

Polymerization

Is the combination of many molecules of the same compound with relatively small Molecular masses to form one complex molecule with very large molecular mass.

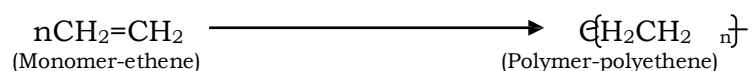
The complex molecule with a large molecular mass formed by the combination of many molecules of relatively small molecular masses is called the polymer. The small molecules from which a polymer is built are called monomers

Types of polymerization

These are mainly two i.e. addition and condensation

Addition polymerization

This is a combination of many small but unsaturated molecules to form a large molecule without any other product. In this case, the polymer possess the same empirical formula as the monomer. E.g. in the formation of polyethene



Condensation polymerization

In the condensation polymerization, two different molecules combine to form one large Molecule with consequent loss of simple molecules like water, hydrogen chloride etc. so the empirical formula of the monomer and the polymer are not the same e.g. formation of starch from glucose and formation nylon 6,6

Types of polymers

Polymers can broadly be divided into two groups namely natural polymers and Synthetic polymers

Natural polymers

Polymer	Monomer	Use
Starch	Glucose	Source of energy
Proteins	Amino acids	Repair of worn out tissues
Cellulose	Glucose	Cell walls
Glycogen	Glucose	Source of energy
Lipids (fats and oil)	Fatty acids and glycerol	Source of energy,
Natural rubber	Isoprene	Making foot wears

Synthetic polymers

polymer	Name	Use
Polyethene	ethene	-Making containers, eg plastics bowls and dust bins -used as wrapping materials
Polyvinyl chloride (PVC)	Chloro ethane (vinyl chloride)	-Making rain coats -Electrical insulation -making pipes and films
Polystyrene	styrene	-making packing materials - making house hold items such as combs, plastic cups and a common lining in refrigerators

Natural polymers are polymers which exist on their own while synthetic (artificial) polymers are made by man.

Classes of addition polymers

There are two main classes of addition polymers i.e. plastics and rubber.

Plastics

A plastic is a substance which when soft can be formed into different shapes

Plastics are minor products formed by cracking of crude oil eg polyethene. Polyvinyl chloride. Melamine

All synthetic polymers are plastics in nature

Advantages of plastics

- They are good thermal and electrical insulators
- They can easily be shaped and molded (they are ductile)
- They resistant to acids and alkalis and they do not rust
- plastics can be colored when they are being manufactured and they do not need repainting
- They are light and therefore portable
- They are cheap

Disadvantages

- Produce poisonous fumes when they are burnt
- They are non biodegradable i.e they do not decay naturally
- Where serious fire hazards occur, molten plastics can inflict very severe burn

Types of plastics

Plastics can be put into two types depending on their behavior upon heating i.e thermo- softening plastics and thermo-setting plastics

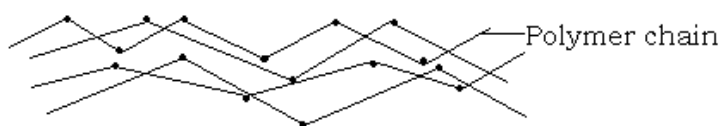
a) Thermo- softening plastics (Thermo-plastics)

These are plastics that soften or melt when heated and can be therefore be moulded into any shape while they are still soft. The plastics only harden when they cool.

Structure of thermo-plastics

The long polymer chains in thermoplastics lie along side each other. They may be

entwined on each other but the polymer chains are not linked (not bonded to each other). When heated, the chains slide over each other making them soft and runny.



Examples of thermoplastics

1. Polythene

Polythene is a polymer of ethene. There are two types of polythene i.e. low density polyethene and high density polythene.

i) Low density polythene

This is made by polymerizing ethene at a high pressure of 1000-2000 atmospheres and temperature of 200°C. Oxygen is used as a catalyst. It has a lower softening temperature of 105°C-120°C. The low density is due to poor packing of the branched polymer chains.

