent covering. However, it has smallmicroscopic pores which help wool fiber fabrics to absorb water vapors from human body, and release it into air.

b. Cuticle: These are scales like cells, which are present under the epicuticle as layers. These layers are called epicuticle, exocuticle, endocuticle. These overlap and protrude for about one third of their length, the ends being directed towards the tip of the fibre. The outer most layers of these scales is a tough membrane known as the epicuticle. Beneath this the exocuticle is situated and the innermost layer described as the endocuticle. These cause aspecial directional frictional effect that has a very important influence on the frictional behavior of wool fibres.

c. Cortex: Bulk of fiber is made of cortical cells or cortex and is enclosed by the cuticle cells. Theseare fibrils (macro and micro fibrils) present in the cortex. Wool is bilateral structure – ortho and paracortex. The corticle cells are 100-200 µ in length and 2-5 µ wide. The tensile strength, elastic properties and the natural colour of the wool are determined mainly by the nature of the cortical cells.

d. Medulla:

There is a hollow space in the center running along the length of fiber. Many coarsewool fibres have a hollow space in the centre. The Medulla is absent in fine wools.

Impurities in Wool:

The wool fibres contain approximately 61% keratin and around 39% impurities such as: Wax, Grease, Suint, Dust, Dirt, Vegetable Particles etc.

Dirt is acquired by the animals (sheep, goat) while roaming.
Saint is an impurity due to sweating and in complex mixture soluble in water.
Fat is yellowish wax like substance and is made of fatty acids and cholesterol. It is soluble in organic solvant. Wool scouringis done to remove this fat or wax with soap and soda ash.
Burrs, seed and straw are vegetable matters. They are removed mechanically or chemically (carbonizing).

Carbonization is removal of seeds (cellulosic materials) by treatment with mineral acids.

Physical Properties of Wool Fiber

1. Length – varies from 1.5 inches to 15 inches. The width of wool fiber is 15 to 17 microns. It has crimps or weaviness.
2. Luster- It has medium luster.
3. Strength- It strength lies between 1 to 1.7 grams per denier. Its decreases on wetting.
4. Enlongation- Its enlongation is 20% to 40%.
5. Elastic recovery – It has 99% elastic recovery.
6. Resiliency – It has excellent resiliency.
7. Density – It has density of 1.3 to 1.32 grams per cc (centimeter cube).
8. Moisture Regain – Its capacity for moisture regain is 13.5% to 16%.

Chemical Properties of Wool Fiber

1. Resistance to acid- Good.
2. Resistance to alkali – Low.
3. Resistance to sunlight – Prolonged exposure to sunlight damages the fiber of wool.
4. Resistance to insects – Damages by moths and carpet bitles.
5. Effect of heat – The wool fiber decomposes above 140 degree Celsius.
6. Affinity for dyes – It has good affinity for dyes.

End Uses of Wool

Depending on the type of wool, the wool fibres are used for the following different end uses:

1. Fine Marino wool being soft and crimpy, it is used for fine quality woolen wears like cardigans and sweaters.
2. Medium wool is mainly used for ladies wear, suiting, coats, fine tweeds etc.

   Medium wool is also used for worsted suitings, flannels, overcoats and blankets.
3. Long wool is semi lustrous. Dress materials and curtains can be made out of it.
4. The long and coarse wool is used for making carpets and rugs. Overcoats, coarse tweeds, hosiery goods are made by mixing carpets wool with finer quality wool.

SILK FIBER

Origin of Silk Fibre:

Larva of a moth is known as Bombyx Mori – is the source of production of silk fiber. These larva are also called silkworm. Silkworm breeds on mulberry leaves.

When silk worm transforms into moth, liquid silk extrudes from two tiny holes in its head. This filament hardens when comes in contact with air before bound into a ball around the silkworm and forms a cocoon. The cocoons are treated with hot water. This hot water kills the moth and removes the wax in the fiber and hence allows the smooth unwinding of cocoon. The length of filament obtained may be up to three kilometers.

The Life Cycle of Silkworm

1. Egg
2. Larva or caterpillar
3. Pupa
4. Moth

A moth lays 350 to 400 eggs. Each healthy egg hatches in an ant size larva of about 3mm.

This larva feeds 5 times a day with chopped mulberry leaves. Initially this larva feeds on soft mulberry leaves, then bigger leaves. After four mouldings (change of skin) the worm reaches full growth in the form of a smooth grey white caterpillar about three and half inches long. It stops eating at this stage and raises its head. The leaves eaten by caterpillar changes into protein. A constant restless rearing movement of the head shows that the caterpillar emits the protein material from its two glands which solidify into the form of filament when comes into the contact of air. The caterpillars spins around itself and hides into the cocoons so formed and changes into the pupa form. The pupa in cocoons are taken into a hot dry chamber, so the pupa terminates at particular temperature and no damage is done to the cocoons. This cocoon is used to obtain silk filaments in hot water unwinding.

Seri-culture – The silk farming is known as seri-culture.

Processes involved in obtaining Silk Filament

1. Filature – The cocoons are brought to filature from the farmers where silk filaments are unwound from cocoons.
2. Sorting – Before unwinding the cocoons are sorted accordingly to their quality .i.e. damaged or good etc.
3. Softening of Sericin – After sorting the cocoons are passed through a series of hot water baths top soften the sericin (gummy substance).
4. Reeling – This process involves in unwinding of silk filament from cocoon and winding o n suitable packages.

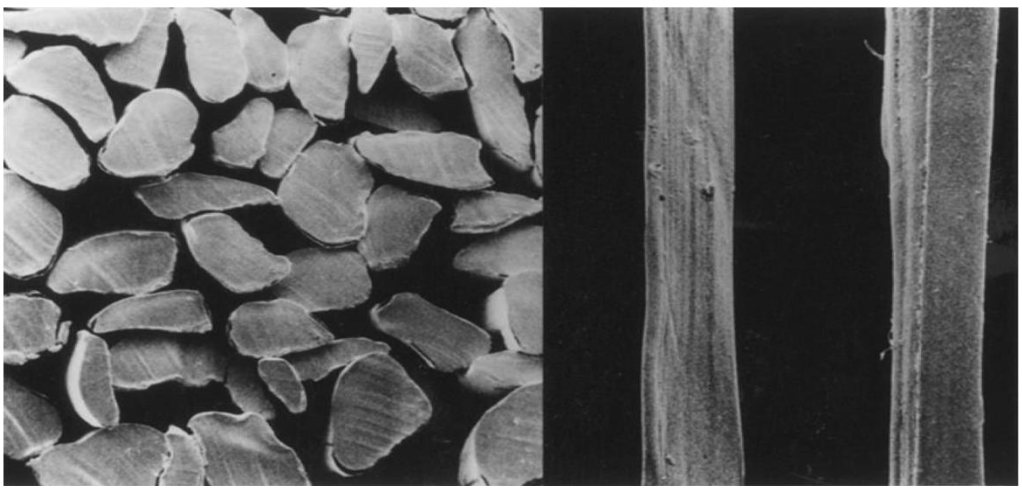
Nature of Silk:

Silk is the only natural fibre that occurs in the form of a fine continuous filament which is produced from the body fluid of silkworm.

