Manufactured Regenerated Cellulosic Fiber

Rayon

•Rayon is the oldest man-made textile fiber. discovered by C.E.Cross and E.J.Bevan in 1891.

• The US Trade commission defines Rayon as “man-made textile fiber and filament composed of regenerated cellulose.”

•It is made from purified cellulose, primarily from wood pulp, which is chemically converted into a soluble compound.

• Then chemically processed into a solution that is then extruded through a spinneret.

•It is biodegradable and renewable fiber.

•It has luster similar to silk so it is also called artificial silk or art silk.

•India’s first rayon factory was started in 1946 in Kerala.

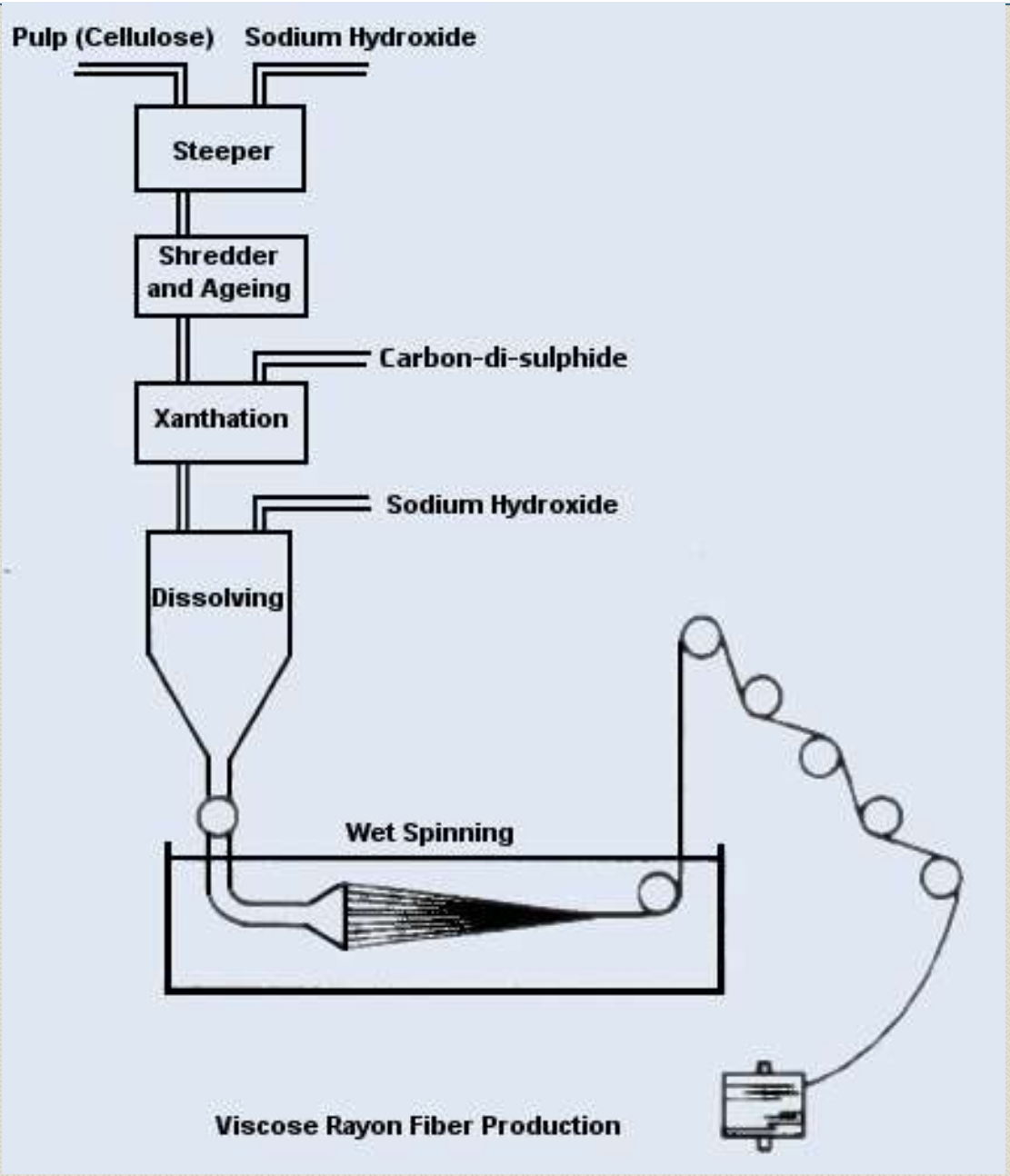
Manufacturing Process

All varieties of rayon are of vegetable origin and are derived from a cellulosic base such as cotton linters and wood pulp. The timber used for wood pulp comes from 8-12 yr old eucalyptus, spruce or pine trees. Harvested trees are stripped of their bark, sun dried, then cut into strips and finally reduced to chips. Chips are treated to remove binding agent (lignin) and resin. The resulting pulp (94% cellulose) is pressed and converted into blotter like sheets for further processing. The process of manufacturing viscose rayon consists of the following steps :

1. **Slurrying**: The cellulose sheets are immersed in a solution of caustic soda (or sodium hydroxide) and allowed to steep for enough time for the caustic solution to penetrate the cellulose and convert some of it into “soda cellulose”, the sodium salt of cellulose.
2. **Pressing:** The soda cellulose is squeezed mechanically to remove excess caustic soda solution.
3. **Shredding:** The soda cellulose is mechanically shredded to increase surface area and make the cellulose easier to process. This shredded cellulose is often referred to as “white crumb”.
4. **Ageing**: These crumbs are then aged for 2-3 days to break the cellulose chains into shorter polymer that can be dissolved easily.
