Water molecules and textile fibres

- Comfort of textile materials depends upon the moisture absorbency, hygroscopic or hydrophilic nature of such material, i.e. the ability of the fibre to absorb moisture or the ability of the its polymer system to attract water molecules.
- Water plays a very important role in textiles and clothing.
- Each water molecule consists of two atoms of hydrogen and one atom of oxygen (H_2O).
- Two hydrogen atoms are on one side of the molecule, while the oxygen atom is on the opposite side. This arrangement of atoms in the water molecule shows that it can develop **Dipolar nature**.
- Dipolar nature of the water molecule is due to very electronegative oxygen atom which will disproportionately concentrate its own electrons, and the one electron from each of the hydrogen atoms, about itself.

- The oxygen atom will have excess of electrons, and assume a slight –ve charge or polarity indicated by delta-negative, whereas the two hydrogen atoms will be deficient in electrons and assumes slight +ve charge or polarity indicated by delta-positive.
- The polarity of water molecules causes them to be attracted to one another , and for the same reason they will also be attracted to any polar sites on fibre polymers.

Requirements or properties of fibre-forming polymers

Fibre forming polymers of apparel fibre should be:

- Hydrophilic
- Chemically resistant
- Linear
- Long
- Capable of being oriented, and
- Able to form high-melting-point polymer systems.

Hydrophilic properties

- Fiber polymer should be hydrophilic i.e. they should be polar, so that they can attract water molecules and making it comfortable to wear .
- A fiber consisting of hydrophilic polymers attracts water molecules which prevents the discharge of any static electricity accumulating on the fiber. The static electricity is discharged by the water molecules, because of their polarity, to the surrounding atmosphere and this will prevent the fiber from attracting dirt particles more readily and thus to soil more quickly.
- Garments that become charged with static electricity may cling together to such an extent as to create discomfort during wear.
- Fibres which are not hydrophilic and yet these are used for the manufacture of apparel. Then the textile materials of these fibres are blended with the hydrophilic fibres, for example, terry cot which is a blend of terylene and cotton.

Chemical resistance

- Fiber polymers should be chemically resistant for a reasonable length of time against the common degrading agents such as sunlight and weather, common types of soiling, body exudations (fluid emitted by an organism through pores or a wound), laundry liquors and dry cleaning solvents.
- Chemically resistant polymers should also not be toxic or hazardous to wear against human skin.
- Although fiber polymers should be chemically resistant, they should not be inert (i.e. totally unreactive).
- For example: the polymers of chlorofibres, fluorocarbon, polyethylene, and polypropylene may be regarded as chemically inert. For this reason the polymers are non-polar and hence hydrophobic, making the textiles of these fibres non-absorbent, with a greasy, slippery, aesthetically displeasing handle.

Linearity

- Fiber polymers should be linear as only linear polymer allow adequate polymer alignment to bring into effect sufficient inter-polymer forces of attraction to give a cohesive polymer system and hence useful textile fiber. For example, nitrile group of acrylics etc.
- The importance of considering side groups on polymers is that they give rise to three types of linear polymer configurations, better referred to as three types of stereo- polymers. Stereo, from the Greek, is used here as three-dimensional arrangements of the side groups on the polymer backbone. The three stereo-polymers are as follows-

- **The atactic polymer-**

- This is a stereo- irregular polymer. It has its side groups arranged at random above and below the plain of the polymer backbone.
- Atactic polymers are usually not found in the polymer systems of fibres, because they do not allow close enough alignment or orientation of polymers for the formation of effective inter-polymer forces of attraction.
- If this polymer system were used they would give an insufficiently cohesive polymer system, as indicated by the wax-like substance formed.

- **The syndyotactic polymer-**

- **T**his is a stereo- regular polymer. It has its side groups arranged in a regular alternating fashion above and below the plane of the polymer backbone.
- Such a regular polymer structure permits close enough alignment or orientation of polymers to form effective inter-polymer forces of attraction, giving a cohesive enough polymer system to form a useful fiber.
- The polymers of cellulose and some chlorofibres are thought to be syndyotactic polymers.

- **Isotactic polymer-**

- **T**his is also a stereo-regular polymer.

- It has, however, all its side groups arranged on the same side or plane of the polymer backbone.

- Isotactic polymers orient themselves readily and very closely which permits effective formation of inter-polymer forces of attraction to give a cohesive polymer system and thus, a useful fiber. E.g. polypropylene and pure acrylonitrile fibers.

Length –

- Fiber polymers should be long. Polymers constituting the commonly used apparel fibers is in excess of 100 nanometers.
- Polymers of such length can readily be oriented. Having the polymers oriented can give rise to sufficiently effective inter-polymer forces of attraction to form a cohesive polymer system and hence, a useful fiber.
- In general, the longer the polymers the more cohesive will be the polymer system and stronger will be the fiber. For this to occur the polymers have to be closely aligned or well oriented so that the maximum formation of inter-polymer forces of attraction can take place.

Orientation-

- Fibre polymers should be capable of being oriented.
- This means that the polymers are or can be arranged or aligned into more or less parallel order in the direction of the longitudinal axis of the fiber or filament.
- It is not known how the orientation of polymers occurs during the growth of natural fibers.
- In man-made fibers, during the drawing operation the extruded and coagulated filament is stretched, which causes the polymers to orient themselves longitudinally into a more or less parallel order.
- The two orientation forms are amorphous and crystalline regions.

Amorphous polymer orientation

- Polymers are oriented or aligned at random
- Interpolymer forces of attraction will be less effective
- Permits easier entry of water and dye molecules
- In general, more amorphous fibers are:

- More absorbent
- Weaker
- Less durable
- More easily degraded by chemicals
- More easily dyed
- More pliable, softer handling
- Plastic, more easily distorted

Crystalline polymer orientation

- Polymers are oriented or aligned longitudinally into more or less parallel order
- Interpolymer forces of attraction will be more effective
- Restricts the entry of water and dye molecules
- In general, more crystalline fibers are:

- Less absorbent
- Stronger
- More durable
- Less easily degraded by chemicals
- Less easily dyed
- Less pliable, stiffer handling
- Less plastic, resist being distorted

- **Formation of high melting point polymer systems-**

- Such fibers tends to have adequate heat resistance to enable it to withstand the various heat treatments of textile finishing, apparel manufacture, and the heat subsequently applied to it during laundering and pressing or ironing during its useful life as a garment.

- The fiber's melting point needs to be above 225 degree C if it is to be useful for textile manufacture and apparel use.

- Longer the polymers and better the orientation, the more inter-polymer forces of attraction will be formed, giving a more cohesive polymer system with a higher melting point. This means more heat or kinetic energy will be will be required to break the inter-polymer forces of attraction.