The low density polythene is soft, light and flexible

Uses:

For making polythene bags; insulation of electric cables because they can withstand bad weather conditions; making of squeeze bottles such as wash bottles; making plastic bags.

Disadvantage:

At boiling water temperature, they become soft so much that they become flappy and lose shape.

ii) High density polythene

It is made by polymerizing ethene at low pressure (5-25 atmospheres) and low temperature (20-50°C) in the presence of a Ziegler catalyst. It has a higher softening temperature of about 140°C. The high density is due to the close packing of the unbranched polymer chains. Very few of these polymers may be branched.

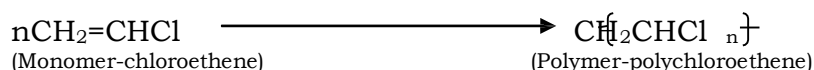
They are much harder and stiff and do not lose shape at boiling water temperature.

Uses

For making crates e.g. of beer and sodas, bowls, toys, buckets, food boxes, e.t.c.

2. Polyvinyl chloride (PVC)/Polychloroethene

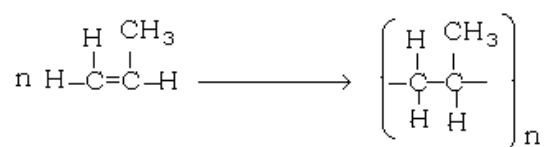
PVC is made by polymerization of vinyl chloride (chloroethene).



PVC are more rigid than polyethene and are used for making water pipes, light switches and sockets, insulation for electric cables,, carpets, plastic rain coats e.t.c.

3. Polypropene

This is made by polymerizing propene at a high pressure in the presence of a Ziegler catalyst.



It is used for making rope and for packaging.

b) Thermosetting plastics

These are plastics which do not soften or melt on heating and therefore cannot be remoulded into different shapes once they are set. They simply decompose upon heating. Thermosetting plastics have polymer chains which are bonded/ linked to each other. This is called cross linking.

Structure



Examples of thermosetting plastics include: Bakelite (used for making electric plugs, sauce pan handler, switches); melamine (used for making cups and children dishes).

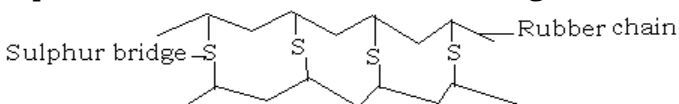
Natural rubber

Natural rubber is obtained from a rubber tree as a milky liquid called latex. Latex can be coagulated by addition of a little ethanoic acid to form a solid of high molecular weight.

The monomer of rubber is isoprene (2-methylbuta-1,3-diene)

Vulcanization of rubber

Rubber in its natural state is not strong or elastic enough and it is made more strong and useful by vulcanization which involves heating the rubber with sulphur. The sulphur combines with rubber forming cross linkages between natural rubber chains.



Vulcanized rubber is stronger, more elastic and more durable.

Uses of vulcanized rubber

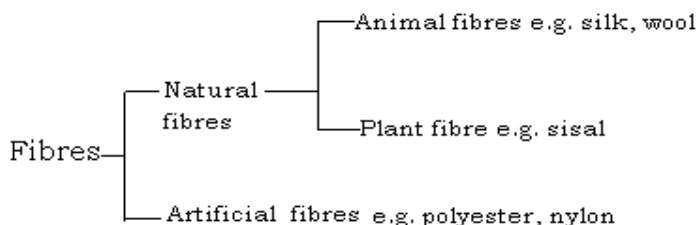
- It is used in the manufacture of tyres
- Used in the manufacture of foot wears

Condensation polymers

Fibres

These are polymers which can be drawn into threads. This is because, the forces of attraction between the linear molecules are weak but those between individual atoms are strong.

Classification of fibres



Advantages of synthetic/artificial polymers

- Relatively low production cost compared to the cost of extracting natural polymers.
- They are usually stronger and more resistant to corrosive substances like acids compared to natural polymers.
- They can easily be modified depending on the purpose for which the polymer is required unlike natural polymers which are hard to modify. As well their quality can easily be improved in terms of appearance, strength e.t.c.

