POLYMERS AND POLYMERISATION

- A polymer may be defined as a high molecular weight compound formed by the combination of a large number of one or more types of small molecular weight.
- The small unit (s) of which polymer is made is known as monomer.
- The polymerisation may be defined as a chemical combination of a number of similar or different molecules to form a single large molecules.
- A polymer which is obtained from only one type of monomer molecules is known as homopolymer.

  Example: polythene, PVC, PAN, Teflon, Buna rubber etc.
- A polymer which is obtained from more than one type of monomer is known as a co-polymers for example- Buna- S, Dacron , Nylon-66, Bakelite etc.

Classification of polymers :

(1) Classification based upon origin (source) :

(a) Natural polymers (b) Semi-Synthetic polymers (c) Synthetic polymers

(a) Natural polymers: These are of natural origin or these are found in plants and animals.

Natural polymers also called as biopolymers.

Example Proteins (Polymers of amino acids), Polysaccharides (Polymers of mono saccharides), rubber (Polymers of isoprene) silk, wool , starch , cellulose, enzymes, natural rubber, haemoglobin etc.

(b) Semi Synthetic polymers :

Examples Nitro cellulose, cellulose acetate, cellulose xanthate, etc.

(c) Synthetic Polymers : These are artifical polymers. For example Polythene, nylon, PVC, bakelite, dacron.

(2) Classification based upon synthesis :

(a) Addition Polymers : These are polymers formed by the addition together of the molecules of the monomers to form a large molecule without elimination of any thing.

The process of the formation of addition polymers is called addition polymerisation.

For example

$$n\,CH_2{=}CH_2 \xrightarrow{\text{Polymerisation}} [{-}CH_2{-}CH_2{-}]_n$$

Ethene Polythene

$$nCH_2{=}CHCl \xrightarrow{\text{Polymerisation}} \left[-CH_2-\underset{Cl}{\underset{|}{CH}}-\right]_n$$

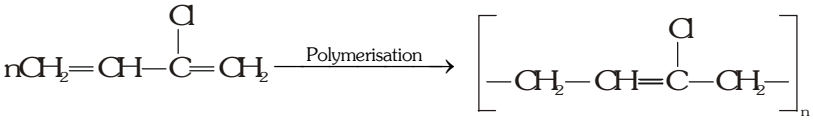
vinyl chloride PVC

$$n\,CH_2{=}CHCN \xrightarrow{\text{Polymerisation}} \left[-CH_2-\underset{CN}{\underset{|}{CH}}-\right]_n$$

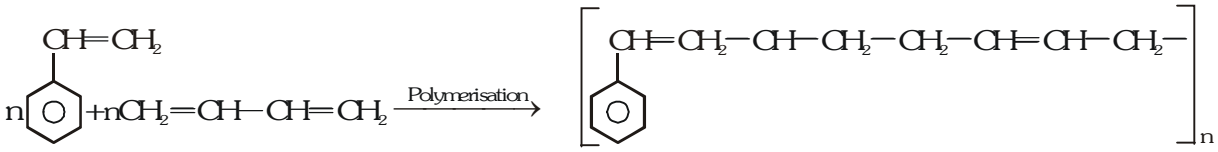
Vinyl cyanide Orlon

$$nCH_2{=}\underset{CH_3}{\underset{|}{C}}{-}CH{=}CH_2 \xrightarrow{\text{Polymerisation}} \left[-CH_2-\underset{CH_3}{\underset{|}{C}}{=}CH-CH_2-\right]_n$$

Isoprene Natural Rubber



Chloroprene Neoprene Rubber



Styrene 1, 3-Butadiene Styrene butadiene rubber (SBR)

(b) **Condensation polymers :** Condensation polymers are formed by the combination of monomers with the elimination of simple molecules such as water or alcohol. This process is called condensation polymerisation.

Proteins, starch, cellulose etc. are the example of natural condensation polymers.

Two main synthetic polymers of condensation types are polyesters (Terylene or dacron) and poly amides (Nylon-66)

(3) **Classification based upon mechanism :**

(a) Chain growth polymerisation : These polymers are formed by the successive addition of monomer units to the growing chain having a reactive intermediate (Free radical, carbocation or carbanion). Chain growth polymerisation is an important reaction of alkenes and conjugated dienes.

Ex: Polythene, poly propylene, teflon, PVC, poly styrene are some examples of chain growth polymers.

(b) **Step growth Polymerisation :** These polymers are formed through a series of independent steps. Each steps involves the condensation between two monomers leading to the formation of smaller polymer.

Exp: Nylon, terylene, bakelite etc.

