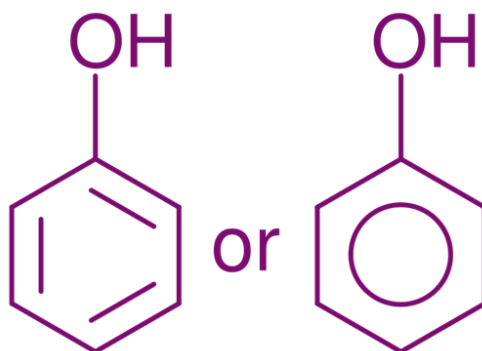


Phenols

Phenols

- Phenols are a class of organic compounds consisting of a hydroxyl group (-OH) attached directly to an aromatic hydrocarbon ring, usually a benzene ring.
- They are derived from and named after phenol, the simplest member of the class.
- Phenols are known for their antioxidant, antiseptic, and preservative properties and are widely used in various industries, such as pharmaceuticals, plastics, resins, and cosmetics.



Types and Classification of Phenols

- Phenols can be classified into different categories based on the number of hydroxyl groups, the type of aromatic ring, and the presence of other substituents.

The common types and classifications include:

1. Monophenols

- These phenols have one hydroxyl group attached to the aromatic ring.
- Examples include phenol itself and cresols.

2. Polyphenols

- These phenols have two or more hydroxyl groups attached to the aromatic ring.
- They can be further divided into different categories:
 - Diphenols:** They have two hydroxyl groups. Examples include catechol, resorcinol, and hydroquinone.
 - Triphenols:** They have three hydroxyl groups. An example is phloroglucinol.
 - Tetraphenols:** They have four hydroxyl groups. An example is pyrogallol.
 - Pentaphenols:** They have five hydroxyl groups. An example is gallic acid.

3. Substituted Phenols

- Phenols can also be classified based on the presence of other substituents on the aromatic ring.
- **Examples:**

- I. **Alkylphenols:** Phenols with alkyl groups.
- II. **Halophenols:** Phenols with halogen atoms.
- III. **Nitrophenols:** Phenols with nitro groups.
- IV. **Aminophenols:** Phenols with amino groups.

Applications of Phenols:

- Phenols are versatile compounds with wide-ranging applications across various industries:
 1. **Pharmaceuticals:** Phenols serve as precursors in drug synthesis, including analgesics like aspirin, antipyretics, and antiseptics such as hexachlorophene.
 2. **Plastics and Resins:** Phenol-formaldehyde resins are key components in adhesives and plastic production, notably in Bakelite.
 3. **Cosmetics:** Phenolic compounds are used as preservatives and antioxidants in cosmetics and personal care products.
 4. **Food Industry:** Phenolic antioxidants like butylated hydroxyanisole (BHA) and butylated hydroxytoluene (BHT) are used in food packaging and processing to prevent spoilage and extend shelf life.
 5. **Chemical Industry:** Phenols are intermediates in the synthesis of various chemicals, including dyes, detergents, and herbicides.

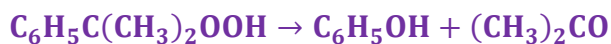
Examples of Phenols:

1. **Phenol:** The simplest phenol, used as a disinfectant and in the production of phenolic resins.
2. **Cresols:** Monophenols with a methyl group, used in disinfectants and solvents.
3. **Catechol:** A diphenol used as a precursor in pharmaceuticals and dyes.
4. **Resorcinol:** A diphenol used in resins, adhesives, and pharmaceuticals.
5. **Hydroquinone:** A diphenol used as a reducing agent, photographic developer, and chemical precursor.
6. **Gallic Acid:** A pentaphenol with antioxidant properties.

General Methods of Preparation of Phenol

1. From Cumene (Isopropylbenzene) - Cumene Hydroperoxide Process

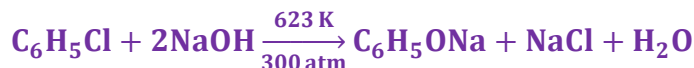
- Cumene is oxidized to cumene hydroperoxide, which is cleaved using an acid catalyst (e.g., sulfuric acid) to yield phenol and acetone.
- **Step 1: Oxidation of Cumene**
 - Cumene (isopropylbenzene) reacts with oxygen to form cumene hydroperoxide.
$$\text{C}_6\text{H}_5\text{CH}(\text{CH}_3)_2 + \text{O}_2 \rightarrow \text{C}_6\text{H}_5\text{C}(\text{CH}_3)_2\text{OOH}$$
- **Step 2: Acid Cleavage (Hock Rearrangement)**
 - Under acid catalysis (usually sulfuric acid):



2. From Chlorobenzene - Dow Process

- Chlorobenzene reacts with aqueous sodium hydroxide at high temperature and pressure to form sodium phenoxide, which is acidified to yield phenol.

- **Step 1: Formation of Sodium Phenoxide**



- (Note: 2 moles of NaOH are required.)

- **Step 2: Acidification**



3. From Aniline - Raschig Process

- Aniline is diazotized with nitrous acid to form diazonium salt, which is hydrolyzed to produce phenol and nitrogen gas.

- **Step 1: Diazotization (0–5°C)**



- (Nitrous acid is formed in situ:



- **Step 2: Hydrolysis of Diazonium Salt**



4. From Benzene Sulfonic Acid

- Benzene is sulfonated using concentrated sulfuric acid to form benzene sulfonic acid, which is treated with hot aqueous sodium hydroxide to form sodium phenoxide, followed by acidification to yield phenol.

- **Step 1: Sulfonation of Benzene**



- (Using concentrated or fuming H_2SO_4) (Nitrous acid is formed in situ:

- **Step 2: Fusion with NaOH (High Temperature ~623 K)**



- Important: The by-product is **sodium sulfite (Na_2SO_3)**, NOT Na_2SO_4 .

- **Step 3: Acidification**



Important Reactions of Phenol

1. Electrophilic Aromatic Substitution



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