5. **Xanthalation**: Carbon disulphide is then added to white crumbs which produce cellulose xanthate and changes the colour to bright yellow orange.

6. Dissolving and ripening: The orange colour crumbs are placed in dissolving tanks of dilute sodium hydroxide. The resulting solution is thick and viscous and known as viscose, it is golden yellow in colour with a consistency similar to honey.

7. Deaeration and filtration: The viscose is filtered to remove any insoluble particles. This is important because the particles would clog the spinnerete holes and interfere with the spinning process. It is at this point that delustering agents such as titanium dioxide or pigment dyes for colouring the fibers may be added.



Viscose Rayon Fiber Production

8. Extrusion: The viscose is forced through a spinneret, a device resembling a shower head with many small holes. Each hole produces a fine filament of viscose. As the viscose exits the spinneret, it comes in contact with a weak/dilute solution of sulfuric acid.

In the acid bath, the acid coagulates and solidifies the filaments, now known as regenerated cellulose filaments. The filaments are ready to be spun into yarn.

If staple fiber is to be produced, a large spinneret with large holes is used. If filament fiber is being produced, then a spinneret with smaller holes is used.

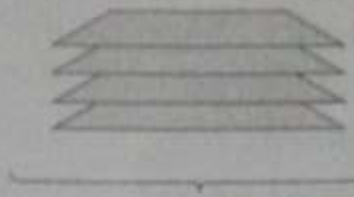
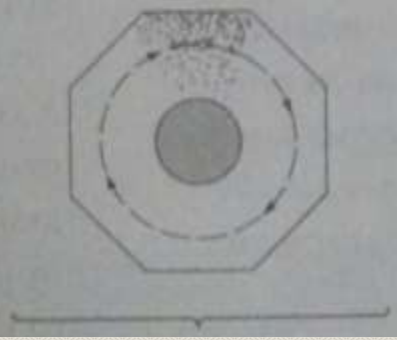
9. **Drawing**: The rayon filaments are stretched while the cellulose chains are still relatively mobile. This causes the chains to stretch out and orient along the fiber axis.
10. **Washing**: The freshly regenerated rayon contains many salts and other water soluble impurities which need to be removed by washing.
11. **Cutting**: If the rayon is to be used as staple, the group of filaments (termed "tow") is passed through a rotary cutter to provide a fiber which can be processed in much the same way as cotton.