Disadvantages of synthetic polymers

- Many are non biodegradable causing pollution to the environment.
- When burnt, they produce toxic gases like hydrogen cyanide (from polypropenenitrile) thus endangering lives of the people working in the factories.

Alcohols/Alkanols

These are organic compounds with hydroxyl (-OH) group attached to the hydro carbon. Alcohols have a general formula of $C_nH_{2n+1}OH$.

Members of the series

N	Molecular formula	Structural formula	Name
1		$\begin{array}{c} \text{H} \\ \\ \text{H}-\text{C}-\text{OH} \\ \\ \text{H} \end{array}$	Methanol
2		$\begin{array}{c} \text{H} \quad \text{H} \\ \quad \\ \text{H}-\text{C}-\text{C}-\text{OH} \\ \quad \\ \text{H} \quad \text{H} \end{array}$	Ethanol
3		$\begin{array}{c} \text{H} \quad \text{H} \quad \text{H} \\ \quad \quad \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{OH} \\ \quad \quad \\ \text{H} \quad \text{H} \quad \text{H} \end{array}$	Propanol

Alcohols are named by placing -ol in the place of -e in the corresponding alkane members.

Ethanol

Physical properties

- It is a colourless liquid with a strong characteristic smell
- It is a volatile liquid and boils at 78°C
- It is very soluble in water

Chemical properties of Ethanol.

1. Combustion

Ethanol burns completely in air with a blue non luminous flame producing carbon dioxide and water vapour.

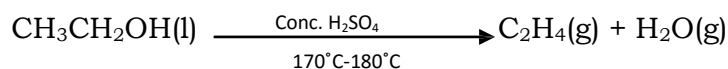


2. Dehydration

When a little concentrated sulphuric acid is added to ethanol, an oily liquid called ethyl hydrogensulphate is produced and the reaction is exothermic.



When concentrated sulphuric acid is heated with ethanol, it produces ethene.



Preparation of ethanol

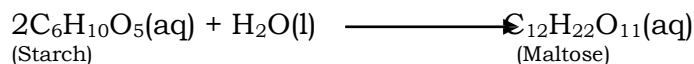
Ethanol is manufactured/ prepared by the process of fermentation of carbohydrates such as starch and sugars.

Fermentation

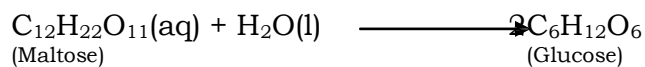
This is a process in which carbohydrates like starch and sugars are converted to alcohol by enzymes. The enzymatic break down of glucose yields simple compounds like ethanol and carbon dioxide. Some heat is as well generated. Fermentation takes place in the absence of oxygen (anaerobic process).

Preparation from starch

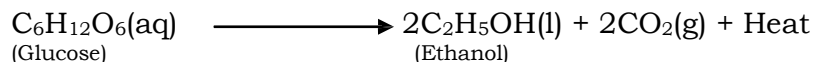
Starch is heated with malt at a temperature of 60°C . Malt contains an enzyme diastase which hydrolyses starch to maltose.



Yeast is added at room temperature to the mixture and left to ferment for 2-3 days. Yeast contains two enzymes, maltase and zymase. Maltase catalyses the hydrolysis of maltose to glucose as below.



Zymase catalyses the breakdown of glucose into ethanol, carbon dioxide, producing heat in the process.



The crude ethanol produced can then be concentrated or purified by fractional distillation.

Preparation of ethanol from millet

- Millet flour is mixed with little water to form paste. The mixture is then put under ground for about 8 days.
- It is then removed, roasted and dried under the sun.

- The dried material is then mixed with germinated millet flour (yeast).
- Water is added and the mixture allowed to ferment for about 3 days in a warm place. This forms a local drink known as –Malwall.

Preparation of ethanol from ripe bananas

- Ripe bananas are squeezed to obtain the juice.
- The juice is filtered to remove the solid particle.
- The juice is mixed with roasted sorghum flour and the mixture allowed to ferment for 1-3 days in a warm place. A crude form of ethanol locally known as –Tonto|| is obtained.

