3 Synthetic Fibres and Plastics

A **fibre** is a kind of thread which is strong and flexible enough to make clothes, nets, ropes, shirts, sarees, curtains, bedcover, towels, bags, etc. All these clothing materials are called **fabrics** and are woven out of fibres. Fibres are used for making a large variety of household articles.

TYPES OF FIBRES

Fibres are of two types: **natural fibres** and **man-made fibres**.

Natural Fibres

These fibres are obtained from natural sources. We get these fibres either from plants (cotton, jute, flax, coir) or animals (wool, silk). Some of the commonly used natural fibres and their sources are given in Table 3.1.

TABLE 3.1
Natural Fibres and their Sources

Natural fibre	*Sources*
1. Cotton	From the fruit of cotton plant
2. Linen	From the stem of flax plant
3. Hemp	From the stems of the marijuana plant
4. Jute	From the stem of the jute plant
5. Wool	From the soft hair of sheep, goat, rabbit and camel
6. Silk	From the cocoon of the silkworm

Man-made Fibres or Synthetic Fibres

These fibres are made by human beings by chemical processes. That is why these are called synthetic or man-made fibres. These fibres are obtained from coal, petroleum and natural gas.

You have already learnt about these fibres in class VI and VII. You will study about synthetic fibres in this section.

In 1935, the first synthetic fibre — **Nylon** was made by an American chemist **W.H. Carothers**.

WHAT ARE SYNTHETIC FIBRES MADE OF?

A synthetic fibre is made up of a long chain of small units joined together to form a **polymer**. Each small unit is called a **monomer**. A polymer is made by joining together thousands of monomers.

The process of linking together small monomers to form polymers is called **polymerisation**.

n (monomers) $\xrightarrow{\text{polymerisation}}$ polymer

There are two types of polymers.

1. **Natural polymer:** Silk, wool, cotton.
2. **Synthetic polymer:** Nylon, rayon.

COMMON SYNTHETIC FIBRES

Rayon

The artificial silk prepared from cellulose is called **rayon**. Rayon resembles silk in appearance, texture, shine and hence the name artificial silk. There are several varieties of rayon. Rayon is obtained from a natural source like wood pulp.

Properties of Rayon

1. Rayon is strong and an extremely absorbent fibre.
2. It burns at high temperature.
3. It does not melt.
4. It has a soft, silky touch and drapes well.
5. It wrinkles easily and may stretch or shrink when washed.

Uses of Rayon

1. It is used in the manufacturing of fabrics for sarees.
2. It is used for making dresses, aprons and caps, when mixed with cotton (50%-50%) (Fig. 3.1).

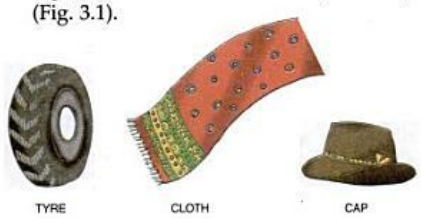

Fig. 3.1 Uses of rayon

3. It is used in medical field for making gauze (for making bandages) and lint (for dressing wounds).
4. It is used for making tyre cord.
5. It is used for making carpets, when mixed with wool.

Nylon

Nylon is a synthetic **polyamide** fibre. In this respect nylon resembles with silk and wool which are also natural polyamide fibres. It was the first fully synthetic fibre. It is made from petroleum products.

The name **nylon** comes from the fact that it was developed in New York and London simultaneously (**ny** from New York and **lon** from London).

Properties of Nylon

1. It is very strong and fairly elastic (Activity 3.1).
2. It absorbs very little water, hence dries up rapidly (Activity 3.1).
3. It resists wrinkles and keeps permanent creases.
4. It is not attacked by moths and moulds.
5. It is fine, light and durable.

ACTIVITY 3.1

Nylon has Maximum Tensile Strength

Take an iron stand with a hook and tie one end of a cotton thread with the hook. Now tie weights on the other end of the thread. Keep increasing the weight until the thread breaks. Repeat the process with nylon and wool. You will find that the total weight required to break the thread was maximum in nylon, followed by wool and cotton. This activity proves that nylon has the maximum tensile strength followed by wool and cotton.

