ECO-FRIENDLY POLYMERS

poly (many) mer (units)

→ polymer is made up of many monomers.

POLYMER

Natural polymer	Synthetic polymer
• cellulose } monomer is	• rubber (polyisoprene)
• starch } GLUCOSE	• $n\,CH_2=CH_2 \longrightarrow (CH_2-CH_2)$
• silk fibroin	

~~DEGREE OF POLY~~

FUNCTIONALITY

→ The no. of repeating units present in a polymer.

- high polymers: high number of monomeric units.
- oligomers: 2-10 monomer units.

FUNCTIONALITY OF POLYMER

- monomer contains some function groups (reactive sites)
  - $-OH$ (hydroxyl)
  - $-NH_2$ (amine)
  - $-SH$ (sulphodryl)
  - $-COOH$ (carboxyl)
- Functionality depends on.

1. no. of reactive sites present in compound

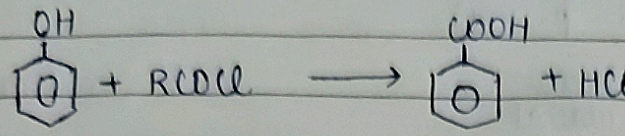
Acetic acid	CH_3COOH	funct^n = 1
Malonic acid	$HOOC\,CH_2\,COOH$	funct^n = 2
Tartaric acid	$HOOC(CHOH)_2\,COOH$	funct^n = 4

2. No. of double bonds & triple bonds in the molecule

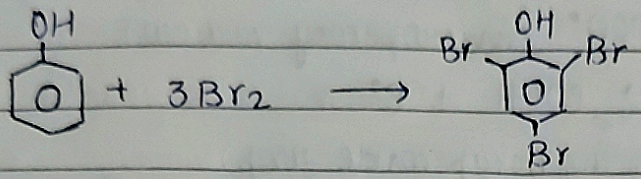
$CH_2=CH_2 \xrightarrow{\text{hydrolysis}} -CH_2-CH_2-$ funct^n = 2

$CH\equiv CH \longrightarrow -CH=CH- \longrightarrow -\overset{|}{C}H-\overset{|}{C}H-$ funct^n = 4

3. No. of replacable H-atoms in a molecule

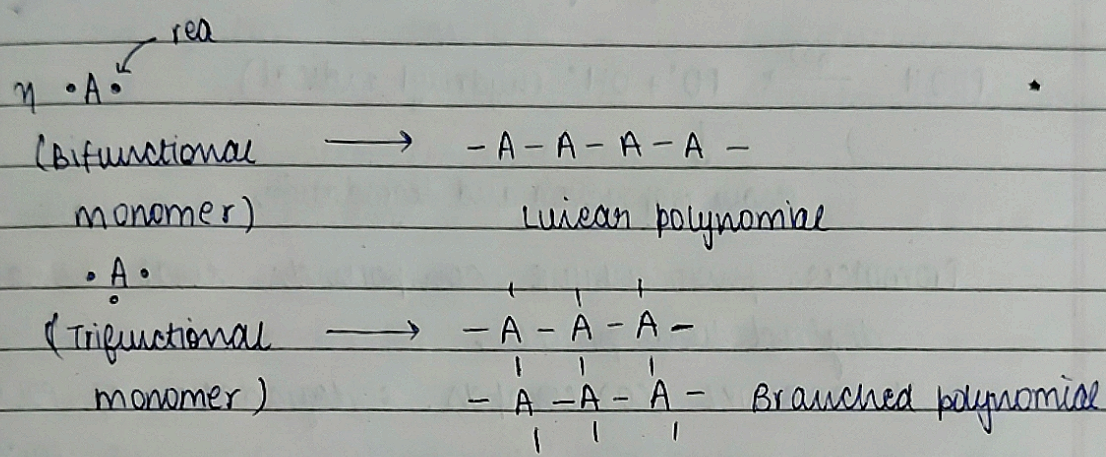


funct^{n} = 2



funct^{n} = 3

4.



DEGRADATION OF POLYMER

1. BIODEGRADABLE polymer
2. PHOTO BIODEGRADABLE polymer
3. HYDRO BIODEGRADABLE polymer

Biodegradable : degraded by enzymes present in the microorganisms.

end product of degradation : $CO_2 + H_2O$

Photobiodegradable : degraded by light

Step 1 : Photodegradation

Chromophores - The funct^{n} group present in polymers above UV light (visible : 400nm - 700nm) ex : CO grp, peroxide, hydroperoxide

Step 2 : Biodegradation

↳ living organism.

