

Synthetic Fibres and Plastics

FIBRES

Fibres are threads which are used to make various materials.

These thread like structures are either obtained from living things or are created artificially.

1. **Natural Fibres** : Natural fibres are obtained from living things that exist in nature. They are obtained either from plants and animal sources. . Ex. Silk, Jute, Cotton and wool.

FIBRE	OBTAINED FROM
Flax, jute and Hemp	skin surrounding the stem of the respective plant and hence called skin fibres.
Coir	a coconut fibre which is obtained from coconut.
Tree Wood	obtained from stocks of different plants like bamboo, straw of wheat or rice.
Wool	obtained from a lot of animals like sheep
Silk	Silkworm
Cotton	obtained from seeds of cotton plants.

Advantages : Biodegradable, Comfortable to wear.

Disadvantages: Expensive (like Silk), Difficult to maintain (Wool shrinks too), Get wrinkled (Cotton), Non-durable (Jute hard).

2. **Artificial Fibres / Synthetic Fibres** : Also called Man – made fibres. They obtained artificially.
 Ex: Nylon (Use for making ropes / clothes), Rayon and polyester (for clothes etc.)

Advantages: Economical, Dry faster (do not soak/absorb water), Wrinkle free (hence easy to maintain), Durable. They are not limited and expensive as compared to natural fibres and hence people started making them artificially in bulk.

Man – made fibres (Artificial) are of two types:

- Cellulosic Fibre: Made from a plant product, cellulose. Example → Rayon
- Non Cellulosic (Synthetic) Fibre: Made from chemicals, Example → Nylon

MAKING OF ARTIFICIAL / SYNTHETIC FIBRES

Most of the artificial fibers are made up of polymers which are in turn made up of small units called monomers.

So,

Polymer:

Polymer (=Poly + mer. POLY=many ... MERS= parts).. i.e. many molecules

Contains many repeating units in a long chain, Each repeating units is a monomer.

Example:

XY – XY – XY – XY – XY (A single polymer may be made up of as many as 2,00,000 monomers).

- **Monomer (= mono + mer. MONO=single ... MER= part) . i.e. one molecule**
- For Example
- **Glucose (C₆H₁₂O₆) → Monomer BUT**
- **Cellulose (C₆H₁₂O₆ - C₆H₁₂O₆ - C₆H₁₂O₆) → Polymer** It occurs in cell – wall of plants.
- Few more examples of a polymer are STARCH AND NYLON, because they are made up of bonding of various monomers together.

The basic chemical **formula** of the **starch** molecule is (C₆H₁₀O₅)_n.

Starch and Cellulose

Starch and **cellulose** are two very similar polymers. In fact, they are both made from the same monomer, glucose, and have the same glucose-based repeat units.

There is only one difference. In starch, all the glucose repeat units are oriented in the same direction. But in cellulose, each successive glucose unit is rotated 180 degrees around the axis of the polymer backbone chain, relative to the last repeat unit.

Does this make any difference? It makes a lot of difference! The most important difference in the way the two polymers behave is this: You can eat starch, but you can't digest cellulose. Your body contains enzymes that break starch down into glucose to fuel your body. But we humans don't have enzymes that can break down cellulose. Some animals do, like termites who eat wood, or cattle who eat grass and break down cellulose in their four-chambered stomachs.

Cellulose is also a lot stronger than starch. Starch is practically useless as a material to make things, but cellulose is strong enough to make fibers, and hence rope, clothing and paper products. Cellulose doesn't dissolve in water the way starch does, and certainly doesn't break down as easily.

HOW ARE FIBRES MADE ????

These polymers are first formed from monomers by a process called polymerization (joining of various monomers together). The polymer then formed then undergoes a process called spinning.

Let's now understand how these artificial fibres are made

Initially when a polymer is made (Joining many monomers together), it is very thick and viscose. This thick polymer is passed through a machine is called Spinnert. This comes in different shapes and has holes of different sizes like incase of a sieve or channi used in kitchen. The polymers which are not exactly solids but are like a thick liquid, they come out of these holes. When they come out as thin liquid strands, they solidify to form fibres.

SYNTHETIC FIBRES

Obtained from Petrochemicals - obtained from Petroleum.

Man- made Fibres are : Rayon , Nylon , Polyester , Acrylic.

