

# Alcohols and Phenols

## Chapter I.5

### Alcohols and Phenols

- Alcohol: A compound that has an –OH group bonded to a saturated, alkane like carbon atom, R-OH.
- Phenol: A compound that has an –OH group bonded to an aromatic, benzene like ring, Ar-OH.



### Some Common Alcohols

- Methyl alcohol,  $\text{CH}_3\text{OH}$  (also known as Methanol)
- Ethyl alcohol,  $\text{CH}_3\text{CH}_2\text{OH}$  (also known as Ethanol)
- Isopropyl alcohol,  $(\text{CH}_3)_2\text{CHOH}$
- Ethylene glycol,  $\text{HOCH}_2\text{CH}_2\text{OH}$
- Glycerol,  $\text{HOCH}_2\text{CH}(\text{OH})\text{CH}_2\text{OH}$

•In a cyclic alcohol, begin with the carbon bearing OH group and proceed in a direction that gives the other substituents the lowest possible number.

•**Step 3:** Write the name, placing the number that locate the hydroxyl group immediately before the parent compound name. Number all other substituents according to their positions, and list them alphabetically.

### Naming Alcohols

- Step 1:** Name the parent compound. Find the longest chain that has the hydroxyl group (OH) attached, and name the chain by replacing the –e ending of the corresponding alkane with –ol.
- If the compound is a cyclic alcohol, add the –ol ending to the name of the parent cycloalkane.
- Step 2:** Number the carbon atoms in the main chain. Begin at the end nearer the hydroxyl group, ignoring the location of the other substituents.

•In a cyclic alcohol, it is not necessary to use number “1” to specify the location of the –OH group.

•In dialcohols or diols, numbering starts from the end closer to an –OH group, and the –diol name ending is used.

•Alcohols are classified as primary, secondary, or tertiary according to the number of carbon substituents bonded to the hydroxyl bearing carbon atom.

## Properties of Alcohols

- Alcohols are much more polar than hydrocarbons because of the electronegative oxygen atom that withdraws electrons from the neighboring atoms.
- Alcohols participate in hydrogen bonding.
- Straight chain alcohols up to 12 carbon atoms are liquids.
- Alcohols have higher boiling points than alkanes with similar molecular weights.
- Alcohols with small organic part (low molecular weight) are water soluble.
- Alcohols with large organic part (high molecular weight) are water insoluble.
- Alcohols containing two or more OH groups have higher water solubility than alcohols with one OH group.
- Alcohols containing two or more OH groups has higher boiling points than alcohols with one OH group.

## Reactions of Alcohols

**•Dehydration:** Alcohol undergoes loss of water upon treatment with a strong acid catalyst and produces an alkene. The  $-OH$  group is lost from one carbon and an H is lost from an adjacent carbon to yield an alkene product.



•When more than one alkenes can result from dehydration of an alcohol, a mixture of products is usually formed. The major product in the mixture is the alkene that has the greater number of alkyl groups attached to the double-bond carbons.

**•Oxidation:** Primary and secondary alcohols are converted into carbonyl ( $C=O$ ) containing compounds on treatment with an oxidizing agent. Many different oxidizing agents, such as potassium permanganate ( $KMnO_4$ ), potassium dichromate ( $K_2Cr_2O_7$ ) can be used. In the oxidation of an alcohol, two hydrogen atoms are removed from the alcohol – one hydrogen comes from the OH group and the other comes from the carbon bonded to the OH group. Water is produced as a by-product.

•Different kinds of carbonyl compounds are formed, depending on the structure of the starting alcohol and reaction conditions.

•*Primary alcohols* are converted either into *aldehyde* if carefully controlled conditions are used, or into *carboxylic acid* if an excess of oxidant is used.

•*Secondary alcohols* are converted into *ketones* on treatment with oxidizing agent.

•*Tertiary alcohols* don't react with oxidizing agents because they do not have a hydrogen on the carbon atom to which the OH group is attached.

## Phenols

•Phenol is the name of the hydroxy benzene,  $C_6H_5OH$ . Phenols have higher melting and boiling points than similarly substituted alkyl benzenes. In the past they were used as antiseptic. It is present in small quantity in topical drugs for pain, itching, and sore throat.