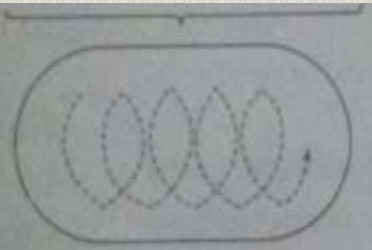
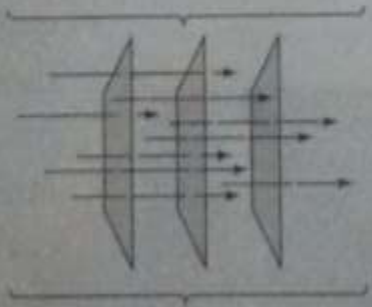
Types of Rayon: The rayons are produced by different methods depending upon various chemicals used in manufacture. The various types of Rayon are:

- Nitro cellulose rayon
- Cuprammonium rayon
- Viscose rayon
- High-wet-Modulus rayon

From the above stated types Nitro cellulose and Cuprammonium method of production are no longer in use because of being less environment friendly.

Spinning process for viscose and HWM rayon.

REGULAR OR VISCOSE		HIGH-WET-MODULUS
1. Blotterlike sheets of purified cellulose		1. Blotterlike sheets of purified cellulose
2. Steeped in caustic soda		2. Steeped in weaker caustic soda
3. Liquid squeezed out by rollers		3. Liquid squeezed out by rollers
4. Shredder crumbles sheets		4. Shredder crumbles sheets
5. Aged 50 hours		5. No aging
6. Treated with carbon disulfide to form cellulose xanthate, 32 percent CS_2		6. Treated with carbon disulfide to form cellulose xanthate, 39–50 percent CS_2

7. Mixed with caustic soda to form viscose solution		7. Mixed with 2.8 percent sodium hydroxide to form viscose solution
8. Solution aged 4–5 days		8. No aging
9. Solution filtered		9. Solution filtered
10. Pumped to spinneret and extruded into sulfuric acid bath		10. Pumped to spinneret and extruded into acid bath
10 percent H_2SO_4 16–24 percent Na_2SO_4 1–2 percent $ZnSO_4$ 120 meters/minute 45–50°C 25 percent	Spinning bath Spinning speed Spinning bath temperature Filaments stretched	1 percent H_2SO_4 4–6 percent Na_2SO_4 20–30 meters/minute 25–35°C 150–600 percent

Viscose rayon and High wet modulus rayon

Regular rayon (Viscose rayon)	High-wet-modulus rayon
It is the most widely produced form of rayon, it has the ability to produce either filament or staple fibers. It has the largest market share. It is also highly absorbent, economical and comfortable to wear. Regular viscose rayon does have some disadvantages. It is not strong when it becomes wet or overexposed to light. Also, regular rayon has a tendency to shrink when washed.	It is a stronger fiber than regular rayon, and in fact is more similar in performance to cotton than to regular rayon. It has better elastic recovery than regular rayon, and fabrics containing it are easier to care for. They can be machine washed, whereas fabrics containing regular rayon generally have to be dry-cleaned.

Viscose rayon and High wet modulus rayon

Regular rayon (Viscose rayon)	High-wet-modulus rayon
Regular rayon is 100% cellulose and has the same chemical composition and molecular structure as the natural cellulose found in cotton and flax, except that rayon chains are shorter and less crystalline. The cellulose breaks down during aging process in rayon production. During spinning in acid bath, regeneration and coagulation takes place at a faster rate.	In high wet modulus rayon aging is eliminated and the molecular chains are not shortened as much as in regular rayon. Because the acid bath is less concentrated regeneration and coagulation takes place slowly and molecules are more oriented.