Beer is made by the fermentation of the starch in barley; wine by the fermentation of sugars in grapes. Spirits are obtained by distillation of dilute solutions produced by fermentation and there fore have an increased alcoholic content.

Uses of ethanol

- It is used as an alcoholic beverage e.g. beers, wines and spirits
- It is used as a solvent for paints, varnishes e.t.c
- It is used as a fuel
- It is used as a preservative and for sterilization
- It is used as a thermometric liquid especially in minimum and maximum thermometers.

SOAPS AND DETERGENTS

Soap

Soap is a sodium or potassium salt of a long chain carboxylic acid known as sodium or potassium stearate.

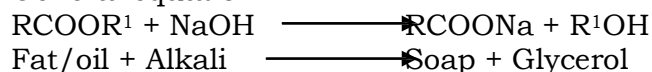
Manufacture of soap

The process of making soap using an alkali and fat/oil (ester) is known as saponification.

Boil vegetable oil (from coconut, ground nuts, cotton e.t.c) or animal fat (from cattle or sheep) with concentrated sodium hydroxide solution until a uniform solution is obtained. Allow the solution to cool. Concentrated solution of sodium chloride (brine) is added to precipitate the soap which floats on the surface. The process of precipitating the soap is known as -salting out||. The soap is then removed and treated further to produce pure soap.

Perfumes may, dyes and disinfectants may be added to make toilet soap e.g. Geisha

General equation



Note

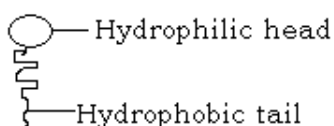
1. Potassium hydroxide can be used instead of sodium hydroxide. Potassium soaps are normally milder and there fore used mainly as toilet soaps.

2. Oils are liquid esters at room temperature whereas fats are solids at room temperature.

Cleaning action of soap

Soaps and detergents act in a similar way to facilitate the cleaning process. They act by lowering the surface tension of water and thus enable the water to spread and wet more effectively i.e. to break up and disperse grease particles.

Dirt is fixed on objects by oil films. Soap has two parts i.e. the long hydro carbon tail that is soluble in oil but insoluble in water (hydrophobic tail) and a carboxylic acid head that is soluble in water (hydrophilic head) but insoluble in oil.



During washing, the hydrophobic tail dissolves in the oil film and the hydrophilic head remains in water, this creates tension making the grease particles to split up into tiny globules which are carried away by water. The dirt particles get suspended in water, a process known as emulsification.

Soaps (synthetic) detergents

A detergent is any substance that facilitates the cleaning process. This means that soap is also a detergent although the name is used for other substitutes of soap like Omo, Nomi, Ariel, Toss etc.

The synthetic detergents function in the same way as soap but they are more soluble than soap and therefore clean more effectively. Even when hard water is used, they do not form scum but soap does.

The soapless detergents are made from concentrated sulphuric acid and hydrocarbons obtained from petrol refining.

Laboratory preparation of a soapless detergent from castor oil

Procedure

- Add 1cm³ of castor oil into a test tube, then carefully add 2cm³ of concentrated sulphuric acid while stirring with a glass rod
- Gently warm the mixture and add about 10cm³ of 4M sodium hydroxide and stir. The mixture gets hot, viscous and dark.
- Add 5cm³ of distilled water and stir. Then decant to separate the liquid from the solids. The solid is the soapless detergent which is then washed with distilled water.

Advantages of soapless detergents

- They are more soluble in water than soap and therefore clean more effectively.
- They do not form scum with hard water therefore can be used with both hard and soft water. Soap forms scum with hard water.

Disadvantages of soapless detergents

- It is more expensive than soap
- Some soapless detergents are non biodegradable and there fore accumulate in the environment. Soap is biodegradable.
- The phosphates from soapless detergents when washed in to water bodies' causes eutrophication. This leads to pollution of water bodies.