EXPERIMENT 8

SYNTHESIS OF A POLYMER

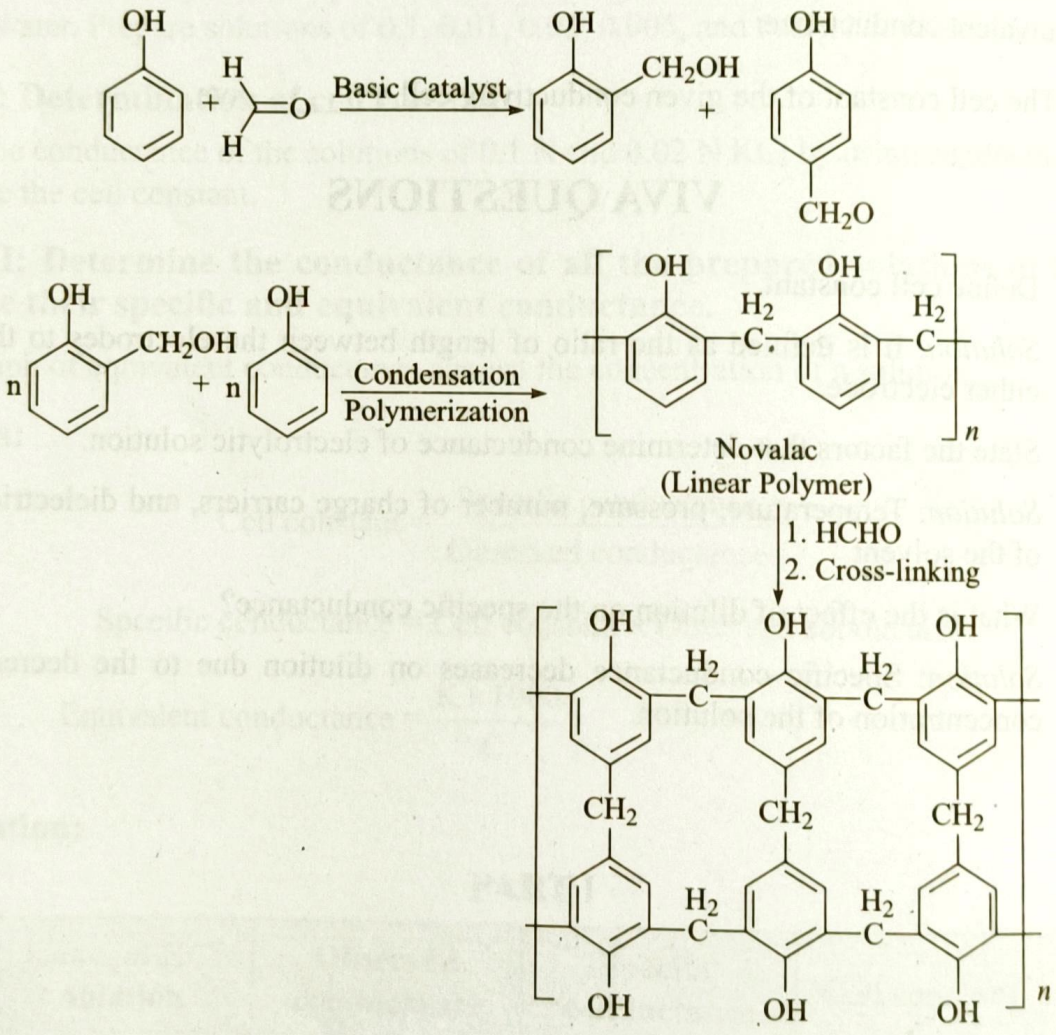
Aim: To prepare Phenol formaldehyde (P-F) resin

Apparatus required: Glass rod, beakers, funnel, measuring cylinder, dropper, and filter paper

Chemicals required: Phenol (2g), 40% aq. Formaldehyde solution or formalin (2.5 ml), glacial acetic acid (5 ml), and concentrated HCl (8ml).

Theory:

The condensation of phenol with formaldehyde in the presence of an acidic or alkaline catalyst produces Phenol formaldehyde resins (PFs), and hence they are called *condensation polymers*. It was, for the first time, prepared by an American Chemist known as Baekeland. He named the new product as *Bakelite*. These are thermosetting polymers.



Scheme: Bakelite synthesis

Thermosetting polymers, when subjected to heat turn hard and rigid, which cannot be further softened. Heating semi-fluid polymers having low molecular mass turns them infusible and forms an insoluble hard mass. The hardening on heating the polymers is due to the formation

of extensive cross-linking between different polymeric chains, which leads to the formation of a 3-dimensional network of bonds, which connects the polymer chains.

Three-dimensional networked structures are rigid and do not soften on heating. Hence, the thermosetting polymers cannot be reprocessed. Some commonly used thermosetting polymers are Urea-Formaldehyde resin and Melamine-Formaldehyde resin.

The properties of Phenol-formaldehyde resins are as follows:

1. Phenol-formaldehyde resins with a low degree of polymerization are soft. They can be used as bonding glue in laminated wooden planks and other articles due to their impressive adhesive properties.
2. Phenol-formaldehyde resins with a high degree of polymerization are hard and rigid. They are resistant to scratches and are infusible.
3. They are resistant to many organic solvents, non-oxidizing acids, and salts. They can withstand very high temperatures and are excellent electrical insulators.

Procedure:

1. Take a 100 ml beaker and pour 5 ml of glacial acetic acid, 2.5 ml of 40 % aq. Formaldehyde, and 2 g phenol safely.
2. Take a wet cloth and wrap the beaker. You can also place the beaker in a 250 ml beaker having a small amount of water in it.
3. Add concentrated HCl dropwise with vigorous stirring using a glass rod till the appearance of a pink coloured gummy mass.
4. Wash the pink residue number of times to wash away the acid and make it free from acid.
5. Filter the product and weigh it after drying in folds of a filter or an oven.
6. Report the yield of the polymer formed.

Observations:

Weight of empty watch glass = W_1 g

Weight of watch glass + polymer formed = W_2 g

Weight of polymer formed = $W_2 - W_1$ g

Result: Weight of phenol formaldehyde resin = W g

Precautions: The reaction may be vigorous. Therefore, it is recommended to stay a few feet away from the beaker while adding the H_2SO_4 and until the experiment is over.

VIVA QUESTIONS

1. Why phenol-formaldehyde resins are called condensation polymers?

   Solution: The condensation of phenol with formaldehyde in the presence of an acidic or alkaline catalyst produces Phenol-formaldehyde resins (PFs), and hence they are called condensation polymers.

2. Name some commonly used thermosetting polymers.

   Solution: Urea-Formaldehyde resin and Melamine-Formaldehyde resin