Viscose rayon and High wet modulus rayon

Regular rayon (Viscose rayon)

- Regular rayon is also called Viscose. Viscose is also the trade name of rayon in Europe.

High-wet-modulus rayon

- HWM rayon is also called high performance (HP) rayon or polynosic rayon. In Europe they are sold by the name polynosic or modal.

Properties of Rayon

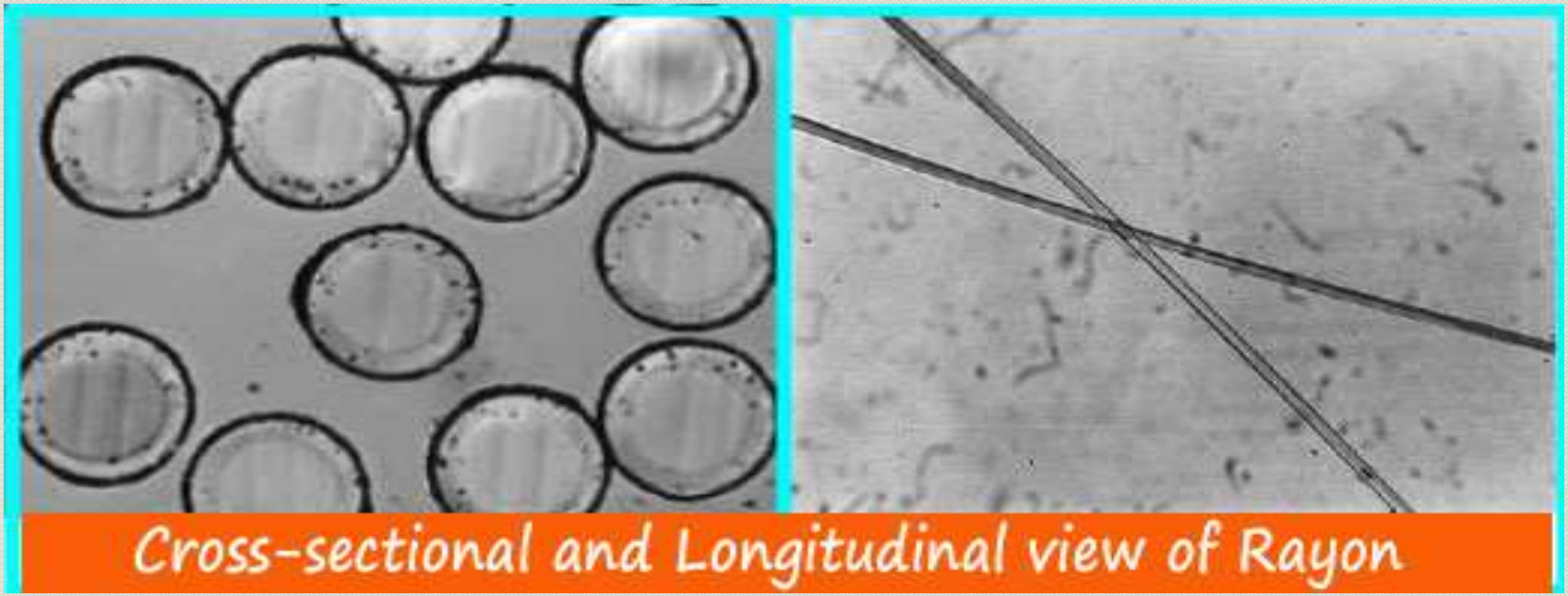
Rayon Fiber's cellulosic base contributes many properties similar to those of cotton or other natural cellulosic fibers. Rayon Fiber is comfortable, soft to the skin, and has the moderate dry strength and abrasion resistance.

One of the Rayon Fiber's strengths is its versatility and ability to blend easily with many fibers—sometimes to reduce cost, other times for luster, softness, or absorbency and resulting comfort.