In addition to the luster, strength is one of the most interesting characteristics of silk. At first touch, one may feel that silk is fragile but it’s actually one of the strongest fibre.

Appearance of Silk:

Raw Silk strand consists of 2 Silk filaments encased by a protein called **sericin**. Raw silkhas uneven and irregular surface due to sericin coating. Silk is a very fine regular translucent Microscopic View:



i. **Longitudinal: View:** It is irregular, random, longitudinal striations are seen on raw silk length. A silk appears like flat, irregular and uneven, rib bond, sometimes separate, sometimes twisted.

ii. **Cross Sectional View:** It has tri angular cross section. Due to this there is softness and lusture in silk. As the silk filament is slightly twisted, the angle of reflectionof light changes continuously. This results in soft and subdued light.

This triangular appearance is due to the slit-like opening of the silk secreting glands insilk moth larva.

Impurities of Silk:

i. Sericin Gum: A natural gum binds the long filament on the cocoon. This is an impurity for processing and dyeing of Silk. It is removed by boiling. This gum importshardness to silk. After degumming it is known as 'Soft Silk'

ii. Colour: Natural yellow colour is due to the expose of cocoon to light or due to thediet pigment of silk worm. This natural colour has to remove in wet processing.

iii. Dirt/dust or handling stains: These are due to faulty handling of the silk filament on machine during

Physical Properties of Silk

1. Shape – Fiber is fine 9-11 microns in diameter, length from 1000-1300 yards. Filament is smooth , even wild silk is uneven and dark color.
2. Lusutre – High.
3. Strength – Its strength is about 2.4 to 5.1 grams per denier. After wetting its strength decreases 2.0 to 4.3 grams per denier.
4. Elastic Recovery – 92% to 2% extension.
5. Elongation – Its elongation is about 10 to 25% when dry. After wetting its elongation is 33% to 35%.
6. Resiliency – Its resiliency is medium.
7. Density – Its density is about 1.25 to 1.34.
8. Moisture region – Its capacity is 11%.
9. Dimensional stability – Good.

Chemical Properties of Silk

1. Resistance to acids – Low, damaged by most minerals.
2. Resistance to Alkali – Strong alkali damages fiber.
3. Sunlight – Prolonged exposure may cause loss of strength.
4. Micro organisms – Good.
5. Thermal – Temperature over 150 degree may results into discoloration.

End Uses of Silk

Silk is used in garments and household items. It is also used in parachutes. Some of the end uses of silk are given below:

i. Bridal and formal wear

ii. Ties and scarves

iii. Bedding

iv. Parachutes

v. Upholstery

vi. Wall hangings

JUTE FIBER

Origin of Jute:

Jute is a bast fiber obtained from Dictotylesnous plants. The world ‘s main jute producing countries are India Bangladesh. In India major jute producing state is West Bengal.

Processes involved in obtaining Jute fiber:

1. Cultivation – Jute plants are grown in damp climate. The plants grown from seed to fully developed in six months up to a height of 4 to 5 meters.
2. Harvesting – Jute plants are harvested after flowering. The plants are cut near its base and collected in bundles.
3. Retting – The bundles of harvested jute plants are exposed to microbiological actions under water. This process is known as retting. The bundles of jute plants are kept under muddy water for several days. After retting jute fibers are separated from the stem.
4. Washing – The separated fibers are then washed.
5. Drying – The washed jute fibers are dried in the sun light after drying it is subjected to further processes.

Nature of Jute

Jute fibre is a type of plant fibre which is widely known for its ability to be spun into strong and coarse threads. Individual jute fibres are known to be soft, long, and shiny in nature. The jute fibre yarn is widely used for ropes/ cords and the jute fabric is used for packaging material.

Appearance of Jute

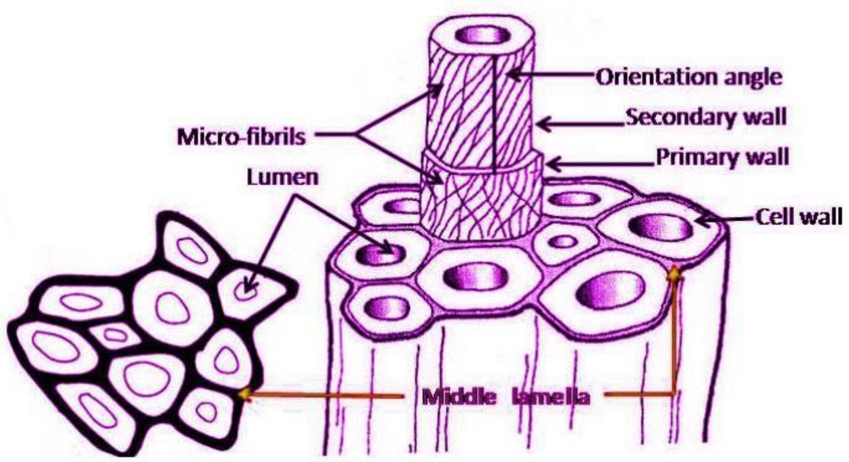
Microscopic Structure

i. Longitudinal View:

Length wise Jute fibre shows irregular thickness (contrictions) in the cell wall.

Externally jute fibre is smooth with nodes.

ii. Cross-sectional View: Cross section is generally round or oval shaped but these are polygonal structureswith sharp and defined angles.



Cross sectional view

Impurities in Jute:

i. Color: This one of the important impurity because presence of natural tannic acid inthis fibre it leads to coloration in retting water which contains ferric(Iron). Because it is stem/root fibre so knots are present in the fibre.

ii. Pectins, Gums: These are present in the stems from where jute fibres are obtained.these are removed by the action of water and micro organism(enzymes).

iii. Impurities due to diseases and pests attacking on the fibre before ratting.