(4) **Classification based upon structure :**

(a) Linear polymers : These consist of extremely long chains of atoms and are also called one dimensional polymers. Examples - Polyethylene , PVC, Nylon, Polyester.

(c) Three dimensional polymers : Those polymers in which chains are cross linked to give a three dimensional network are called three dimensional polymers . Example- Bakelite.

(5) **Classification based upon molecular forces :**

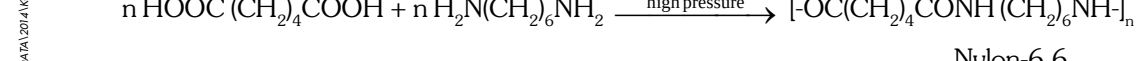
(a) Elastomers : These are the polymers having very weak intermolecular forces of attraction between polymer chains.

Elastomers posseses elastic character.

Vulcanised rubber is very important example of an elastomer.

(b) Fibres : These are the polymers which have bit strong intermolecular forces such as hydrogen bonding. Ex. Nylon - 6, 6, Nylon-6,10, Terylene.

Nylon - 6,6 : It is obtained by condensation polymerisation of hexamethylene diamine (six carbon) and adipic acid (a dibasic acid having six carbon)

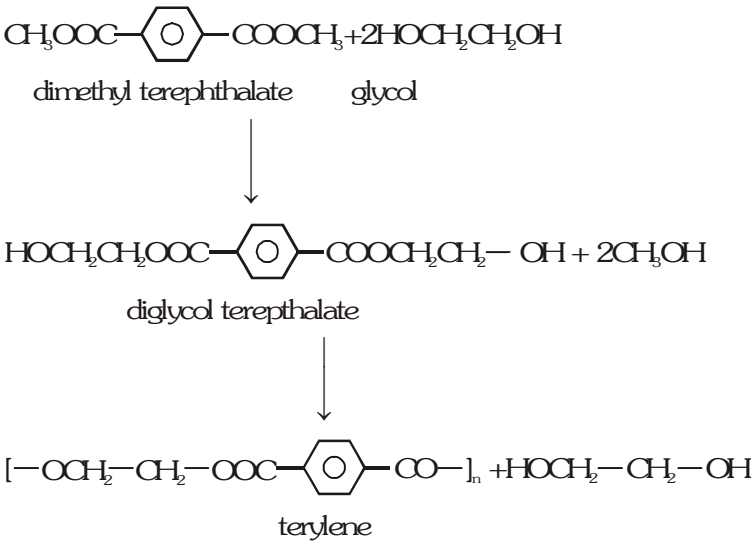


Nylon-6,6

Nylon - 6,10 : It is obtained by condensation polymerisation of hexamethylene diamine (6C) and sebasic acid (10C)

Terylene : (Dacron, teron, cronar, mylar)

It is a polyester fibre made by the esterification of terephthalic acid with ethylene glycol.



(c) Thermoplastics : A thermo plastic polymer is one which softens on heating and becomes hard on cooling. Polyethylene, polypropylene, polystyrene are the example of thermo plastics.

(d) Thermo setting polymers or resin : A thermo setting polymer becomes hard on heating. Bakelite , Aniline aldehyde resin, urea formaldehyde polymer.

MONOMERS AND POLYMERS

S.N.	Monomer	Polymer	Type of Polymers
1.	$CH_2=CH_2$ (Ethylene)	Poly ethene	Addition polymer
2.	$CH_2=CHCH_3$ (Propylene)	Poly propylene	Addition homo polymer
3.	$CH_2=CHCl$ (Vinyl chloride)	Polyvinyl chloride (PVC)	Homopolymer, chain growth
4.	$CH_2=CH-C_6H_5$ (Styrene)	Polystyrene (styron)	Addition homo polymer, linear chain
5.	$CH_2=CH-CN$ (Acrylonitrile)	Ploy acrylonitrile (PAN), Orlon	Addition homopolymer
6.	$CH_2=CH-CH=CH_2$ (1,3 Butadiene)	BUNA rubbers	Addition copolymer
7.	$CH_2=CHOCOCH_3$ (Vinyl acetate)	Poly vinyl acetate (PVA)	Addition homopolymer
8.	$CF_2=CF_2$ (Tetrafluoro ethylene)	Teflon	Chain growth homopolymer (Nonstick cookwares)
9.	$CH_2=\underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}}-CH=CH_2$ (Isoprene)	Natural Rubber	Additon homopolymer
10.	$CH_2=\underset{\displaystyle Cl}{\overset{\displaystyle |}{C}}-CH=CH_2$ (Chloroprene)	Neoprene (Artificial Rubber)	Addition homopolymer
11.	Ethylene Glycol + dimethyl terephthalate	Terylene or Dacron (Polyester)	Copolymer, step growth
12.	Hexamethylene diamine + adipic acid	Nylon-6,6 (Polyamide)	Copolymer, step growth linear
13.	Formaldehyde + urea	Urea formaldehyde resin	Copolymer, step growth
14.	Formaldehyde + Phenol	Bakelite	Copolymer, step growth thermo setting polymer
15.	Maleic anhydride + methylene glycol	Alkyl plastic	
16.	Methyl methacrylate	Poly methyl meth acrylate (PMMA)	Addition homopolymer
17.	Ethylene Glycol	Glyptal or Alkyds + Phthalic acid	Copolymer, linear step growth, thermo plastic
18.	Melamine + formaldehyde	Melamine formaldehyde resin	Copolymer, step growth thermosetting polymer
19.	Hexamethylene diamine + sebasic acid	Nylon - 6,10	Copolymer, step growth linear
20.	6 - Aminohexanoic acid	Nylon - 6	Homopolymer, step growth linear