ACTIVITY 3.2

Nylon Absorbs Very Little Water

Take two socks of the same size. One of these should be of cotton and the other of nylon. Soak these socks in different mugs containing the same amount of water. Take out the socks from the containers after 10 minutes and spread them in the sun for drying. Compare the volume of water left in each mug. You will find that the volume of water is more in the mug containing the nylon sock than the volume of water in the other mug. What does this indicate? This activity proves that different fibres have varying water absorbing capacities. The nylon socks will dry

faster than cotton socks. It is because nylon socks retain less water than cotton socks.

Uses of Nylon

1. Because of its high tensile strength, it is used for making fishing nets, tyre cords, climbing ropes, parachute fabrics, bristles for tooth brushes and paint brushes (Fig. 3.2).

Fig. 3.2 Uses of nylon

2. It is used in the production of textiles like sarees, shirts, neck-ties, socks and other garments.

Polyester

Polyester is another synthetic fibre. It is actually made up of the repeating units (monomers) of esters. Polyester is made from petroleum products.

Terylene, decron and **terene** are examples of polyester fibres. Fabrics are sold in the market by names like **polycot** (polyester + cotton), **polywool** (polyester + wool).

PET (polyethene tetraphthalate) is a very familiar form of polyester.

Properties of Polyester

1. It is strong and wrinkle resistant.
2. It retains creases.
3. It is not attacked by moths and moulds.
4. It absorbs very little water, so clothes dry out quickly.
5. It is not so elastic and is, therefore, unsuitable for stockings.
6. It is quite resistant to the action of chemicals.

Uses of Polyester

1. It is widely used for making fabrics for suits, jackets, shirts, trousers, sarees and other dress materials.
2. It is used for making sails for boats.
3. It is used for making protective clothing for the workers in chemical industries.
4. It is used for making fire hoses and conveyor belts.
5. PET is used for making bottles, utensils, films, wires, etc.

Fig. 3.3 Uses of terylene

Acrylic

Acrylic fibre is obtained by the polymerisation of **acrylonitrite** monomer. The clothes made from this fibre are relatively cheap and are available in a variety of colours. It resembles closely with wool in its properties.

Some of the well-known acrylic fibres are **orlon, acrilon** and **cashmilon.**

Properties of Acrylic

1. They are resistant to the attack of moths and other insects.
2. They are quite resistant to the action of chemicals.
3. They are washable and shrink-proof.

Uses of Acrylic

They are used for making sweaters, shawls and blankets.

DISTINCTION BETWEEN VARIOUS TYPES OF FIBRES

We can distinguish between the various types of fibres by the **burning test.** For example, we can distinguish between the fibres of cotton, wool, silk, rayon, nylon, polyester and acrilon by burning a small piece of each of these fibres. Table 3.3 shows the result of burning of these fibres.

ACTIVITY 3.3

Suspend small pieces of cotton, wool, silk, nylon, rayon and acrilon from some support. Bring a burning matchstick to each one of them at their loose ends. Allow them to burn for sometime and make observations. Draw your inferences about the nature of fibres on the basis of information given in Table 3.3.

ACTIVITY 3.4

Put a piece each of wool, cotton, rayon and nylon in water, 10% sodium hydroxide (NaOH) and acetic acid separately. Observe what happens. You will find that wool is soluble in 10% NaOH, while nylon and rayon are soluble in acetic acid.

Advantages of Synthetic Fibres

1. They are strong and cheaper.
2. They are crease resistant.
3. They are not attacked by moths and moulds.
4. They are easy to wash and maintain.
5. They dry up quickly.
6. They can be dyed in attractive colours and shapes.
7. They are light, durable and easy to maintain.

Disadvantages of Synthetic Fibres

1. They do not allow air to pass freely through them and hence are not good for summer.
2. They do not absorb sweat as well as natural fibres do.
3. They get damaged by high temperature when ironed.
4. They catch fire more easily than cotton or wool.