Physical Properties of Jute Fiber

1. Strength: Jute is the cheapest textile fiber. Jute fiber is not durable. It looses strength when exposes to moisture.
2. Absorbency: It absorb moisture quickly. Its moisture regain capacity is high.
3. Elasticity: Its elasticity is low.

Chemical Properties of Jute Fiber

1. Reaction to Acids: It is very sensitive to acids.
2. Reaction to Bleaches: Jute fibers are very difficult to bleach and can’t be made pure white.
3. Effect of Light: It looses strength when expose to sunlight.

End uses of Jute Fiber

1. Jute is used to produce bagging in which stems such as sugar, coffee, various grains are packed.
2. Jute is used to make carpet ‘s backing.
3. Jute is used to make ropes and cords.

<u>After completing this unit the student will be able to tell :</u>

Q. Wool fibre are example of ....

A Plant B Animal C Synthetic D Regenerated

Q. We get wool fibre from.

A Dog B Goat C Sheep D Cow

Q. Raw Wool contains impurities .

A 2-5% B 10-20% C 30-70% D None of Above

Q. Silk fibre is obtained from

A Sheep B Cocoon C Jute plant D Cotton ball

Q. Which natural fiber obtained from insect?

A Cotton B Wool C Nylon D silk

Q. Sweater in winter made of....... .

A wool B silk C nylon D polyester

Q. .... is Protein Fibre.

A Cotton B Wool C Nylon D Viscose

Q. Name two animal fibers.

Q. Write one end use of silk.

Q. Write two impurities present in Wool fibre.

Q. Where do we get silk from?

Q. Write two end use of wool.

Q. Write two end use of jute.

Q. Draw cross sectional view of silk?

Q. Give general composition of wool fibre.

Q. Name different layers in wool morphological structure?

Q. Give chemical composition of wool fibre.

Q. What places Jute fibre is grown?

Q. Explain physical properties of jute fibre.

Q. Give chemical composition of silk fibre.

Q. Give chemical properties of Jute fibre.

Q. Give physical properties or chemical properties of wool fibre.

Q. Write about various types of impurities found in silk

Q. What is a cocoon?

Q. Draw an enlarged cross sectional view of wool fibre to show the different parts of it including cortex, cuticle, keration etc.

Uuni-IV REGENRETED FIBRES

Syllabus - Regenerated Fibers **-** Monomers of regenerated fibres. Sequence of steps for making fibre. formula, physical & chemical properties Viscose rayon. End use of Viscose rayon. Monomers of regenerated fibres Acetate rayon. Sequence of steps for making fibre. formula, physical & chemical properties Acetate rayon. End use of Acetate rayon

READING MATERIAL -

4.1. Introduction

Regenerated fibres are manufactured from a natural polymer, cellulose, which is obtained from wood. Cellulose is reacted chemically so as to make viscos solution which can be extruded to make viscose fibres. These fibres are chemically similar to cotton and share their desirable properties of moisture absorbancy. The first regenerated fibre, called rayon, which was originally intended to be a substitute for silk.

By adopting the basic production process, a range of viscose fibres with different characteristics, like high tenacity, high wet modulus, crimped and inflated fibres can be produced for different uses. The viscose process is long and complicated and the byproducts give rise to environmental problems. So other man-made cellulosic fibres are produced called modified re-generated fibres by using an alternate process. These fibres include cellulose, diacetate and tri-acetate. The raw material is cellulose, but in these fibres it is modified chemically so that polymer can be dissolved in an organic solvent. These fibres are produced almost entirely as continuous filament yarns and are used in soft silk like dress fabrics. Most cigarette filter tips are made from cellulose di-acetate fibres.

4.2. Viscose rayon

Viscose rayon is a regenerated cellulosic fibre and cellulose is the raw material for producing this fibre. It is obtained by the process viscose. The name viscose was derived from the liquid state of the spinning solution as the spinning solution is thick and flow like honey.

4.2.1. Manufacturing process

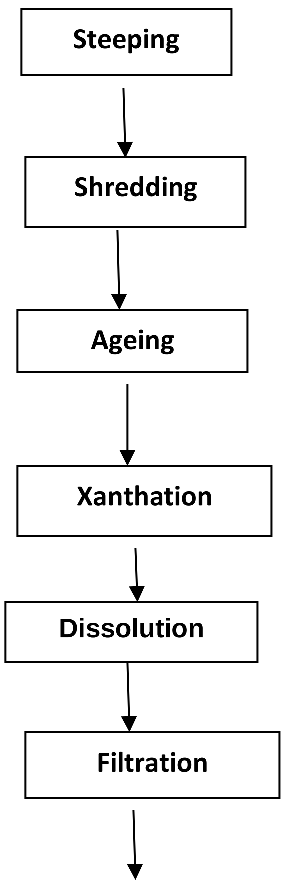
Flow diagram for production of viscose rayon filament and viscose fibre is givenas per following Flow chart

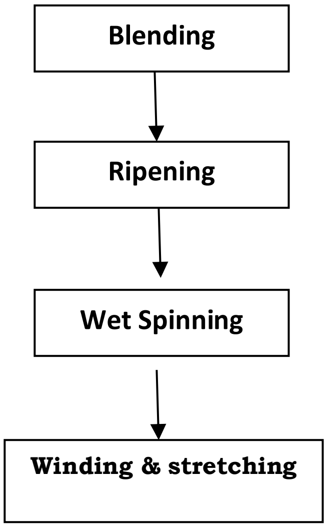
Cellobiose is the basic unit of the cuprammonium, polynosic and viscose rayon.

Cellulose, in regenerated form, is the polymer of these three regenerated cellulose fibres; their degree of polymerisation is about

- 250 cellobiose units (i.e. n = 250) for cuprammonium;
- 300 cellobiose units (i.e. n = 300) for polynosic;
- 175 cellobiose units (i.e. n = 175) for viscose.

The raw material for the viscose rayon is cellulose (Cellulose is a white amorphous, shapeless substance that forms the cell walls of plant life. Chemically, it is a carbohydrate. Carbohydrate is a compound, sugar, starch or cellulose of carbon with hydrogen and oxygen). Viscose rayon is obtained by reduction of cotton linters or high alpha cellulose woods to a pulp, same as in the manufacture of paper. The pulp is bleached and pressed into sheets this is done in the pulp mill. In the rayon mill the following are the processes to manufacture the rayon filament or fibre.