Physical Properties of Rayon:

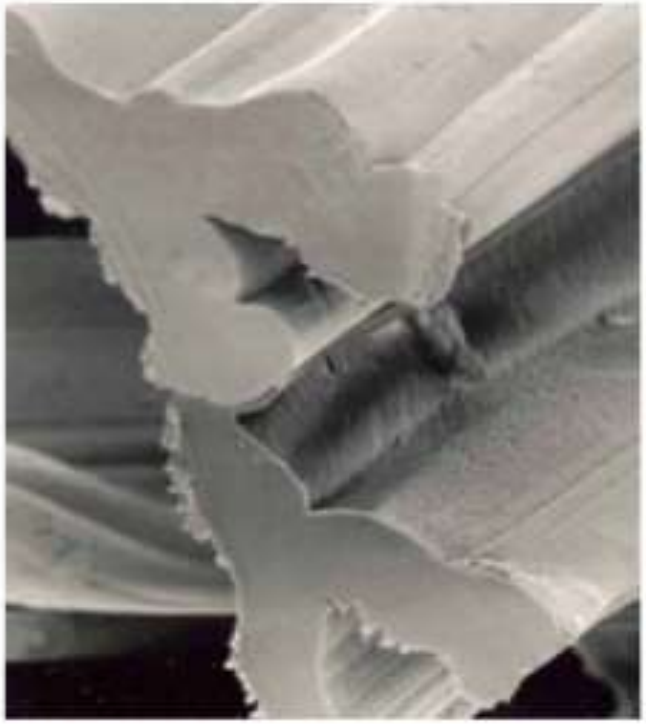
1. **Colour and luster:** rayon fibers are normally white in colour. The luster of rayon can be modified by adding titanium dioxide, a delustering agent, to the solution before the fibers are extruded.

2. Shape: manufactured fibers can be made to any length and diameter. In cross section the viscose rayon fibers appear as irregular circles with serrated edges. When lengthwise fibers are examined microscopically, longitudinal lines called striations are seen.

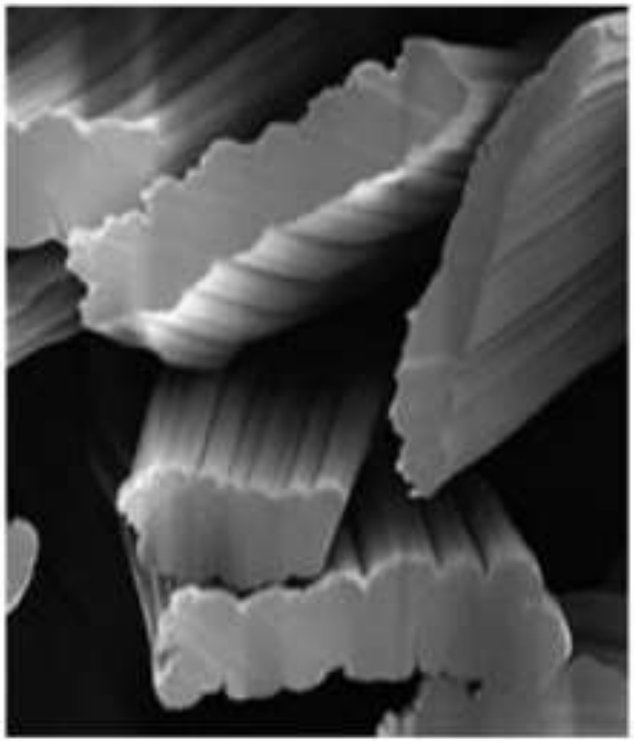


Cross-sectional and Longitudinal view of Rayon

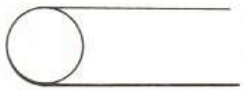
Viscose rayon of different cross-sectional shapes