TABLE 3.3

Testing Fibres by Burning a Thread

Fibre	*Result of burning*
Cotton	Burns vigorously, with a characteristic smell of burning paper. No beads produced.
Wool and Silk	Burns slowly with a smell of burning feathers or hairs. No bead formation.
Rayon	Burns readily with a smell of burning paper.
Nylon	Burns slowly, fabric shrinks from flame, forms a bead.
Polyester	Burns slowly, forms a bead.
Acrilon	Shrinks from flame, forms a black bead and a sooty flame.

PLASTICS

Any synthetic material which can be easily moulded into any desired shape on heating is called **plastic**. Plastic is also a polymer like the synthetic fibres. In some plastics, the arrangement of monomers is linear whereas in others it is cross-linked as shown in Fig. 3.4.

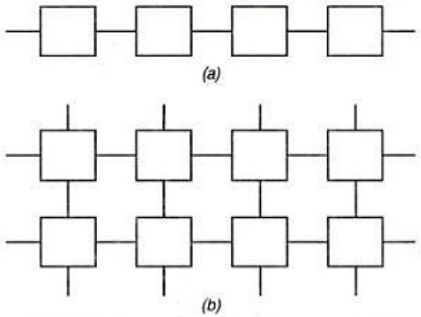

Fig 3.4 Linear and cross-linked arrangement of monomers in plastic

Plastic can be reused, recycled, coloured, melted, and rolled into sheets and wires. This is the reason that it finds such a variety of use in our life.

The twentieth century may be known as the plastic age. To a great extent, plastics are taking up the place of wood, glass, cloth, metal, paper, stone, etc. We have toys and chairs made of plastic instead of wood. Bottles and raincoats are now made of plastics. Toothbrushes, hairbrushes, combs, ropes, etc. are also made of plastics. We buy our eatables and many other things in plastic bags or wrappings. We play plastic records on our record players. Thus, plastic materials are all around us.

Fig 3.5 We use a variety of plastic products

Properties of Plastics

1. They are cheap, light and available in different colours.
2. They are strong, durable and resistant to corrosion.
3. They can be moulded to any shape when hot.
4. They are sensitive towards heat and melt quickly on heating.
5. They are bad conductors of heat and electricity.
6. They may be transparent, translucent or opaque.

ACTIVITY 3.5

Plastics are Lighter than Water and are Heat-sensitive

Collect a few pieces of used photographic film or X-ray films. Try to see through these pieces. Are you able to see through these pieces? Take a small piece of plastic and drop it into a container half-filled with water. What do you observe? You will find that it floats on the surface of water which shows that it is lighter than water.

Heat one piece of this film on a flame. You will find that it melts quickly which shows that it is very sensitive towards heat.

Types of Plastics

There are two types of plastics.

1. Thermoplastics
2. Thermosetting plastics

Thermoplastics

A plastic substance which can be melted repeatedly by heating and can be moulded again and again into different shapes is called a **thermoplastic** polymer. **Polythene, PVC** and **polystyrene** are common examples of thermoplastics.

Thermosetting Plastics

A plastic substance which does not soften much on heating and can be moulded only once is called a **thermosetting plastic.** Thus, softening and moulding are irreversible. **Bakelite** and **melamine** are common thermosetting plastics.

ACTIVITY 3.6

List ten substances made of plastics which you use in your daily life. Classify them as thermoplastics and thermosetting plastics.

Some Common Thermoplastics and their Uses

Polythene (or polyethylene)

Polythene is obtained by the polymerisation of ethylene monomers. It is a thermoplastic polymer. It is unbreakable, corrosion resistant, tough and flexible. It is resistant to chemical actions by acids, alkalis and other organic solvents. It is an insulator.

Uses

1. It is used as a waterproofing material.
2. It is used for making containers and pipes for storing and transporting water, oil and other materials.
3. It is used for making bags and for wrapping food and other eatables.