(a) Steeping

The cellulose sheets are soaked in alkali in the steeping tank containing 17-18% NaOH for 30-60 minutes at temperature 18°C. After steeping, sheets of cellulose are pressed to remove the excess alkali.

(b) Shredding

In this operation the cellulose sheets are shredded mechanically into fluffy crumbs. At this stage surfactants like polyethylene glycol are added to decrease the surface tension and improve dispersion of carbon disulphide during the later process of xanthation.

(c) Ageing

This is depolymerisation step in the presence of oxygen. Here the degree of polymerization come down from 1000 to 300. In this process the crumbs are stored in rectangular galvanized steel container covered with lids. The oxygen present within the crumbs is responsible for the depolymerisatioin, exposure to outside air is avoided. Aging is carried out for 24-72 hours at 25-30°C. The process can be accelerated in the presence of catalysts or at higher temperature.

(d) Xanthation

The aged alkali is transferred into sealed hexagonal drums rotating at 2-4 revolutions per minute where the 10 % by weight of cellulose carbon disulphide is introduced. The process is carried out for 2-4 hrs and the colour change takes place from white to yellow, yellow to deep yellow and then to reddish orange. The product at this stage is sodium cellulose xanthate in the form of small balls.

(e) Dissolution

Dissolution of sodium cellulose xanthate is carried out in 4 - 6% solution of NaOH in a cylindrical vessel provided with agitators for 4 - 5 hours. The air whipped into the solution is removed by evacuation.

(f) Filtration

The solution is filtered to remove any impurities and un-dissolved cellulosic particles. Filtration is done at several stages.

(g) Blending

To have the uniformity and to avoid any batch to batch variation, viscose solutions from several tanks are mixed in a large vessel.

(h) Ripening

The viscose solution obtained is difficult to coagulate. The solution is kept for 1 - 3 days for ripening, at this stage the solution is kept at controlled temperature 15 - 25°C. In this step various changes takes place, here first the degree of polymerization falls and then rises to original value. The ripened solution is again filtered carefully to remove any foreign matter and deaerated. Pigments can be added to produce died fibres. Delustering agents TiO_2 is added for controlling the lustre and other chemicals for special yarns. After ripening the solution is ready for spinning.

(i) Wet spinning

In the spinning of the solution into fibre formation, the regeneration of cellulose from cellulose xanthate in the presence of acid takes place. Spinning is carried out by extrusion of the spinning solution from the spinneret having the tiny holes (diameter is in the order of 0.05 mm). Spinneret is present in the coagulation bath. The spinning speed may be as high as 120 m/min. As the acid in the coagulation bath diffuse into the filaments, regeneration of the cellulose takes place. The composition of the coagulation bath is as follows

H_2SO_4	-	8 - 10 %
Na_2SO_4	-	16 - 24 %
Glucose	-	2 %
$ZnSO_4$	-	1 - 2%
H_2O	-	69 %

Each chemical has its own function; Na_2SO_4 precipitates the sodium cellulose xenthate from the viscose solution into filaments and H_2SO_4 converts in to cellulose, Glucose gives the pliability and softness to the filaments and $ZnSO_4$ is responsible for added strength and serrated cross section.

(j) Winding and stretching

Winding the stretching of the filaments is also done to orient the molecules in the direction of the fibre axis to improve the mechanical properties of the filaments. After that the filaments strands are wound and are further processed with following operations.

Washing

↓

Desulphurising

↓

Bleaching

↓

Washing

↓

Drying

↓

Winding

The cake is washed with water to remove the impurities using a cake washing machine. After that it is washed with sodium sulphide solution at 62 65°C to remove the residual sulphur. Then bleaching is done with sodium hypochlorite or with hydrogen per-oxide (H_2O_2) to remove the residual chlorine, cake is treated with mild HCl in the case of sodium hypochlorite bleaching and finally it is dried.

4.2.2. Properties

(A) Physical properties

(i) Degree of polymerization	-	175 - 240 celluboise
(ii) Amorphous region	-	60 – 65%
(iii) Crystalline region	-	35 – 40%.
(iv) Moisture regain	-	11-12 %
(v) Tenacity	-	14 – 45 g/tex (dry) 50% of the dry (wet)
(vi) Specific gravity	-	1.49 g/cm^3

(B) Chemical properties

Chemical properties of the viscose rayon are similar to cotton being cellulosic fibre. Shorter polymer and very amorphous region are responsible for greater sensitivity to acids, alkalis, bleaches, sunlight and weather in comparison to cotton.

4.2.3. Uses

The role of viscose rayon in the field of man-made fibres is similar to that of cotton in natural fibres. Rayon is relatively cheap and has a wide range of applications. Its lustre is high but it can be appropriately delustred. Viscose rayon conducts heat more readily than silk, the most lustrous natural fibre, and rayon has a cooler feel against the skin. The loss of strength that viscose undergoes under wet conditions can be controlled and brought to a minimum by modern resin finishes.

The introduction of rayond staple has opened prospects for blending rayon with other natural or synthetic staple fibres and in fact, rayon staple is quite largely used in this fashion. Rayon imparts its unique moisture absorption character and some other ‘cellulosic’ features to its blends with stronger, lighter and less moisture absorbing fibres. Rayon-cotton, rayon-polyester, rayon-jute and rayon-wool blends made by using rayons of appropriately matching staple lengths are of particular importance.

Cellulose acetate

4.3.1. Introduction

The three types of rayon- viscose, cuprammonium and nitro-cellulose are known as regenerated rayons since the original raw material, cellulose, is changed chemically in to another form, which in turn is again changed i.e. again regenerated into cellulose once more. The forth method i.e. cellulose acetate is not a regenerated cellulose product, as the filaments are not regenerated cellulose, but are formed from cellulose acetate which is a derivative of cellulose.

4.3.2 Polymer system

The hydroxyl groups on the cellulose polymer are acetylated to the degree that the acetate or secondary cellulose acetate polymer has less than 92 per cent but at least 74 per cent of its hydroxyl groups acetylated; that is, 2.3 to 2.4 of the OH-groups per glucose unit are acetylated. This is usually shown as 4 acetate groups per cellobiose unit.