CHEMISTRY IN EVERYDAY LIFE

Medicine or Drugs

Chemical substances helping to a human body or an animal either for treatment of diseases or to reduce suffering from pain are called medicine or drug.

The treatment of disease by chemical compound which destroy the micro organism without attacking the tissue of the human body is known as chemotherapy, and the compounds used are called chemotherapeutic agent.

Various type of medicinal compdounds are -

(A) Antiseptics :

Which prevent or destroy the growth of the harmful micro organism, common antiseptics are-
Dettol, Savlon, Cetavelon, acriflavin, lodine, methylene blue, mercurochrome & $KMnO_4$.

Dettol is a mixture of chloroxylenol and terpineol. Its dilute solution is used to clean wounds.

Bithional -It is added to soap to impar tantiseptic properties

(B) Disinfectants :

The chemical compounds capable of completely destroying the micro organism are termed as disinfectants.
These are toxic to living tissues.

These are utilized for sterilization of floor, toilets instruments & cloths.

eg. 1% solution of phenol in disinfectant while 0.2% solution of phenol is antiseptic.

(C) Analgesics :

The substance which are used to get relief from pain. These are of two types -

(a) Narcotics or habit forming drugs

(b) Non-narcotics

(a) Narcotics : These are alkaloids and mostly opium products, causes sleep and unconciousness when taken in higher doses.

e.g. Morphine, codeine, heroine

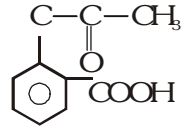
(b) Non-narcotics : Analgesics belonging to this category are effective antipyretics also.

e.g. Aspirin & novalgin, Ibuprofen, Naproxen

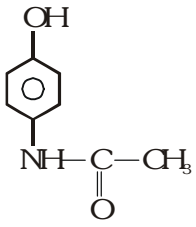
(D) Antipyretics :

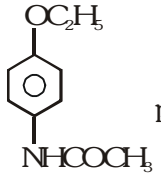
To bring down the body temp. in high fever are called antipyretics.

e.g - (a) Aspirin, (b) Analgin (Novalgin), (c) Paracetamol, (d) Phenacetin



Aspirin





p– Ethoxy acetanilide
(Phenacetin)

(E) Antimalarials :

To bring down the body temperature during malarial fever.

e.g. Quinine, Chloroquine, Paraquine and Primaquine etc.

(F) Tranquilizers :

The chemical substances which acts on the central nervous system and has a calming effect.

Since these are used for mental diseases so are known as psycotherapeutic drugs.

They are of two types - (a) Sedative or hypnotics (b) Mood elevators

(a) **Sedative** : Reduce nervous tension and promote relaxation. e.g. Reserpine, barbituric acid and its derivatives as luminal & seconal.

(b) **Mood elivators or Antidepressants :** A drug used for treatment of highly depressed patient, who has lost his confidence.

Example : Benzedrine (amphetamine)

(G) Anaesthetics :

These are chemical substances helping for producing general or local insensibility to pain and other sensation.

These are of two types (a) General (b) Local

(a) General : - Produce unconciousness and are given at the time of major surgical operations.

Example : Gaseous form $\rightarrow$ Nitrous oxide, ethylene, cyclopropane etc.

Liquid form $\rightarrow$ Chloroform, divinyl ether and sodium pentothal etc.

(b) Local anaesthetics: Produce loss of sensation on a small portion of the body. It is used for minor operations.

