Examples of Vinyl Polymers

1 Polyethylene, $+CH_2-CH_2+_n$ or Polythene

it is a widely used addition polymer, and two types of polyethylene are produced which have widely different properties. These are

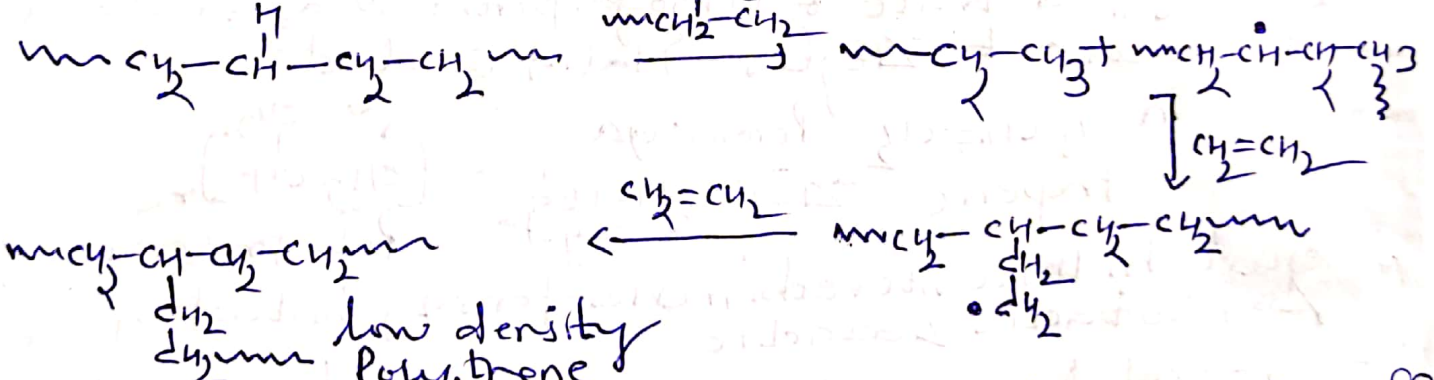
a) Low density polythene b) High density polythene

a Low density Polythene – it is prepared by heating ethylene to 350-570K under a pressure of 1000-2000 atm and in the presence of trace amt. of peroxide. This polymerization occurs by a free radical mechanism, initiated by peroxide.

The polythene thus produced has a high molecular mass and has a highly branched structure. This branching occurs due to chain transfer of a special kind by which chain transfer agent is a polymer molecule.

Reason for branching

At high temperature, the growing free radicals not only add to the double bond of the monomer but also abstract hydrogen from a chain already formed. This abstracting generates a new free radical from which a chain can now grow.



→ These branched polythene molecules donot pack well and has a low density and a low m.pt (384K)

→ These low density polythene is a transparent polymer of moderate tensile strength and high toughness, chemically inert, is Lightly flexible and is poor conductor of electricity.

→ it is used as packaging material, as insulation for wires, in manufacture of squeeze bottles, toys and flexible pipes.

b High density Polythene

It is prepared by co-ordination polymerization of ethylene. In this process, ethylene is heated to 330-350K under a pressure of one atm. in presence of catalyst consisting of $((C_2H_5)_3Al + TiCl_4)$ (Ziegler-Natta catalyst)

$$n\,CH_2=CH_2 \xrightarrow[(C_2H_5)_3Al + TiCl_4]{330\text{-}350K,\ 1atm} \underset{\text{Polythene}}{-(CH_2-CH_2)_n-}$$

The polythene thus produced practically consists of a linear chain. These polymer molecules pack well & hence this type of polythene has higher density and high melting point (403K). Thus polythene prepared by coordination polymerization is called high density polythene.

→ High density polythene is a translucent polymer. it is also chemically inert but high toughness, hardness & tensile strength than low density polythene.

→ it is used in the manufacture of containers (buckets, tubs), pipes etc.

2 Polypropene

Polypropene is prepared by heating propene in the presence of a trace of benzoyl peroxide as a radical initiator or by Ziegler-Natta catalyst.

$$n\,CH_3-CH=CH_2 \xrightarrow[\text{Ziegler-Natta catalyst}]{\text{Peroxide}\ \Delta} \underset{\text{Polypropene}}{-(CH_2-\overset{CH_3}{\overset{|}{C}}H)_n-}$$

Propene

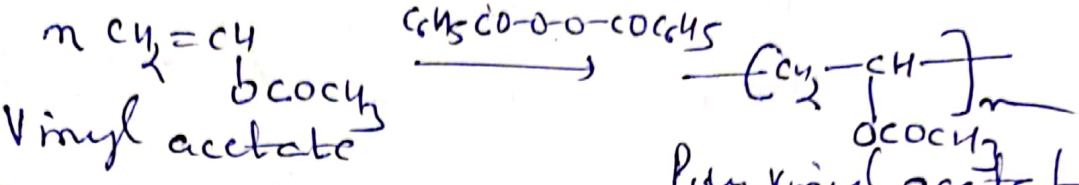
it exists in three stereoisomeric forms, isotactic, syndiotactic & atactic

free radical polymerization usually gives branched chain atactic polymer. However, linear polypropene can be prepared by Ziegler-Natta catalyst.