The acetate or secondary cellulose acetate polymer, DP is about 130 units i.e. n = 130

The triacetate or primary cellulose acetate polymer has at least 92 per cent of its hydroxyl groups acetylated. In general, this is shown as 6 acetate groups per cellubiose unit [Fig. 3.4 (b)].

The triacetate or primary cellulose acetate polymer, DP is about 225 units i.e. n = 225

The flow diagram for the manufacture of cellulose acetate rayon is as

Raw material

↓

Purification

↓

Pretreatment

↓

Acetylation

↓

Hydrolysis

↓

Preparation of spinning solution

↓

Spinning

(a) Raw material: The raw material for cellulose acetate is cotton linters or wood pulp.

(b) Purification: First cotton linters are purified by kier boiling under pressure for 4-10 hours followed by washing and then bleaching with sodium hypochlorite and drying.

(c) Pretreatment: The purified cotton is steeped in glacial acetic acid under controlled temperature to make it more reactive

(d) Acetylation: In this process the cotton is treated with an excess of acetic anhydride and glacial acetic acid in an closed vessel fitted with a powerful stirrer. H_2SO_4 increases the rate of reaction. Reaction is exothermic and the vessel is cooled to keep the temperature low otherwise degradation of cellulose takes place. For the first four hours the temp. is kept at 20°C and then increased to 25-30°C for the next 7-8 hours. The cellulose dissolves completely in to the reaction mixture then it is considered to be completely acetylated. At this stage all the three hydroxyl groups of the cellulose are replaced by three acetyl groups. This is also called cellulose triacetate or primary acetate.

(e) Hydrolysis: Primary acetate is not suitable for spinning as it is soluble only in expensive and objectionable solvent chloroform. The hydrolysis of primary acetate is done to convert it into acetone (cheap) soluble called secondary acetate or diacetate. In this step the primary acetate is run into water with excess acetic acid anhydride (95 % solution of acetic acid in water) for 20 hours at high temperature. During this hydrolysis of cellulose triacetate takes place and some of acetyl groups are replaced by hydroxyl groups. Degree of acetylation in the secondary or diacetate is about 2.3. Degree of polymerization is in the range of 350-400. The cellulose diacetate is washed separately centrifuged and dried at low temperature. Blending of various batches is carried out for uniformity and to reduce the batch to batch variation.

(f) Preparation of spinning solution: The spinning solution 25-35 % is prepared with acetone in a closed vessel. For completely dissolution it takes around 24 hours. Dulling agents, like TiO_2 and other coloring pigments are added at this stage if required. The spinning solution is called *Dope*. The dope is filtered and deaerated.

(g) Spinning: The dope is extruded through the spinnerets having tiny holes located inside of the spinning cabinet. In the cabinet hot air at temp 100°C is circulated form the bottom, this causes the evaporation of acetone. The air with the acetone is allowed to escape the cabinet from the top and is taken to recovery plant from where the acetone is recovered and reused. The hardened filaments move down to feed rollers.

Stretch is applied on the filaments to orient the molecules in the direction of applied force to improve the mechanical properties of the filaments and are finally wound upon the bobbins individually or in filaments form. Several spinneretes are drawn together in the form of the rope called Tow. For the manufacture of staple fibres, after drawing process crimping is carried out and then the fibres are cut into desired length that may be used as alone or blended with other fibres.

4.3.3. Properties of cellulose acetate

(A) Physical properties

(i) Degree of polymerization	130 - 225 celluboise
(ii) Amorphous region	60 %
(iii) Crystalline region	40%.
(iv) Moisture regain	6.5 %
(v) Tenacity	1.2 g/tex (dry)
(vi) Specific gravity	
Triacetate	1.32 g/cm^3
Acetate	1.25 - 1.30g/cm^3

(B) Chemical properties

Chemical properties of the acetate rayon are similar to cotton being cellulose “back bone” fibre. Shorter polymer and very amorphous region are responsible for greater sensitivity to acids, alkalis, bleaches, sunlight and weather in comparison to cotton.

Burning test

Cellulose acetate rayon will melt when placed close to flame, the residue is hard, blackish-brown bead, difficult to crush between the fingers.

4.3.4. Uses

Drip-dry property, permanent pleating effect and ‘need no-ironing’ character of the triacetate make it a good choice for easy-care slacks, skirts and dresses. In the staple form, it is suitable as a blend component with other staple fibres, such as cotton and viscose, needing moderately high ironing temperature due to its relatively high melting temperature. Blended with wool, the triacetate provides fabrics having the characteristic heat-setting and drip-dry properties combined with the warmth of wool.

After completing this unit the student will be able to tell :

Q. Which of following is example of Regenerated Fibre.

A Cotton B Wool C Nylon D Viscose

Q. Which of following fibre is known as artificial silk.

A Cotton B acrylic C rayon D polyester

Q. Viscose is .... fibre.

A Plant B Animal C Syntetic D Regenerated

Q. Viscose is an alternative for .... fibre.

A Jute B Silk C Cotton D all of above

Q. After wetting Viscose fiber strength.

A Increase B Decrease C Remain same D Can’t say

Q. Which is fiber that is alternative to cotton fiber?

Q. Give two examples of regenerated fibre.

Q. Write two Physical properties of Viscose.

Q. What is the range of degree of polymerizations of Rayon?

Q. What is the major end use of Rayon?

Q. Give physical properties of Viscose Rayon?

Q. Draw the chemical structure of Viscose Rayon?

Q. Strength of Viscose fabric increases or decreases on wet. Write correct answer.

Q. Write in detail about manufacturing process of Viscose fibre.

Q. Write about wet and dry spinning of fibre production.

Q. Give two examples of protein based regenerated fibres.

Q. Describe the chemical properties of viscose fibre.

Q. What is 'steeping' in viscose rayon process?

Q. Discuss the ageing and Xanthation process in viscose rayon process.

Q. Give steps for making viscose fiber.

Unit-V SYNTHETIC FIBRES

ACRYLIC

Acrylic fibre is synthesised through polymerisation of **acrylonitrile (vinyl cyanide)** and has the chemical name polyacrylonitrile (PAN) with the empirical formula where 'n' is the degree of polymerisation. Acrylic fibers are made by **spinning acrylonitrile copolymers containing at least 85% acrylonitrile monomer**. Typical comonomers are vinyl acetate or methyl acrylate To produce continuous filaments, the polymer is dissolved in a solvent and extruded through spinnerets. Afterwards, the continuous filaments are washed and dried.

