AIM: - To prepare phenol formaldehyde resin. (Bakelite)

CHEMICALS USED: - Glacial acetic acid, 40% formaldehyde solution, Phenol, conc. H₂SO₄

APPARATUS REQUIRED: - Glass rod, beakers, funnel, measuring cylinder, dropper and filter paper.

PRINCIPLE: - Phenol formaldehyde resins (PFs) are condensation polymers and are obtained by condensing phenol with formaldehyde in the presence of an acidic or alkaline catalyst. They were first prepared by Backeland, an American Chemist who gave them the name as Bakelite. These are thermosetting polymers.

Thermosets: - The polymers which on heating change irreversibly into hard rigid and infusible materials are called thermosetting polymers. These polymers are usually prepared by heating relatively low molecular mass, semi fluid polymers, which becomes infusible and form an insoluble hard mass on heating. The hardening on heating is due to the formation of extensive cross-linking between different polymeric chains. This lead to the formation of a 3-Dimnesional network of bonds connecting the polymer chains. Since the 3D network structure is rigid and does not soften on heating, the thermosetting polymers can not be reprocessed. Some important examples of thermosetting polymers are Urea-Formaldehyde resin and Melamine-Formaldehyde resins.

Properties: -
- Phenol- formaldehyde resins having low degree of polymerization are soft. They possess excellent adhesive properties and are usually used as bonding glue for laminated wooden planks and in varnishes and lackuers.
- Phenol- formaldehyde resins having high degree of polymerization are hard, rigid, scratch-resistant and infusible. They are resistant to non-oxidising acids, salts and many organic solvents. They can withstand very high temperatures. They act as excellent electrical insulators also.

Uses: -
- They are used for making moulded articles such as radio and TV parts, combs, fountain pen barrels, phonograph records etc.
- They are used for making decorative laminates, wall coverings etc.
- They are used for making electrical goods such as switches, plugs etc.
- They are used for impregnating fabrics wood and paper.
- They are used as bonding glue for for laminated wooden planks and in varnishes and lackuers.
- Sulphonated phenol-formaldehyde resins are use as ion-exchange resins.
Preparation:- PFs are prepared by reaction of phenol with formaldehyde in the presence of acidic or basic catalyst. The process may be carried out as follows:

A mixture of phenol and formaldehyde are allowed to react in the presence of a catalyst. The process involves formation of methylene bridges in *ortho*, *para* or *both ortho* and *para* positions. This results first in the formation of linear polymer (Called NOVALAC) and then in to cross-linked polymer called phenol-formaldehyde resin or bakelite.

![Chemical Reaction Diagram]

**NOVALAC** (Linear Polymer)

**Bakelite** (Cross-linked Polymer)
PROCEDURE: -
1. Place 5ml of glacial acetic acid and 2.5ml of 40% formaldehyde solution in a 500ml beaker and add 2 grams of phenol.
2. Add few ml of conc. Sulphuric acid into the mixture carefully. Within 5 min. a large mass of plastic is formed.
3. The residue obtained is washed several times with distilled water, and filtered product is dried and yield is calculated.

RESULT: - The weight of the phenol formaldehyde resin is ___ g.

PRECAUTIONS: -
1. The reaction is sometimes vigorous and it is better to be a few feet away from the beaker while adding the H₂SO₄ and until the reaction is complete.
2. The experiment should be preferably carried out in fume cupboard.

QUESTIONS BANK:
1. Phenol formaldehyde is also called as.
2. What do you understand by resin?
3. Give main uses of the phenol formaldehyde resin.
4. What type of co-polymer is phenol formaldehyde resin?
5. Briefly describe the properties of phenolic resins.
6. Write chemical equations for preparation of phenolic resins.

Safety Instructions
1. Phenol:- Most phenols are harmful if inhaled, ingested or absorbed through skin. They cause severe irritation or damage to skin and eyes. Some phenols are suspected carcinogen, should not inhale its dust or vapor, wear gloves and avoid contact.
2. H₂SO₄:- It is poisonous and corrosive. Contact or inhalation can cause severe damage to the eyes, skin and respiratory tract. Wear gloves and dispense under a hood, avoid contact and do not breathe the vapour.