

20/03/2021

## Engineering Chemistry

## Polymer - Tutorial 3

1.) Write a note on Conducting Polymers.

Ans Organic polymers with highly delocalized  $\pi$ -electron system having electrical conductance of the order of conductors are called conducting polymers. The basic requirement for them is the formation of continuous conjugation through the polymer chain.

Different types of conducting polymers are as follows:

1.) Intrinsically conducting polymers:

- (1) It is a polymer whose backbone or associated groups consists of delocalized electron pair or residual charge.
- (2) In an electric field, conjugated  $\pi$ -electron of the polymer get excited, and hence can be transported through the solid polymeric materials. Overlapping of orbitals over the entire backbone results in the formation of valence bands as well as conduction bands.

(3) Some common examples are polyacetylene polymers, polyaniline, polyanthrylene, polypyrrole, polyazomethine, etc.

2.) Extrinsically conducting Polymers:

- (1) It is a polymer whose conductivity is due to the presence of externally added ingredient in them. They are of two types:

a) Conductive elements-filled polymers: It is a resin filled with conducting elements such as carbon black or metal oxides, in which the polymers acts as a binder to hold the conducting elements. Along with conductivity these polymers

are low in cost, light in weight, durable and strong.

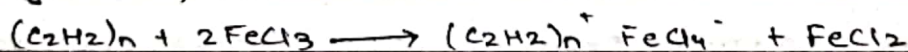
(b) Blended conducting polymer: It is a polymer obtained by blending a conventional polymer with conducting polymer. Such polymers possess better physical, chemical and mechanical properties.

3) Doped conducting Polymers :

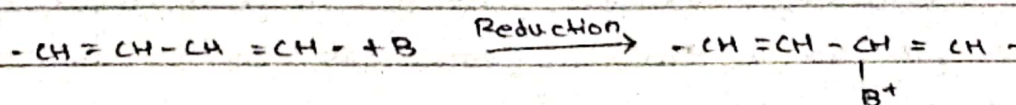
(i) It is obtained by exposing a polymer to a charge transfer agent either in gas phase or in solution phase. The conductivity of intrinsically conducting polymers (ICP) can be increased by creating either positive or negative charges on the polymer backbone by oxidation or reduction known as doping.

(ii) It is of two types:

(a) P-doping: In this an intrinsically conducting polymer is treated with a Lewis acid where oxidation process takes place and positive charges on the polymer backbone are created. Commonly used p-dopants are  $I_2$ ,  $Br_2$ ,  $AsF_5$ ,  $PF_6$ , naphthylamine, etc.



(b) N-doping: In this an intrinsically conducting polymer is treated with a Lewis base where reduction takes place and negative charges are created on the polymer backbone. Commonly used n-dopants are lithium (Li), Sodium (Na), Calcium (Ca), etc.





#### 4) Co-ordination conducting polymers:

1) It is a charge transfer complex containing polymer obtained by combining a metal atom with a poly-dentate ligand.

##### Applications :

1) In rechargeable light weight batteries based on perchlorate doped polyacetylene-lithium system. These are about 10 times lighter than conventional lead storage batteries.

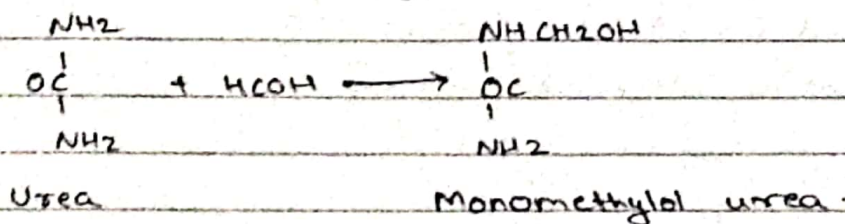
2) In wiring in aircrafts and aerospace components.

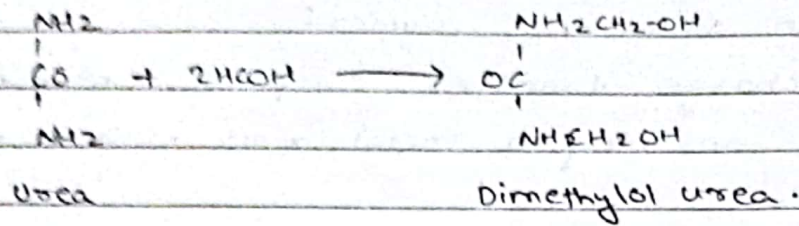
3) In electronic devices such as transistors and diodes and in telecommunication systems.

2) Give the synthesis, properties and uses of urea formaldehyde resin.

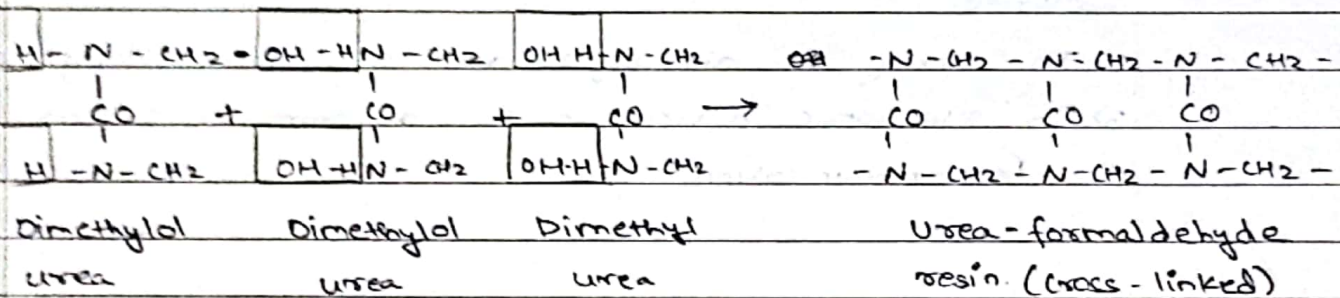
Ans 1) Amino resins are condensation products, obtained by the reaction of urea or melamine with formaldehyde.