"Galaxy"- a Y–shaped viscose rayon fibre with highly absorbency and bulk

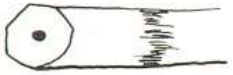


Viloft - a flat cross sectional viscose rayon fiber gives a unique soft handle and pleasing drape



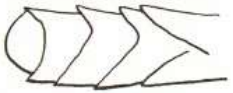
Circular, Uniform in Diameter

Nylon, Dacron, Cuprammonium Rayon



Polygonal Lumen

Flax

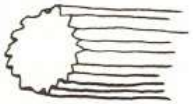


Oval to Round, Overlapping Scales,

Medulla Wool

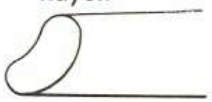
Flat Oval, Lumen Convolutions

Cotton



Circular, Serrated, Lengthwise Striations

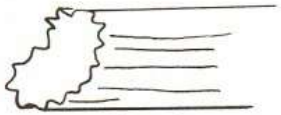
Viscose Rayon



Lima Bean, Smooth

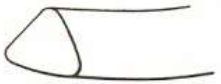
Fiber T

Darvan



Lima Bean, Serrated

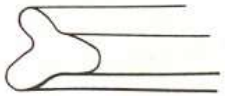
Avril Rayon



Triangular, Rounded Edges, Uniform in Man-Mades

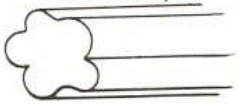
Silk, Nylon Type 90

Dacron Type 62



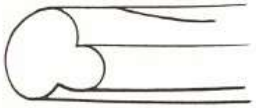
Trilobal

Antron Nylon



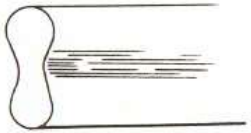
Lobular, Lengthwise Striations

Acetate



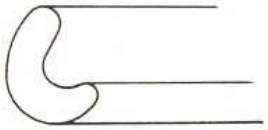
Mushroom (Multiform)