Example : Jelly form $\rightarrow$ Oxylocain

Spray form $\rightarrow$ Ethyl chloride

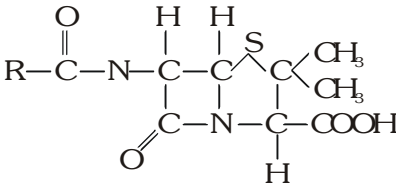
Injection form $\rightarrow$ Procain

(H) Antibiotics : The chemical substances produced from some micro organism (fungi bacteria or mold) and are used to inhibits the growth of other micro organism.

These are effective in the treatment of infections diseases.

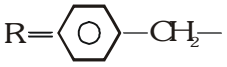
Example : Penicillin - It is highly effective drug for pneumonia, Bronchitis, abcesses, sore throat etc.

For other naturally occuring penicillin -



Penicillin

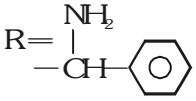
R - May be -



(Penicillin G)

$R = CH_3—CH_2—CH=CH—CH_2—$ (Penicillin-F)

$R = CH_3—(CH_2)_6—$ (Penicillin-K)



(Ampicillin)

Synthetic antibiotics are Streptomycin - (Tuberculosis),

Chloromycetin - (Typhoid, Meningitis, Pneumonia, diarrhoea, dysentary etc.)

Tetracyclins - (Acute fever, trachoma, dysentery & urinary tract infection)

(I) **Sulpha drugs :** Having great antibacterial powers. These are a group of drugs which are derivatives of sulphanilamide.

Other sulpha drugs are - (a) **Sulphathiazole** -Mainly used in severe infections.

(b) **Sulpha guanidine** - Used in bacillary dysentery

(c) **Sulpha pyridine -** Used in pneumoina

(d) **Sulpha diazine** - Used in dysentery, urinary infection and respiratory infection.

ROCKET PROPELLANTS

In order to provide sufficient push to the rocket satellites to enter into the space, some chemical fuels are used, which are termed as rocket propellants.

u A propellant is a combination of two compounds i.e.

(a) An explosive compound called fuel (b) Oxidiser

d A chemical compound should satisfy the following conditions to function as propellant–

(1) The burning of fuel should not leave any ash.

(2) The burning of fuel should produce a large volume of gases/g of fuel.

(3) The combustion should proceed at a fast rate.

Depending upon physical state of fuel and oxidiser, the propellants are of three types

(a) Solid propellants (b) Liquid propellants (c) Hybrid propellants

(a) Solid propellants : In which fuel and oxidiser both are solid. These are of two types

(I) Composite propellant : It contains polymeric binder as fuel and ammonium perchlorate as oxidiser.

Fuel - Polyurethane or polybutadiene, Oxidiser - Ammonium perchlorate

(II) Double base propellant : It consist of nitro cellulose and nitroglycerine.

Disadvantage of solid propellant :

- Once they ignite, they burns with a predetermined rate.
- These do not have the start and stop capability.

(b) Liquid propellant : These are of two types -

(I) Monoliquid propellant : when a single liquid acts as fuel and oxidiser.

eg. -Nitromethane, Methyl nitrate, H_2O_2 etc.

(II) Biliquid propellant - It comprises a liquid fuel and a liquid oxidiser e.g. Fuel $\rightarrow$ Kerosene, alcohol, hydrazine monomethyl hydrazine (MMH) or liquid hydrogen

Oxidiser $\rightarrow$ Liquid oxygen, nitrogen tetraoxide (N_2O_4) or nitrous acid

Advantages :

(I) These provides higher thrust than solid propellants.

(II) The thrust can be controlled by switching on and off the flow of liquid propellant.

(C) **Hybrid propellant :** These consists of a solid fuel and a liquid oxidizer. e.g.

Fuel $\rightarrow$ Acrylic rubber

Oxidiser $\rightarrow$ Liquid N_2O_4

Specific impulse (Is) :

The superiority and performance of a propellant is expressed in terms of specific impulse (Is).

$$Is = \sqrt{\frac{T}{M}}$$

Where T = Flame temperature, M = average molecular mass.

Thus the performance of rocket propellant will be better if flame temperature is higher and the average mass of the product gas is lower.