2) Commercially, important amino resin is urea-formaldehyde, which is prepared by the reaction between 1 part of urea and 2 part of formaldehyde, in basic medium, in a stainless steel vessel at about 50°C. Primary products are mono and dimethylol ureas.





3) For moulding, the methylol derivatives are compounded and then cured. During curing long  $-\text{C}-\text{N}-\text{C}-\text{N}-$  chains are formed.



### Properties :

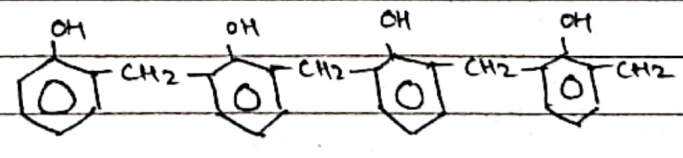
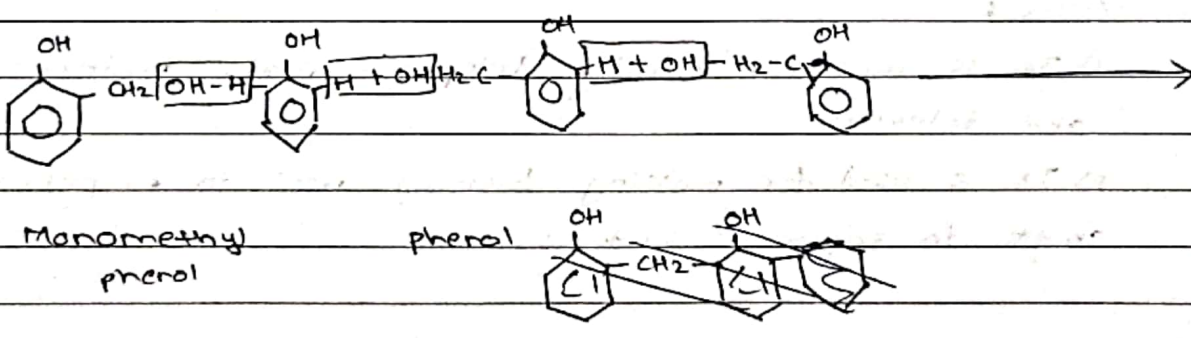
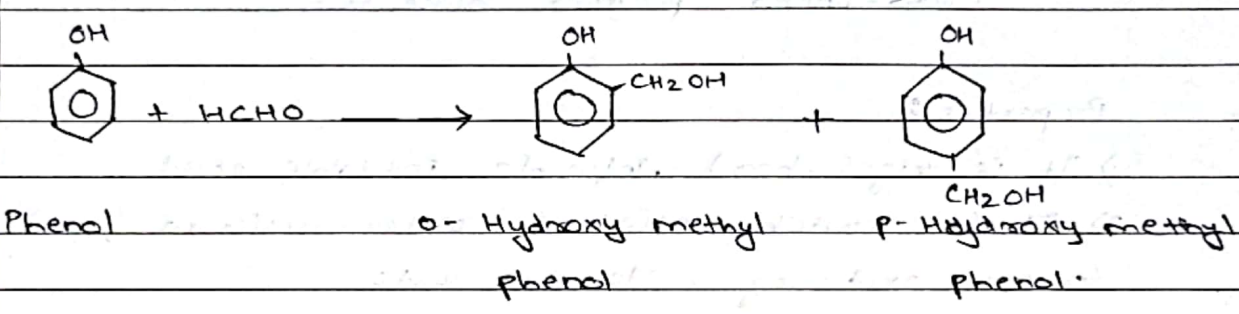
- 1) Urea formaldehyde resins give clear, water-white products of good tensile strength.
- 2) It also gives good electrical insulation and good chemical resistance.

### Uses:

- 1) It is used for bonding grinding wheels.
- 2) It is used for foundry cores.
- 3) It is used as electrical insulator.

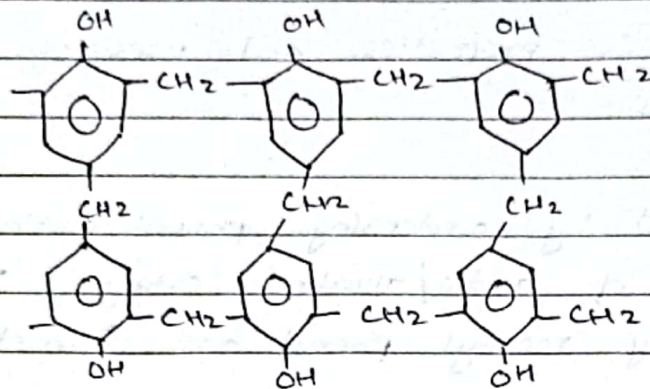


→ It is prepared by condensing phenol with formaldehyde in the presence of acidic/alkaline catalyst. Initially, o- and p-hydroxy methyl phenol are formed which react to form linear polymer novolac.



Novolac:

2) Hexamethylene tetramine is added to novolac which provides formaldehyde. This converts the soluble and fusible novolac into a hard infusible and insoluble solid of cross-linked bakelite.



Cross-linked polymer bakelite.

### Properties:

- 1) It is rigid, hard, infusible, insoluble solid.
- 2) It is scratch resistant, water resistant, and resistant to non-oxidizing acids and salts.

### Uses:

- 1) It is used for making telephone parts, cabinets for radio and television.
- 2) It is used for making bearing used in propeller shaft in paper industry.