Fig. 3.6 Polythene bags

Polyvinyl Chloride (PVC)

It is also a thermoplastic. It is obtained by the polymerisation of vinyl chloride. It is tougher than polythene.

Uses

1. It is used as insulating covering for electrical wiring.
2. It is rolled between rollers to produce PVC sheets.
3. It is used for making hand bags, rain coats and floor covering materials and covering for suitcases.
4. It is used to cover motor car seats and furniture.
5. It is used for making gramophone records and refrigerator linings.
6. It is also used for making shoes and shoe soles.

Fig. 3.7 Electric wires are coated with PVC

Polystyrene

It is a thermoplastic and is obtained by the polymerisation of styrene monomers. It is one

of the cheapest plastics and is lighter than polythene. It is hard and brittle. It can be blown-up into a very large foam containing air bubbles. In this form, it is called **styrofoam** or **thermocole.**

Fig. 3.8 Thermocole used for packing

Uses

1. It is used as packing material for expensive items such as refrigerators, TVs, cellphones and other fragile objects (Fig. 3.8).
2. It is used as a thermal insulator in the hollow walls of refrigerators and coolers.
3. It is used for making toys, lamp shades and thermos flasks.

Perspex

Perspex is a substitute for glass. It is transparent and unbreakable.

Uses

1. It is used for making the windscreens of cars and windows in aircrafts.
2. It is also used in street light fittings and telephones.

Fig. 3.9 Perspex is a transparent plastic

Polypropylene

It is a thermoplastic and is obtained by the polymerisation of propene monomer. It is a rigid and tough plastic.

Uses

1. It is used for making gloves used by surgeons, while they perform operations.
2. It is used for making fishing nets.
3. It is used for making different kinds of brushes.

Teflon or Polytetrafluoroethylene

It is a thermoplastic and is a polymer of tetrafluoroethylene. It is one of the best plastic polymers. It has a much higher melting point, very low friction (non-stick) and is quite inert.

Uses

1. It is used for making non-stick cookwares (Fig. 3.10).

Fig. 3.10 A non-stick frying pan is coated with teflon

2. It is used as lubricants in ball-bearings, chains, brakes, etc. in bicycles and motor vehicles.
3. It is used as a fabric protector as any liquid spilled on the fabric roll off its surface and stains are easily released during cleaning.
4. It is also used as a lens coating.
5. It is used for coating industrial parts to increase their durability.

Some Common Thermosetting Plastics and their Uses

Bakelite

It is a thermosetting polymer. It is made by reacting phenol with formaldehyde in the presence of a catalyst. It is hard, stiff and a good electrical insulator.

Uses

1. It is used for making plugs, switches, telephone cases and other electrical fittings.
2. It is used for making radio and television casings.
3. It is used for making handles of tea-kettles, sauce pans and pressure cookers.
4. It is used for making artificial leather.

(a) Handle of pressure cooker

(b) A telephone case

Fig. 3.11 Articles made of thermosetting plastics

Melamine

It is also a thermosetting polymer. It is hard. It resists fire and can tolerate heat better than other plastics.

Uses

1. It is used for making unbreakable dinner ware and decoration pieces.
2. It is used for making floor tiles.
3. It is used for making fire proof fabrics.

DISADVANTAGES OF EXCESSIVE USE OF PLASTICS

Excessive use of plastic has led to certain environmental hazards and this is becoming a global concern.

Since plastic takes several years to decompose, it is not environment friendly. A material which gets decomposed easily by the activity of microbes is called **biodegradable.** A material which cannot be decomposed by microbes is called **non-biodegradable.** Almost all the plastic which we use are non-biodegradable.

The problems associated with the excessive use of plastics are given below.

1. Plastic materials when thrown out destroy the natural beauty of a place and provide homes for many pathogens.
2. Plastic bags choke the drains which results in overflowing of waste water. This provides a good breeding place for mosquitoes.
3. Plastic bags sometimes eaten by stray animals along with leftover food results in their death (Fig. 3.12).

