Project Report on

"Preparation of phenol formaldehyde resin (bakelite) in laboratory"

Submitted By

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Certificate

This is to certify that project report entitled **"Preparation of Phenol Formaldehyde Resin (bakelite) in Laboraoryt"** are carried out by students mentioned below. They have been satisfactorily completed their project work for academic year 2022-23. The project has been approved as it satisfies the academic requirement in respect of project work prescribed for the Master of Science. -[1]

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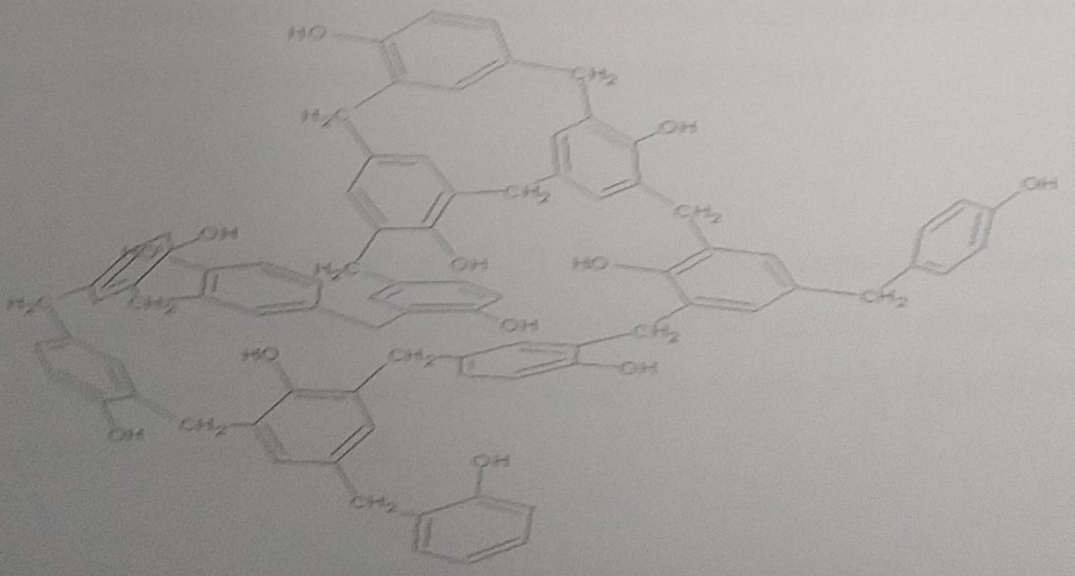
Introduction of the Bakelite

- Bakelite or polyoxybenzylmethylenglycolanhydride was the first plastic made from synthetic component.
- It is a thermosetting phenol formaldehyde resin, formed from condensation reaction of phenol with formaldehyde.
- It was developed by the Belgain-american chemist **'Leo Baekeland'** in Yonkers, New York in 1907.

- Chemical formula: - $(C_6H_6O \cdot CH_2O)_n$
- Molar Mass: - Variable
- Density: - 1.3 g/cm³



(Bakelite)

Preparation of phenol formaldehyde resin (Bakelite) in laboratory.

- **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 **Baekeland**, 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 cannot 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 lacquers. Phenol- formaldehyde resins having high degree of polymerization are hard, rigid, scratchresistant and infusible. They are resistant to non-oxidizing acids, salts and many organic solvents. They can withstand very high temperatures. They act as excellent electrical insulators also.

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 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 Bakelite.

Procedure:-

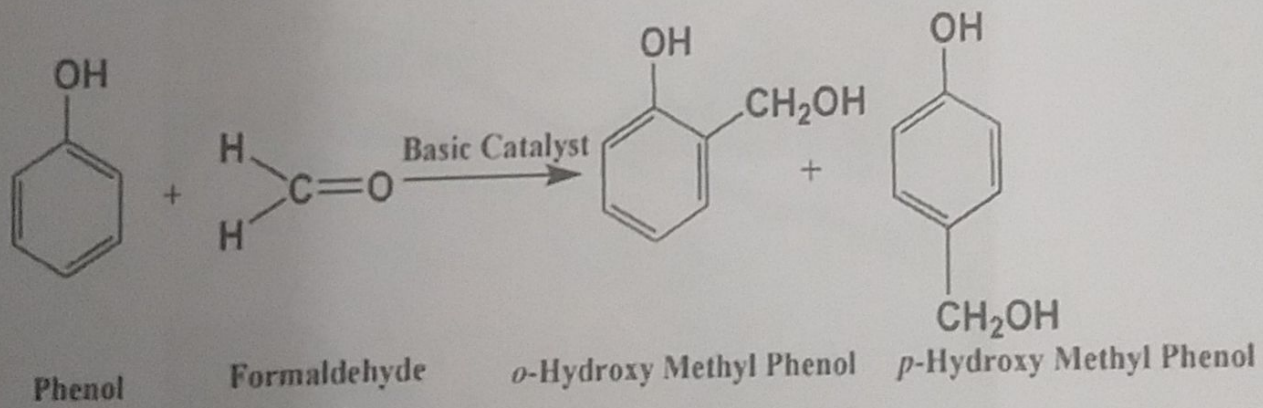
1. Place 5ml of glacial acetic acid and 2.5ml of formaldehyde solution in a 500ml beaker and add 2 grams of phenol and stir well.
2. Add few ml of conc. Hcl into the mixture carefully and then put the beaker on water bath until the light pink colored plastic is formed.