1. Rayon

- Also called artificial silk. It is used as a substitute for silk.
- First man – made fibre.
- Obtained from cellulose of wood pulp and cotton.
- It is also called a semi synthetic fibre. This is because it is made not only of artificial materials but also made up of wood pulp which occurs naturally in nature.
- Wood pulp contains a polymer called cellulose. This polymer is then chemically converted into a soluble compound by chemical reactions and this soluble compound is then passed through a spinneret. The filaments that come out are then solidified and these make up the Rayon fibre.
- Hence rayon is also called a cellulosic polymer.

Properties:-

- Lustrous and soft
- Economical
- Comfortable
- Can be dyed easily
- Absorbs moisture

Uses:-

- Clothing (Reason: Lustrous, Bright, Comfortable)
- Furnishings (Blankets, Bedspreads, Curtains, Carpets)
- Industries (Medical products)

2. NYLON

First man-made fully synthetic fibre (Unlike Rayon which is semi synthetic).

- Non – cellulosic polymer
- Obtained from coal, air, water
- The structure of nylon also has various repetitive units of monomers joined together by bonds.
- Nylon is prepared from coal, water and air. With the help of these three things various acids, amines or a mixture of di-amines or di-acids. These react together to form what we called Nylon.
- It is prepared in chemical plants using organic material obtained from coal. Organic means carbon containing materials. Coal contains carbon. So for preparing nylon two large molecules are reacted together to form a polymer that is Nylon.

Properties:-

- Lightweight
- Elastic
- Strong
- Wrinkle free
- Dries faster

Uses:-

- Swimsuits, Raincoats, Umbrellas, Hats
- Leggings, Curtains, Carpets, Ropes, Packing materials
- Toothbrush, Bath sponges, Tents, Fishing nets, Parachutes, Tyres.

3. POLYESTER

Poly means many

- **Polymer of ester (Polyester = Poly + ester i.e. many esters linkages)**
- **Ester is a carbon containing chemical compound.**
- Depending upon which other thing it is mixed with a polyester can form different things.

- **Eg. Polyester + Cotton → Polycotton.**
- A synthetic fibre
- Example → Terylene (used to make fabric cotton mixed with other types of fibres to make different varieties of fabrics)
- → PET (Polyethylene terephthalate)

Properties:

- Strong, Durable, Stretchable (elastic)
- Wrinkle free
- Easy washing
- Dries faster

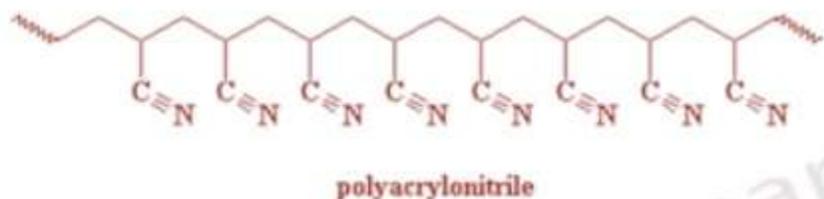
Uses:

- Dress material. Since it does not wrinkle easily it is used to make many clothes.
- Polycot, Polywool, Pillow stuffings.
- Bottles and storage containers (PET)
- It is used to give a finishing look by coating it on wood products like on guitar, piano etc.
- It is also combined with many fibres to form different types of clothes.
- E.g. Terylene + Cotton → Terrycot
- Polyester + Wool → Polywool

4. ACRYLIC

Another Synthetic fibre

- A substitute for wool- resembles wool
- Polymer – prepared from Polyacrylonitrile by polymerization reaction.
- Monomer – Acrylonitrile. Around 900 monomers joined to form Polyacrylonitrile. This is dissolved in solvent and passed through a spinnerette.



- **Properties** – Soft, Lightweight, Warm
- Economical
- Resistant to weathering
- **Uses** - Sweaters, Socks, Blankets
- **Used to make Acrylic lenses, acrylic sheets (instead of using a glass).**

ADVANTAGES OF SYNTHETIC FIBRES

1. Absorb less water, hence dry faster (used for umbrellas and raincoats)

EXPT 2:

- Take cotton, wool and nylon fabrics
- dip in the same amount of water
- spread the cloth for drying
- OBSERVATION: 1. Water left in beaker
2. Time taken for drying

Result:

- i. Water absorbed → Nylon < Cotton < Wool
- ii. Water left → Wool < Cotton < Nylon
- iii. Time for drying → Nylon < Cotton < Wool

2. Economical

3. Chemical Resistant – Do not react with acids, alkalis and harmful chemicals. Natural fibres are easily damaged.

DISADVANTAGES OF SYNTHETIC FIBRES

1. Shrink and Melt on heating. Do not burn, but melt and stick. Hence, it is advised to use cotton fabric in laboratory, kitchen and industries using flame.
2. Do not absorb Sweat.
3. less comfortable to wear.
4. Production process might harm environment

PLASTICS

Look around yourself and you will see a lots of things made up of plastics. Why do we use plastics?