GOLDEN KEY POINTS

- Plastics have high molecular weight ranging from 20,000 (nylon) to 2,50,000 (PVC)
- Thermo plastics are linear polymers (nitrocellulose, polyethene,perspex)
- Plasticizers fit between the polymer chains and thus weaken the attraction between the chains there by increasing the flexibiliy.
- Nylon-6(USA) or perlonl (Germany) is prepared by prolonged heating of caprolactum at 540K.
- Saran is a copolymer of vinylidene chloride (85%) and vinyl chloride (15%).
- Dynel is a copolymer of acrylonitrile (40%) and vinyl chloride (60%). It is used in making water softener bags, cloth blankets and dyenets etc.
- Aspirin is used to prevent heart attacks besides being antipyretic and analgesic agents.
- Derivatives of barbituric acid, viz. veronal, amytal, nembutal, luminal and seconal are hypnotic tranquillizer while meprohamate equanil, valium and serotonin are non-hypnotic tranquiiizers.
- Any organism which causes disease is called a pathogen.
- Penicillin, aminoglycosiders and ofloxacin are bactericidal while erythromycin, tetracycline and chloramphenicol are bacteriostatic antibiotics.
- Magnesium hydroxide, magnesium carbonate, magnesium trisilicate, aluminium hydroxide gel, sodium bicarbonate are antacids which neutralize the HCl in the stomach but Omepyrazole and Lansoprazole prevent the formation of acid in the stomach.
- The preservative C_6H_5COONa is metabolized in the body and is converted into hippuric acid (benzoylglycine) which is secreted in urine.
- Soaps, detergents and phospholipids are called surfactants since they lower the surface tension of water.
- All surfactants consist of two characteristic groups, i.e., apolar head group which is water-soluble (hyudrophilic group) and a non-polar hydrocarbon tail which is oil-soluble (lyophilic or lipophilic group).
- Sodium soaps are hard while potassium soaps are soft. Therefore, washing soaps are mostly sodium soaps while liquid soapshaving creamsand toilet soaps are potassium salts.
- Like soaps, detergents of the type, linear benzene sulphonate (LBS) in which the phenyl group is randomly attached to the various secondary positions of a long straight chain or n-alkyl hydrogen sulphates are 100% biodegradable.
- Unlike soaps, detergents can be used in hard water. The reson being that magnesium and calcium salts of detergents are soluble in water while those of soaps are insoluble in water.
- APC mixture contains aspirin, phenacetin and caffeine.
- Piperazine is used against round worms and pin worms.
- Aspirin, phinacetin and paracetamol act both as antipyretics and analgesics.
- The alkaloid morphine and its derivatives such as codeine (morphine methyl ether) and heroin (morphine diacetate) are important narcotic analgesic.
- Aspirin is a non-narcotic analgesic but is toxic to liver. It also undergoes hydrolysis in the stomach producing salicylic acid which causes bleeding from the stomach wall. Therefore, other non-narcotic analgesics such as naproxen, ibuprofen and diclofenac sodium or potassium are preferred to aspirin.
- Enovid E which is a mixture of norethindron (a progestogen) and ethynysestradiol (an estrogen) is the most commonly used oral contraceptive.
- AZT (3'-Azido-3-deoxythymidine) is used against AIDS i.e. HIV-infections.
- Sulpha drugs are effective against bacterial infections.
- Ciprofloxacin and norfloxacin are quinolene based antibacterial drugs.
- NO_2,NO, N=N and quinonoid structures are chromophores while OH, NH_2,CO_2H, Cl etc. are auxochromes.

- Orange-I, orange-II, ethylorange, methyl red, congored, aniline yellow, butter yellow, chrysoidine G are azo dyes.
- Orange-I, orange-II, methylorange, methyl red and congo red are acid dyes while aniline yellow, butter yellow and chrysoidine G are basic dyes.
- Congo red (azo dye) and martius yellow (nitro dye) are also called direct dyes.
- Indigo is a Vat dye while alizarin is mordant dye.
- Indigosol O is a soluble vat dye and is especially suitable for wool.
- Dettol, bithional, tincture of iodine, boric acid, salol, hydrogen peroxide, mercurochrome, gentian violet and methylene blue are important antiseptics.
- Aspartame, alitame, sucralose, cyuclamate and saccharin are used as artificial sweetners. These have no caloric value and hence are useful for diabetic persons.
- A mixture of polyurethane or polybutadiene (a fuel) and ammonium perchlorate (oxidiser) is an example of composite solid propellant.
- Methyl nitrate, nitromethane and hydrogen peroxide are monoliquid propellants.
- Biliquid propellants consist fo two liquids- one of which acts as a fuel kerosene, alcohol, hydrazine, (monomethylhydazine, unsymmetrical dimethylhydrazine or liquid H_2) while the other acts as an oxidiser (liquid O_2, liquid N_2O_4, nitric acid etc.)
- A mixture of a solid fuel (acrylic rubber) and liquid oxidiser (liquid N_2O_4) is an example of hybrid propellant.