Uses:
→ It is harder and stronger polymer than polyethene
→ for packing of textiles & foods.
→ for making automotive mouldings, seat covers, ropes etc.

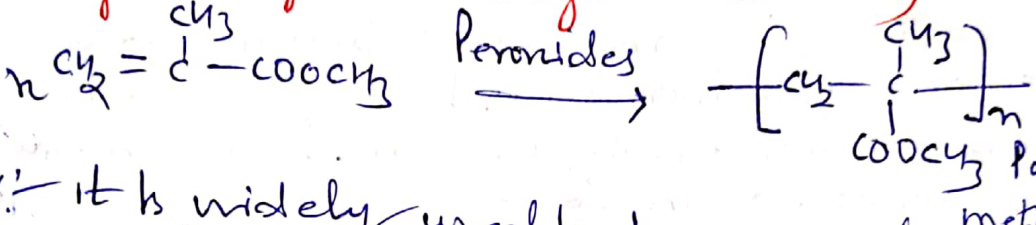
6. Poly Vinyl acetate, PVA

It is prepared by free radical polymerization of Vinyl acetate in the presence of benzoyl peroxide as radical initiater



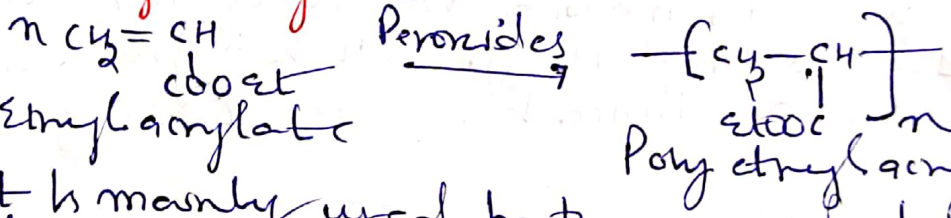
Use:- It is a soft rubber like polymer and used in making plastic emulsion paint, in making paper grease proof.

7. Poly methyl methacrylate (PMMA)



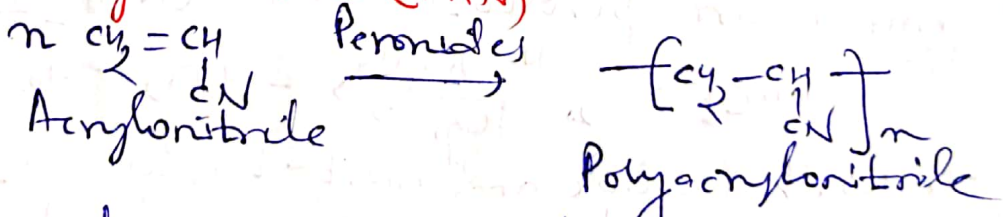
Use:- It is widely used in the manufacture of lenses, light covers, aircraft windows, transparent domes etc

8. Poly ethyl acrylate



Use:- It is mainly used in the manufacture of blankets, carpets & Variety of clothes.

9. Poly acrylonitrile (PAN)



Use:- PAN forms water resistant & quick drying fibres. The fibres can be worn and knitted and can also be blended with Wool.

3 Polystyrene / Styron

Polystyrene can be prepared either by free radical polymerization or by using Ziegler-Natta catalyst

$$n\,CH_2=CH \xrightarrow[\text{Ziegler-Natta catalyst}]{C_6H_5CO\text{-}O\text{-}O\text{-}CO\,C_6H_5} \left[CH_2-CH\right]_n$$

(Styrene: C_6H_5 substituent; Polystyrene: C_6H_5 substituent)

Use:-

Polystyrene is a good light weight material, and is used for making plastic toys, telephone radio, television bodies etc

4 Poly Vinyl chloride (PVC)

It is prepared by free radical polymerization of Vinyl chloride. Polymerization is carried out in water suspension which contain soap as an emulsifier and persulphate as initiator

$$n\,CH_2=CH \xrightarrow{\text{Persulphate}} \left[CH_2-CH\right]_n$$

(Vinyl chloride: Cl substituent; Poly Vinyl chloride: Cl substituent)

Use:-

It is used for making rain coats, hand bags, dolls, shoe soles & Vinyl flooring. It is a good electrical insulator and hence is used for coating wires, cables.