Fig. 3.12 Feeding on plastic bags can cause illness in domestic animals

4. Use of recycled plastic bags to keep food items is harmful for health.
5. Burning of plastic releases poisonous gases into the atmosphere causing air pollution.
6. It reduces the percolation of water into the soil and prevents replenishment of ground water.
7. Dumping of plastic goods in waterbodies poses a threat to aquatic life.
8. It causes soil pollution.

MEASURES TO TACKLE PLASTIC POLLUTION

The environmental problem caused by plastic has become so alarming that people are advised to use following methods to prevent health hazards.

1. Reduce your dependence on plastic bags and other items made of plastics.
2. Carry your own cloth bag or jute bag for shopping.
3. Never burn plastic bags and other plastic items in the open.
4. Don't throw plastic articles here and there after use.
5. Say 'No' to plastics to save the future generation.
6. Keep plastic bags clean and dry for reusing.
7. Keep separate garbage bins in your home for biodegradable (green bins) and non-biodegradable wastes (blue bins).
8. Recycle thermoplastic goods for reuse.
9. Avoid the use of plastic as far as possible.
10. Use biodegradable plastic instead of non-biodegradable plastic.
11. Follow and practice the 4-R principle of **reduce, reuse, recycle** and **recover** to minimise environmental pollution.

EVALUATION

OBJECTIVE EVALUATION

A. Write True (T) or False (F) against the following statements in the given brackets.

1. Polyester shrinks on washing. ( )
2. Plastics are not affected by heat. ( )
3. Acrilon is a pure wool obtained from sheep. ( )
4. Bakelite is a thermosetting plastic. ( )
5. P.V.C. is a good conductor of electricity. ( )

B. Fill in the blanks.

1. P.V.C. is the short form of ..... .
2. Teflon is used for making ..... cookware.
3. Plastics are ..... material.
4. A material that can be decomposed by natural processes is called a ..... material.
5. Bakelite is a ..... plastic.

C. Match the items in Column A with the items in Column B.

Column A	Column B
1. Rayon	(a) Unbreakable kitchen ware
2. Nylon	(b) Non-stick pans
3. Melamine	(c) Handles of saucepan
4. Teflon	(d) Tooth brush
5. Bakelite	(e) Bandages

D. Tick (✓) the only correct choice amongst the following.

1. Which one of the following is used for making non-stick pans?
   (a) polystyrene (b) polypropylene (c) teflon (d) polythene
2. Which plastic is unbreakable and can be used as a substitute for glass?
   (a) perspex (b) teflon (c) PVC (d) polystyrene
3. Which of the following is a bad conductor of electricity?
   (a) plastics (b) copper (c) iron (d) gold
4. Which of the following is a natural fibre?
   (a) PVC (b) jute (c) nylon (d) rayon
5. Which of the following is highly inflammable?
   (a) polystyrene (b) bakelite (c) PVC (d) polythene

SUBJECTIVE EVALUATION

E. Answer the following in one word or very briefly.

1. Name two synthetic fibres.
2. Why is rayon called artificial silk?
3. Give two properties of nylon fibre.
4. Which plastic can be used as a substitute for glass?
5. Name the plastic used to make non-stick cookware.

F. Answer the following in brief.

1. List the advantages of synthetic fibres over natural fibres.
2. List three qualities of polyester.
3. Name two thermosetting plastics.
4. What is a non-biodegradable material?
5. Why are synthetic clothes not suitable for summer?

G. Answer the following in appropriate detail.

1. What is a synthetic fibre? Name three synthetic fibres.
2. State four advantages of synthetic fibres.
3. What are thermoplastics and thermosetting plastics? Give two uses and examples of each.

H. Projects and activities.

1. Cut pieces of fabric from old and discarded clothes. Categorize them as knitted or woven fabric. Separate thread from each of these fabrics. In which case is it easier to separate yarn and why?
2. Find out what kind of measures are taken in your locality to dispose of plastic wastes. Can you suggest some methods to the residents of your area?
3. Design an eco-friendly bag.
4. Form a plastic awareness club with your friends and design a poster on the topic 'say no to plastics' to discourage people from using plastic bags.