MECHANISM

PH —sunlight→ P• + H•

polymer — macro radical

P• + O_2 → POO• (macroperoxy radical)

POO• + PH → POOH + P•

(hydroxyperoxide group)

POOH —hν→ PO• + OH• (hydroxyl radical)

↓

chain propogation and degradation

Promoters: photosensitive compounds that enhance degradation process.

1. CARBONYL (CO) compds. : degradation of POLYTHENE & POLYSTYRENE.

2. METAL COMPLEXES: react with O_2 and form PEROXIDES → help in degradation.

✓ {Zn, Cu, Fe, } X {Cd, Cr, Hg, Pb, As}

Photostabilizers: introduced in plastic, to protect from light degradation.

ex: 2,4 dihydroxy benzophenone.

Hydrobiodegradation: degradation in presence of water

Step 1: Hydrolysis ① $-\overset{O}{\overset{\|}{C}}-NH-$ (amide bond) —H_2O→ $-COOH$ (carboxyl) + $-NH_2$ (amine)

② $-\overset{O}{\overset{\|}{C}}-O-$ (ester) —H_2O→ $-COOH$ (carboxyl) + $-OH$ (hydroxy)

degradatn should be done to active $CO_2 + H_2O$ as

✓ cholestrol: degraded using nanoparticles but end products are even more harmful.

BIO POLYMERS & BIO PLASTICS (GREEN PLASTICS)

BIO POLYMERS
- obtained from living organisms or polymeric materials (carbs and proteins)

BIO PLASTICS
- obtained from living organisms or biopolymers
- → should not generate waste
- → no toxic products should be generated and should be biodegradable

example:
- STARCH - glucose (potatoes, rice)
- POLYESTER - bacterial polyester fermentation
- CASEIN - milk protein
- SOY PROTEIN - plant protein
- CELLULOSE - wood, cotton, plant cell wall

⇒ BIOPLASTICS are produced by
1. Fermentation Process
2. Growing plastics in plants (using genetic engineering)

1. Fermentation

complex substances —(micro-organisms, absence of O_2)→ simple organic compounds.

a) Bacterial polyester fermentation.
- RALSTONIA EUTROPHIA BACTERIA

Bacteria: corn sugar to catalyse its biochemical reaction forms polyester fermentation ←

b) Lactic acid fermentation

sugar → lactic acid —(polymerisation)→ poly lactic acid (PLA)

2. Green Plastics in Plants

gene coding enzyme that helps in plastic formation is removed (gene slicing is done to remove defective gene and combine / insert the useful genes)

from bacteria, it is inserted into plants. → collect leaves → grind in solvent → GREEN PLASTIC

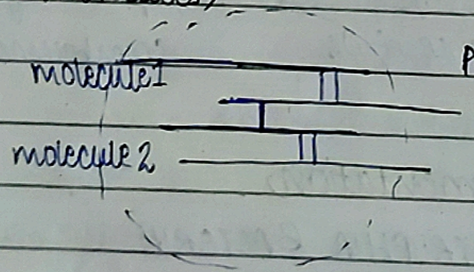
NUMBER AVERAGE & WEIGHT AVERAGE MOLECULAR WEIGHT OF POLYMERS

Q. In a polymer sample 30% molecules have MM = 20,000, 40% have MM = 30,000, rest have MM = 60000. Calculate no. avg. and weight avg. molecular masses.

$$\bar{M}_n = \frac{\sum n_i M_i}{\sum n_i} = \frac{(30\times 20000)+(40\times 30000)+(30\times 60000)}{30+40+30} = \underline{36000}$$

→ amt. of no. avg. MM

polymer (contains molecules) ⟶ monomers $(-COOH + NH_2^-)$



POLYMERIC CHAIN : polymeric chains are joined together by bonds.

Polymers have avg. MW b/c it is composed of numerous diffrent molecules.

$$\bar{M}_w = \frac{\sum n_i M_i^2}{\sum n_i M_i} = \frac{30(20000)^2 + 40(30000)^2 + 30(60000)^2}{30\times 20000 + 40\times 30000 + 30\times 6000}$$

$= \underline{43333}$ → weight avg. MW of polymer.