3. Obtain the residue and then wash it several times with distilled water. Filter the product after and dried calculate the yield. Bakelite is obtained as light yellow plastic.

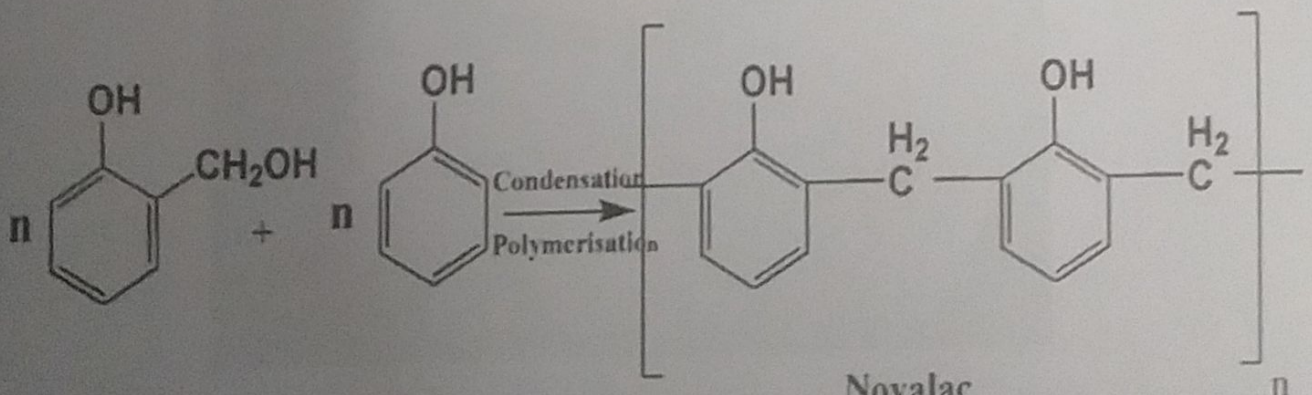
Precautions:-

- The reaction is harmful so it's better to be a few feet away from the beaker while adding Hcl and until the reaction is complete.
- Most phenol are harmful if inhaled or absorbed through the skin. They cause severe irritation or damage to skin and eyes. So wear gloves, mask and avoid direct contact.

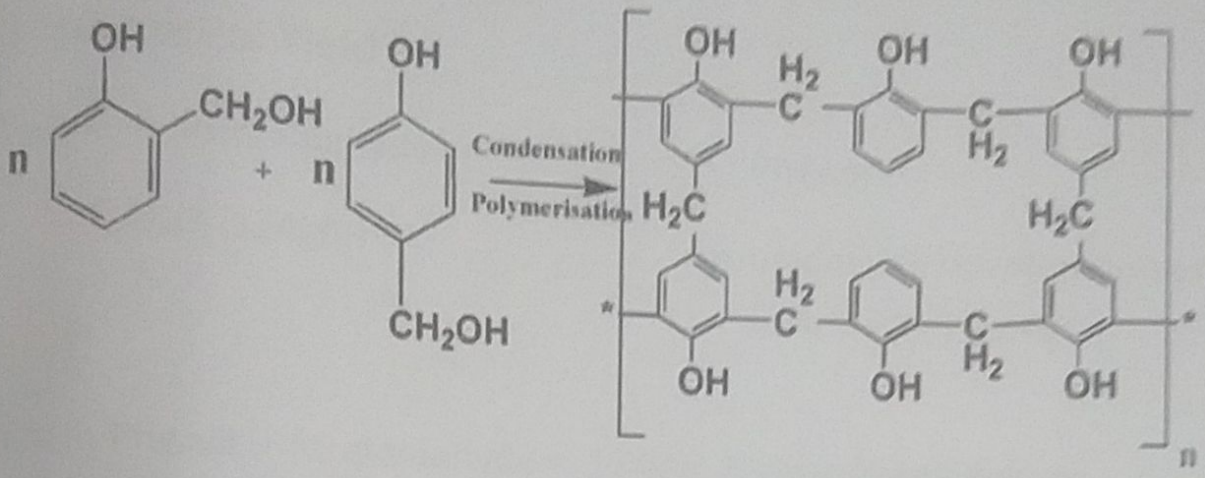
Reaction:-



Phenol Formaldehyde *o*-Hydroxy Methyl Phenol *p*-Hydroxy Methyl Phenol



Novalac
(Linear Polymer)



Bakelite
(Cross-linked Polymer)

Actual product obtained.

Calculation:

(1) Theoretical Yield :

Phenol + formaldehyde ⟶ Phenol - formaldehyde resin(monomer)

$C_7H_8O_2$(124gm) $C_6H_6O.CH_2O$(124gm)

124gm Phenol + formaldehyde = 124gm Phenol-formaldehyde Resin (Bakelite)

4.5gm Phenol + formaldehyde = (?)

$$= \frac{4.5 \times 124}{124}$$

= 4.5 gm

(2) Practical Yield:

Obtained Actual weight of the dried product = 3.2 gm

(3) % of Yield:

$$= \frac{\text{Actual weight} \times 100}{\text{Theoretical Yield}}$$

$$= \frac{3.2 \times 100}{4.5}$$

= 71.11 %

- **Result Table:**

(1) Theoretical Yield = 4.5 gm

(2) Practical Yield = 3.2 gm

(3) % Yield of the product = 71.11 %

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 laminated wooden planks and in varnishes and lacquers.
- Sulphonated phenol-formaldehyde resins are use as ion-exchange resins.