Chemical names of Acrylic Fiber:

1. Orlen.
2. Acrilan.

3. Creslam.
4. Zefran.

Physical properties of acrylic fiber:

1. Tenacity: Dry= 5gm/den, wet= 4.8gm/den.
2. Elongation: Dry=16%, Wet= 17%.
3. Moisture regain: 1-2%.
4. Flammability: More flammable, burns rapidly with bright yellow flames.
5. Abrasion resistance: Good.
6. Dimensional stability: Good.
7. Color: Dull.
8. Diameter: 15µm to 25µm.

Chemical properties of Acrylic Fiber:

1. Effect of acid: Damage by strong concentrated acid.
2. Alkali: Affected by strong alkaline.
3. Bleaches: Resistance to bleach.
4. Heat: Most heat sensitive.
5. Dye: Acid, basic.
6. Light: Resistance not for less time.

Uses of Acrylic Fiber:

Acrylic is a synthetic fibre which appears to resemble wool. It is flexible, resistant to moth, oil and chemicals. It is used in the following ways:

1. All acrylic fibers used in knitted and woven fabrics.
2. Blends of acrylic fibers with wool, cotton etc.
3. End uses such as blankets, carpets and upholstery.
4. Popular in sports wear, ski cloths, children snow suit.
5. Used in industrial applications like filter cloth, protective cloth.

Modified acrylic Fibre

Modacrylic fibre is a modified acrylic fibre. Modacrylic fibre is a man-made (manufactured) fibre in which the fibre forming substance is any long chain synthetic polymer composed of less than 85% but at least 35% by weight of acrylonitrile monomer units. (-CH2CH[CN]-)x. Modacrylic fibres are made from resins that are copolymers (combinations) of acrylonitrile and other materials, such as vinyl chloride, vinylidene chloride or vinyl bromide. These substances are added to the fibre to give it better flame-retardant properties. Modacrylic fibres are either dry spun or wet spun.

Characteristics of Modacrylic Fibre

1. Soft

2. Resilient
3. Easy to dye to bright shades
4. Abrasion resistant
5. Flame resistant
6. Quick drying
7. Resistant to acids and alkalies
8. Shape retentive
9. The low softening temperatures of modacrylic fibres allow them to be stretched, embossed and moulded into special shapes.

General Properties

Chemistry	35% acrylonitrile / 65% vinylidene chlor
Size	3 denier x 51mm cut length
Crimp Level	3.8 crimps/cm
Moisture	3.5% (typical)
Tensile Strength (Tenacity)	Fair – Good
Abrasion Resistance	Fair – Good
Absorbency	Poor
Static Resistance	Fair – Poor
Heat Resistance	Fair
Wrinkle Resistance	Good
Resistance to Sunlight	Excellent
Elasticity	Good
Flame Resistance	Does Not Burn

Resilience	Good

Uses of Modacrylic Fibre

Modacrylic fibres are used, alone or in blends, in fabrics for various application as follows: Apparel: Dresses, suits, sportswear, deep-pile coats, trims and linings, simulated fur, wigs and hair pieces, children's sleepwear, career apparel.

Fabric: Fleece, knit-pile fabric backings, nonwovens

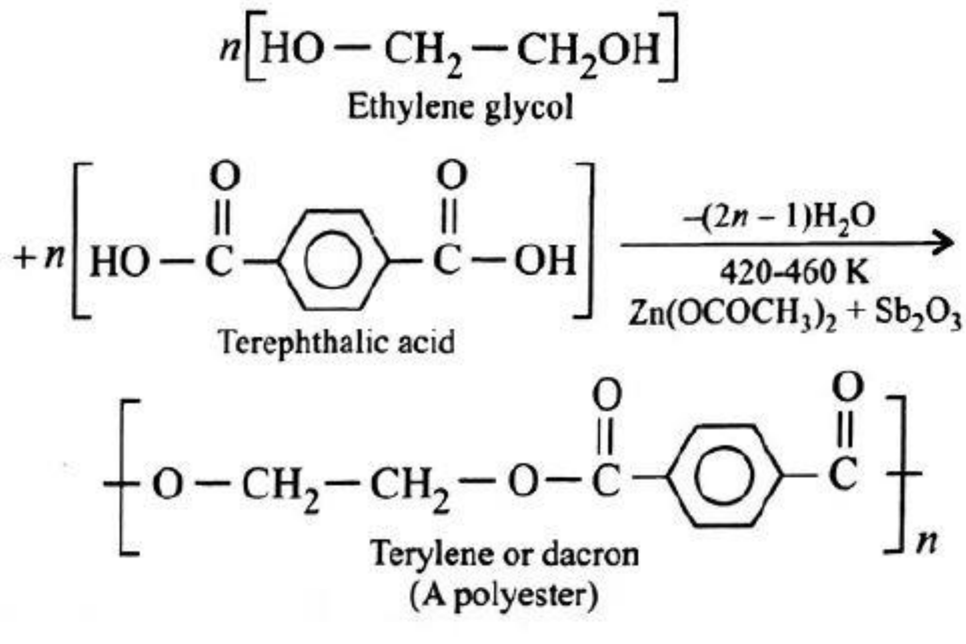
Home Furnishings: Awnings, blankets, carpets, flame-resistant draperies and curtains, scatter rugs

Other Uses**:** Filters, industrial fabrics, paint rollers, stuffed toys, and chemical-resistant clothing.

POLYESTER FIBRE

Polyester is a synthetic fiber, but its raw materials still come from nature. Most polyester is made out of petroleum, a natural non-renewable resource.

The chemical name of polyester is Polyethylene terephthalate the polyester with the greatest market share, is a synthetic polymer made of purified terephthalic acid (PTA) or its dimethyl ester dimethyl terephthalate (DMT) and monoethylene glycol (MEG).



Physical Properties of polyester fiber:

1. Length and diameter: The length of the polyester fiber depends upon the end-use and can be controlled while the diameter of fiber varies from 12-25 m.
2. Colour and lustre: The colour of acrylic fiber is off-white and possess bright lustre as the incident light is reflected evenly when it falls on the smooth surface of the fiber.
3. Tenacity: The tenacity of polyester is quite high and varies from 2.5-9.5g/den. It is the large crystalline region present in the polyester fiber that contributes towards strength. There is no loss of strength in wet conditions.
4. Elongation and elastic recovery: The polyester fibers have good elastic recovery.
5. Density: The density of polyester is 1.39g/ which makes it even heavier than nylon.