5 Polytetrafluoroethylene or Teflon $\left[CF_2-CF_2\right]_n$

It is an addition homopolymer and is obtained by heating tetrafluoroethylene in the presence of ammonium peroxosulphate $(NH_4)_2S_2O_8$ as initiator

$$n\,CF_2=CF_2 \xrightarrow[\text{High P}]{(NH_4)_2S_2O_8} \left[CF_2-CF_2\right]_n$$

Uses Teflon is flexible and inert to solvents and to boiling acids even to aqua regia and is stable upto 598K.

→ It is used for making non-stick utensils

→ It is also used for making Valves, Seals gaskets etc.

Condensation or step Growth polymerization

In this type of polymerization, a large no. of monomer molecules combine together usually with the loss of simple molecules like water, alcohol, NH_3, CO_2, HCl etc to form a macromolecule in which the molecular formulae of the repeating structural unit is generally not the same as that of the monomer. The polymers thus formed are called Condensation Polymers.

Condensation polymerization generally occurs between monomers containing bifunctional and polyfunctional compounds.

Eg: $n\,H_2N-(CH_2)_6-NH_2$ + $n\,HOOC-(CH_2)_4-COOH$ $\xrightarrow{\Delta,\ 525K}$

Hexamethylenediamine Adipic acid

$$-\left[NH-(CH_2)_6-NH-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}\right]_n + n\,H_2O$$

Nylon-6,6

Condensation polymerization occurs through a series of independent reactions. Each such rxn involves the condensation b/w two difunctional monomer molecules to form a dimer which is also a bifunctional. Since in this process, the polymer is formed in a step-wise manner, it is called step growth polymer and process is called step growth polymerization.

mechanism

$$HO-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-OH + H_2N-(CH_2)_6-NH_2$$

$\xrightarrow{\Delta,\ 525K,\ (-H_2O)}$

$$HO-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_6-NH_2$$

$\xrightarrow{-H_2O,\ +HO-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-OH}$

$$HO-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_6-NH-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-OH$$

$\xrightarrow{-H_2O,\ H_2N-(CH_2)_6-NH_2}$

$$H_2N-(CH_2)_6-NH-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-NH-(CH_2)_6-NH-\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}-OH$$

$\xrightarrow{\Delta\Delta\Delta}$

Polymer

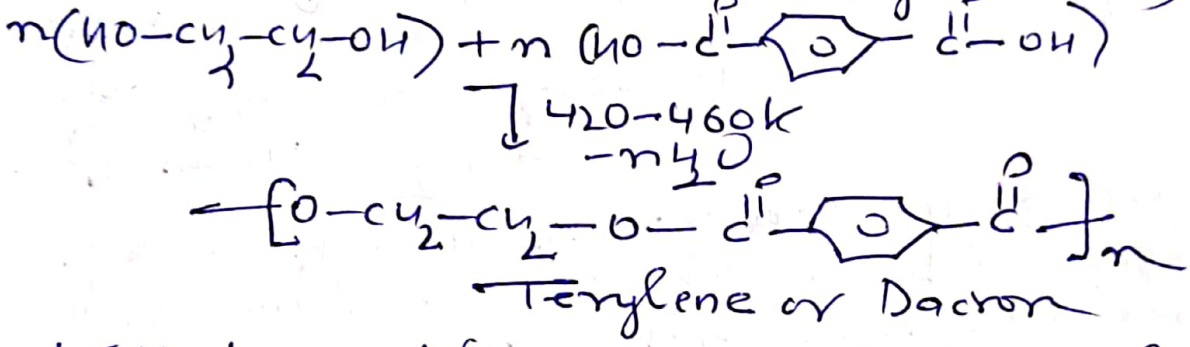
In contrast to chain growth polymers, the formation of step-growth polymers does not occur through chain reactions involving free radicals, carbanions or carbocations as reactive species

Polyesters

Polymers which have ester linkages are called polyesters and are prepared by the condensation polymerization of diacids with diols.

1. Polyethylene terephthalate (PET) / Teylene / Dacron

It is prepared by condensation polymerisation of ethylene glycol and terephthalic acid with elimination of water. The rxn is carried out at about 420–460K in the presence of catalyst mixture (Zinc acetate + antimony trioxide)



Terylene or Dacron

Use; It is used for the manufacture of wash and wear fabrics, tyre cords, seat belts. It is also blended with cotton and wool to increase their resistance to wear and tear.