Characteristics of Plastics

- Easily moldable to different shapes
- Reusable
- Light
- Poor conductor of electricity,
- heat resistant for example, bake light
- do not react with water and air
- durable – no rusting, no corrosion
- can be moulded into wires and sheets.
- Can have variety of colors

Its old name is plastikas (capable of been shaped / moulded)

It is a polymer.

There are different types of plastics with different properties.

TYPES OF PLASTICS

Depending on their behavior when heated, plastics can be classified into 2 types:

- 1) **Thermoplastics**
- 2) **Thermosetting Plastics**

Thermoplastics and thermosetting plastics are two separate classes of polymers, which are differentiated based on their behavior in the presence of heat. The material difference between the two is that **thermoplastics can be remelted**, while **thermoset plastics remain in a permanent solid state once hardened**

THERMOPLASTICS

Thermo means HEAT.

These thermoplastics:

- Melt on heating and forms new shapes on cooling.
- Hence, easily reformed or bent
- Shape – long, linear, polymer chains.
- Chains are weakly connected.
- Weak bonds are broken easily on heating.
- On cooling, weak bonds are reformed changing the shapes.

- For example: Polythene, PVC – used for making pipes (they are rigid but flexible on heating)

Uses of Thermoplastics

- Plastic wraps, Containers, lighting panels, Garden hoses, bags, Toys etc.

THERMOSETTING PLASTICS

- These plastics don't get deformed on heating.
- For example: Electrical appliances, utensils, etc. are exposed to more heat and hence are made up of thermosetting plastics.
- Thermosetting plastics:
 - Once molded, do not deform on heating
 - Heat & Fire resistant
 - For example: Bakelite (heat resistant, poor conductor of electricity. So used in electrical appliances as it is poor conductor of electricity. It is also used in kitchenware), melamine (used for making dinner sets, plates etc. which don't easily break)

Melamine	Bakelite
Tolerates heat and fire	Poor conductor of heat and electricity
E.g. Household products – Crockery	E.g. Circuit Board – Electrical Switches

Composition of thermosets

- Linear polymer chains are cross linked. Strongly bonded. Unaffected by heat.
- Hence, thermosets cannot be melted / reformed/ remolded.
- 20% plastic.

Uses of thermosets

- Household products – spatula
- Handles of cookware
- Kitchenware – plates, bowls
- Glue, Varnishes
- Electronic components (circuit board, Switches)
- Floor tiles

PROPERTIES / CHARACTERISTICS OF PLASTICS

1. Chemical Resistant

- Application : Plastic storage containers / bottles can store chemicals without reacting with them.

2. Lightweight, Strong, Durable Economical

- Application: Plastics used in aircrafts, spacecrafts, cars, lightweight household and industrial products – strong, durable.

3. Thermal and Electrical Insulators

- Application: Handles and holders of cookware are made of plastics.

Example:

Coffee pot handle, Microwave, Cookware, Refrigerators, Dispensers – Thermal insulator.

Electrical appliances, wires, cords covered with plastic – Electrical insulator.

DISADVANTAGES / DANGERS OF PLASTICS

1. Environmental Damage

- Non – biodegradable.
- Does not decompose easily by microbes (fungi and bacteria).
- Hence, plastic waste is increasing uncontrollably. (A single plastic bag can take up 1000 years to decay completely).

2. Animals Death

- Ecological imbalance
- Polybags eaten by animals, chokes and causes death.

3. Suffocation

- Thin, air tight, plastic bags can block nostrils and mouth.

4. Pollution

- Non – biodegradable, hence, removed by burning.
- Releases toxic gases increasing pollution.

5. Fumes

- Air pollution, due to release of SO₂ – Sulphur dioxide
NO₂ – Nitrogen dioxide, SO₃ – Sulphur trioxide

PLASTIC WASTE MANAGEMENT

3 R's Principle:-

Reduce – Minimize plastic use. Use glass instead of plastic or Jute / Cotton wherever possible.

Reuse - Empty containers can be reused for different purposes.

Recycle - Thermoplastics – Easily recycled – Hence remolded into new shapes.

straight lined polymer which also turns elastic