6. Resiliency: The acrylic fiber when crushed or bent it returns to its original position which imparts good resiliency to fiber.
6. Moisture regain: Polyester fiber is hydrophobic due to the presence of a crystalline arrangement that does not allow easy entry of water in the structure.
7. Thermal Property: Polyester fiber is thermoplastic in nature and can be easily heat set and thus softened and shaped accordingly.

Chemical Properties of polyester fiber:

1. Acids: Polyester fibers are resistant to the action of acids.
2. Alkalis: The polyester fibers have a fair resistance to alkalis.

3. Polyester has excellent resistance to sunlight but faces a problem of static charge

Uses of Polyester:

1. Polyesters are widely used in clothing fabrics. Examples include polyester shirts, polyester jackets, polyester pants, and polyester hats.

2. Polyester is used in the manufacture of many home furnishing materials such as bedsheets, curtains, blankets, and pillowcases.

3. Polyester is also used in upholstered furniture and mouse pads.

4. Polyester is known to play a vital role in the manufacture of certain types of car tyre , conveyer belts and safety belts used in automobiles

5. Owing to its insulating properties and its relatively soft texture, polyester is used in the production of cushioning materials for pillows. They are ideal for use as tablecloth.

6. Certain types of polyesters are also employed in the manufacture of Polyesters are also used in the manufacture of dielectric films that are used in capacitors.

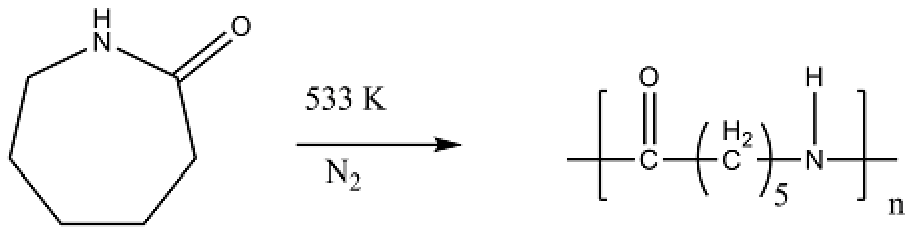
7. These polymers are also used as film insulation in insulating tapes and some wires.

8. It can be noted that polyesters can be employed as a component for high-quality finishes for certain wood products. Common examples include guitars, interiors, and some pianos.

NYLON 6

Nylon-6 is manufactured from **the monomer called caprolactum**. The monomer caprolactum is heated at 533 K in an inert atmosphere, it polymerises to give nylon-6.

Caprolactum has 6 carbons hence called Nylon 6



caprolactum.

Nylon-6

Nylon 6 has certain advantages over Nylon 6,6,. Firstly the systheisi fo caprolectum is easier than that of Hexamethylene Diamine and Adipic Acid. Therefore it is cheaper to make Nylon 6 than Nylon6,6. Secondly Nylon 6 has greater affinity for acid dyes than Nylon6,6,

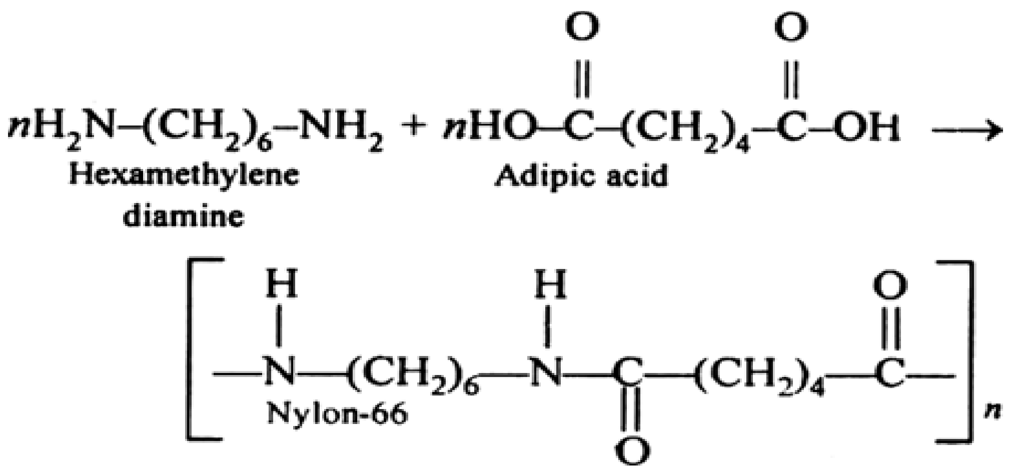
Physical Properties of Nylon 6
1. Density: 1.14 g/cc
2. Tenacity: Dry= 4.2-5.8 gpd, Wet=4.0-5.3 gpd
3. Elongation at Break--> Dry = 24-40, Wet=28-43
4. Elastic Recovery at 4% extension= 100%
5. Moisture Regain= 4%
6. Because of low MR, wet nylon dries quickly.
7. Melting Point= 215 deg C (Nylon 66-250 deg C)
8. It is weakened by prolonged exposure to sunlight.

Chemical Properties of Nylon 6
1. It is resistant to most organic acids such as benzene, chloroform, acetone, esters ethers etc.
2. It dissolves in phenol, cresol and strong mineral acids.
3. good resistant towards alkalies.
4. Resistant to inorganic acids

Uses of Nylon 6
1. Tyre Cord Manufacturing
2. Fishing Lines
3. Luxury Yachts
4. Stockings with good fit, sheerness, quick washing and drying properties.

NYLON 66

Nylon-6,6 is a polymer formed by the polymerization reaction of hexamethylenediamine and adipic acid. Thus, the monomers of nylon-6,6 are of **hexamethylenediamine and adipic acid**.



Physical Properties of Nylon 66:

1. Tenacity: 4.5 – 8.5 gm/den.
2. Density: 1.14 gm/c.c.
3. Elongation at break: Very good.
4. Elasticity: Very good.
5. Moisture Regain (MR%): 4.0%
6. Resiliency: Good.
7. Melting point: 250^0C.
8. Ability to protest friction: Excellent.

Chemical properties of Nylon 66:

1. Acids- not stable with acidic action

2. Alkalies- enough ability to protect the action of alkali
3. Effect of Bleaching- Strong oxidising agents cause harm
4. Organic solvents- becomes soluble in formicacid, sulphuric acid and phenol
5. Dyes- Direct, acid and Vat dyes are suitable for dye
6. Protection against Mildew- Not affected by Mildew

The uses of Nylon 6,6 is :

1. Because Nylon is a light material , it is used in parachutes .

2. Nylon 6,6 is waterproof in nature so it is also used to make swimwear.

3. . Nylon 6,6 being waterproof in nature is used to make machine parts. It is also used in the following like airbags , carpets , ropes . hoses etc .