Orlon Sayelle



Dog-Bone

Orlon, Verel, Lycra



Ribbon-Shaped

Dynel

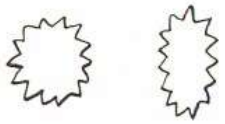
Flat, Broad

Crystal Acetate

Y-Shaped

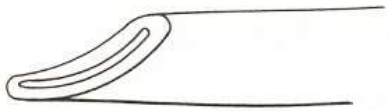
Celacloud, Type 20 Acetate

Cumuloft Nylon



Star or Concertina

Profile Fibers

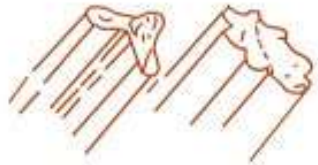


Collapsed Tube, Hollow Center

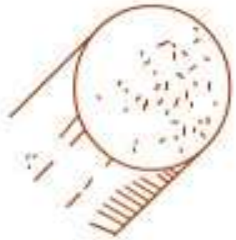
Avlin Rayon,

Vinal 5F

Rayon



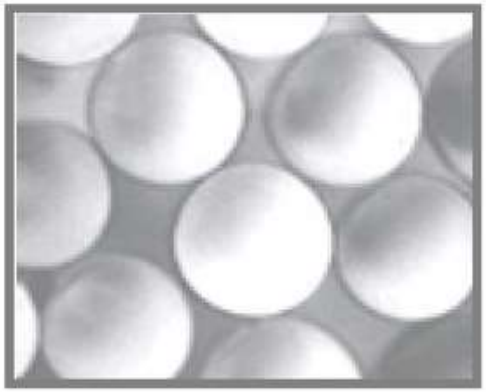
Special pitch



Pitch

PAN

Round type

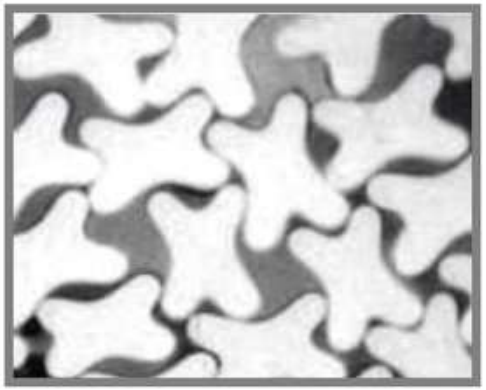


- Normal

Trilobal type

- Luster

X type



- Water uptake

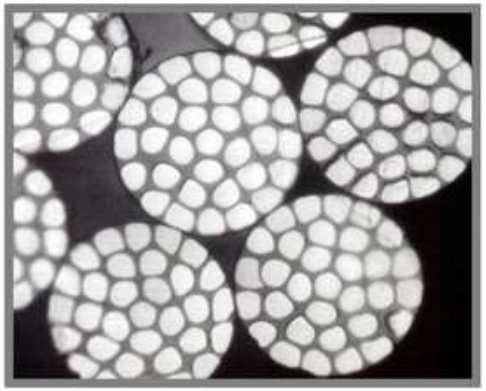
S type

- Water uptake

Hollow type

- Light

Sea-island type



- Fine

3. Specific gravity: The specific gravity of rayon is 1.51 comparable to cotton and linen. Viscose, cotton and linen of similar weave and construction will have comparable weights.

4. Strength/ Tenacity: The strength of viscose is less as compare to cotton and linen because of small polymer length. Rayon has amorphous region in its polymer system hence the strength is low. Its wet strength is also very low, so rayon fabrics must be handled carefully while laundering. High-wet-modulous rayon has good wet strength.

5. Elasticity and resiliency: rayon has poor elasticity as well as resiliency hence it tend to stretch and wrinkle badly untill certain finishes are applied.

6. Absorbency and moisture regain: The molecular structure of rayon is more amorphous than cotton and linen making it more absorbent and comfortable to wear. Moisture regain is 11% . Because of good absorbency these fibers also accept dyes readily .

7. Dimensional stability: viscose rayon stretch and having low elastic recovery, tend to remain stretched. Fabrics may be stretched during processing and exhibit relaxation shrinkage upon a first laundering. Special finishes can be given to viscose to overcome some of the problems of shrinkage.

8. Heat and electrical conductivity: The Heat and electrical conductivity of rayon is satisfactory, so that the fiber is reasonably comfortable in hot weather and does not build up static electricity.

9. Effect of heat; combustibility: Viscose fabrics must be ironed at lower temperatures than cotton. Too- high ironing temperatures will produce scorching . The recommended ironing temperature of viscose rayon is 250F. Long exposure to high temperatures deteriorates the fibre.

Chemical properties

10. Chemical reactivity: the amorphous molecular structure of viscose makes it susceptible to the action of acids and bases. Acids attack viscose more readily than cotton or any other natural cellulosic fiber. Viscose is more susceptible to damage from bases as well.

11. Resistance to microorganism and insects: Viscose is subject to damage from mildew and rot-producing bacteria. Silver fish will attack the fiber. Care in storage is necessary to prevent exposure of the fabric to conditions that encourage mildew and silver fish.

12. Resistance to environmental conditions: Exposure to sunlight will deteriorate viscose rayon more rapidly than cotton. Although it is often used in curtains and draperies, viscose rayon is not especially satisfactory for these products unless they are lined to protect against sunlight.

Uses of Rayon:

- Rayon is used in fabrics, home furnishing and industrial applications.
- The fabric is used to create clothing such as blouses, jackets, sportswear and dresses.
- In home furnishing, blankets, sheets and curtains may all be made from rayon.
- Rayon's industrial applications include medical surgical products.

USES OF RAYON

- Used in textile industry to make textiles.
- Making tyre cords.
- Making carpets and surgical dressings.
- Used to make bedspreads, curtains, blankets, etc.
- Used for sportswear, slacks, suits, etc.

Thankyou.....