SPANDEX/ LYCRA

Both Lycra and Spandex are the same. Spandex is the generic name of fiber and Lycra is a spandex product of DuPont company. When you are specifically using Lycra® product (spandex fiber) for your clothing products,

What is Spandex?

Spandex is a synthetic polymer. It is also called Elastane Fiber. Chemically, it is made up of a long-chain polyglycol combined with a short di-isocyanate, and contains at least 85% polyurethane. It is an elastomer, which means it can be stretched to a certain degree and it recoils when released. These fibers are superior to rubber because they are stronger, lighter, and more versatile. In fact, spandex fibers can be stretched to almost 500% of their length.

Molecular Structure:

Spandex is a polymer; its macromolecular structure is made up of repeating units (mars) denoted by the x and n next to the parentheses in the structure. Each Spandex fiber will differ somewhat in length and composition depending on the exact value of x and n.

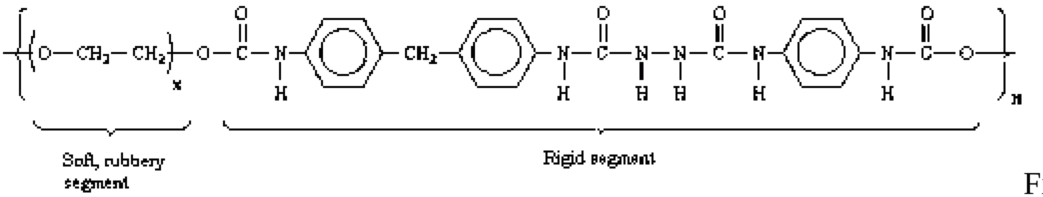


Fig: Chemical Structure of spandex

Microscopic view of spandex is-

Fig: Microscopic view of spandex

Physical Properties of Spandex Fiber:

1. Cross section– Spandex filaments are extruded usually from circular orifices, but the evaporation of solvent or the effects of drying may produce non-circular cross-sectional shapes. This may take various forms. In the multi-filament yarns, individual filaments are often fused together in places. The number of filaments in a yarn may be as few as 12 or as many as 50; the linear density of filaments ranges from 0.1 to 3 tex (g/km).
2. Density: The density of spandex filaments ranges from 1.15 to 1.32 g/cc, the fibers lower density being based on polyesters.
3. Moisture regain: The moisture of fibers from which the surface finish has been removed lies between 0.8 & 1.2%
4. Length: It can be of any length. It may be used as filament or staple fiber.
5. Color: It has white or nearly white color.
6. Luster: It has usually dull luster.
7. Strength: Low strength compared to most other synthetic fiber.
8. Elasticity: Elastic properties are excellent. This is the outstanding characteristic of the fiber.
9. Heat: The heat resistance varies considerably amongst the different degrades over 300 F.
10. Flammability: It Burn slowly.
11. Electrical conductivity: It has Low electrical conductivity.
12. Breaking tenacity: 0.6 to 0.9grams/denier.

Chemical Properties of Spandex Fiber:

1. Acid: Good resistance to most of acids unless exposure is over 24 hours.
2. Alkalis: Good resistance to most of the alkalis, but some types of alkalis may damage the fiber.
3. Organic solvents: Offer resistance to dry cleaning solvents.
4. Bleaches: Can be degraded by sodium hypo-chloride. Chlorine bleach should not be used.
5. Dyeing: A full range of colors is available. Some types are more difficult to dye than others

Uses of Spandex Fiber:

Garments where comfort and fit are desired: Hosiery, swimsuits, aerobic/exercise wear, ski pants, golf jackets, disposable diaper, waist bands, bra straps and bra side panels.

Compression garments: Surgical hose, support hose, bicycle pants, foundation garments

<u>After completing this unit the student will be able to tell :</u>

Q. Which of following is example of Synthetic Fibre.

A Cotton B Wool C Nylon D Jute

Q. Which of the following fibres have the highest moisture regain?

A Cotton B Wool C Nylon D Polyster

Q. Which of the following fibres have the lowest moisture regain?

A Cotton B Wool C Nylon D Spandex

Q. Which of the following fibres have highest strength?

A Cotton B Wool C Nylon D Spandex

Q. Which of the following fibres is stretchable?

A Cotton B Wool C Nylon D Spandex

Q. Which is fiber that is alternative to wool fiber?

Q. What is the solvent of acrylic?

Q. What is moisture regain of Acrylic?

Q. Give raw material for Acrylic polymer?

Q. Give specific gravity of acrylic fiber?

Q. Draw the microscopic view of acrylic fiber?

Q. What is modacrylic?

Q. Give the raw material used for formation of Acrylic?

Q. Draw structure of acrylic fiber?

Q. What are end uses of acrylic fiber?

Q. Give popular name of polyester?

Q. What is moisture regain of polyester?

Q. Draw microscopic view of polyester fiber?

Q. Draw microscopic view of polyester fiber?

Q. Write down chemical properties of polyester fiber?

Q. What are the end uses of polyesters?

Q. Give raw material for Nylon 6?

Q. What are different types of Nylon?

Q. Give strength of Nylon fiber?

Q. Give strength/ tenacity of polyester fiber?

Q. What is difference between Nylon 6 & Nylon 66?

Q. write end uses of Nylon.

Q. Name polyamide fiber.

Q. Give chemical formula of Nylon?

Q. Name two mmf who have least specific gravity?

Q. Give physical properties of Nylon 6 and 6,6.

Q. Draw structure of Nylon fiber?

Q. Give chemical properties of Nylon 6 and 6,6.

Q. Write about Physical properties of Spandex.

Q. Write about Physical properties of Lycra.

Q. What are various advantages of cotton over synthetic cloths.

Q. Write in detail monomer formula of Polyester fibre.

Q. Write about monomer and formula of Nylon fibre .

Q. Write about various end use of it.

Q. Give monomer of Acylic fibre with proper diagram.

Q. Which fibre is considered to be a substitute of wool & why?

Q. Discuss the important characteristics of spandex fibre.

Q. What is 'Lycra'?

Q. Give the chemical formula of caprolactam.