# **Alcohols**

Dr. Neeta Sinha

# Jamshedpur Cooperative College Jamshedpur

## **Outline**

- Classification
- Nomenclature
- Synthesis
- Chemical Reaction

#### Classification

- Alcohols are defined as hydroxy derivatives of aliphatic hydrocarbons. Its general formula is R-OH, where R is alkyl group and -OH is functional group.
- Alcohols are classified as follow:
- Monohydric alcohol Alcohols having one –OH gr. e. g.
   CH<sub>3</sub>OH, C<sub>2</sub>H<sub>5</sub>OH
- Dihydric alcohol Alcohols having two -OH grs. e.g.

CH<sub>2</sub>OH

CH<sub>2</sub>OH

**Ethylene glycol** 

- Trihydric alcohol - Alcohols having three -OH gr. e.g.

CH<sub>2</sub>OH

ı

**CHOH** 

ı

CH<sub>2</sub>OH Glycerol or Propane-1,2,3-triol.

- Monohydric alcohols are further classified as
- 1. Primary alcohol If –OH gr. is attached with primary carbon or one degree carbon atom e.g. CH<sub>3</sub>OH, CH<sub>3</sub>CH<sub>2</sub>OH
- 2.Secondary alcohol If –OH gr. Is attached with secondary carbon or two degree carbon atom e.g.

CH<sub>3</sub>
I
CH<sub>3</sub>CHOH
Isopropyl alcohol

3. Tertiary alcohol – If –OH gr. Is attached with tertiary or three degree carbon atom. e.g.

 $CH_3$ I  $CH_3COH$ I  $CH_3$ Tert. Butyl alcohol

#### **Nomenclature**

1. Common system – Alcohols are called alkyl alcohol, adding the word alcohol to the name of the alkyl group.

2. IUPAC system – In this system alcohols are called "ALKANOLS", replacing 'e' of corresponding alkane by suffix – ol. The longest chain containing –OH gr is selected as parent chain and numbered in such a way that carbon containing –OH gr gets the smallest number.

### **Synthesis**

1. From aldehyde and ketone: By the process of reduction alcohols can be prepared from aldehydes and ketones.

$$H_2/Ni$$
 or Pt or Pd
$$LiAlH_4$$
 $CH_3CH_2CHO \longrightarrow CH_3CH_2CH_2OH$ 

$$Primary alcohol$$

$$H_2/Ni \text{ or Pt}$$
 $CH_3COCH_3 \xrightarrow{} CH_3CHOHCH_3$ 
Secondary alcohol

2. From carboxylic acid: By reducing acid with LiAlH4.

LiAlH<sub>4</sub> / dry ether

RCOOH 
$$\longrightarrow$$
 RCH<sub>2</sub>OH

LiAlH<sub>4</sub> / dry ether

CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>COOH  $\longrightarrow$  CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH<sub>2</sub>OH

#### Synthesis continued .....

3. From ester: When esters are reduced with sodium in alcohol or LiAlH<sub>4</sub> / mixture of alcohols are obtained.

$$\frac{\text{Na/ C}_2\text{H}_5\text{OH}}{\text{or LiAlH}_4}$$
RCOOR'
$$\text{RCH}_2\text{OH} + \text{R'OH}$$

## **Properties**

1. Boiling point of alcohols are higher than hydrocarbons of comparable molecular wt. because of the presence of inter molecular hydrogen bonding in molecules.

2. Alcohols are soluble in water because it forms inter molecular hydrogen bonding with water molecule.

#### **Properties continued** .....

3. Acidic nature – Alcohols are weak acid because it ionises to give alkoxide ion and hydrogen ion because hydrogen is attached to the highly electronegative oxygen atom. This is why alcohols react with metals like Na, K, Mg, etc.

$$2ROH + 2M \longrightarrow 2ROM + H_2$$

$$2C_2H_5OH + 2K \longrightarrow 2C_2H_5OK + H_2$$

4. Reaction with Grignard reagent – It reacts with Grignard reagent to form alkanes.

ROH + R'MgX 
$$\longrightarrow$$
 R'H + MgXOR  
CH<sub>3</sub>OH + C<sub>2</sub>H<sub>5</sub>MgBr  $\longrightarrow$  C<sub>2</sub>H<sub>6</sub> + CH<sub>3</sub>MgBr

5. Reaction with acids – Alcohols react with carboxylic acid in presence of conc. Sulphuric acid to form esters.

RCOOH + R'OH 
$$\longrightarrow$$
 RCOOR' + H2O  
CH<sub>3</sub>COOH + C<sub>2</sub>H<sub>5</sub>OH  $\longrightarrow$  CH<sub>3</sub>COOC<sub>2</sub>H<sub>5</sub> + H2O

6. Reaction with acid chloride and acid anhydride – alcohols react with acid chloride or anhydride to produce esters.

RCOCI + R'OH 
$$\longrightarrow$$
 RCOOR' + HCI  
(RCO)<sub>2</sub>O + R'OH  $\longrightarrow$  R'COOR' + RCOOH

7. Dehydration of alcohol – Alcohols after dehydration with  $H_2SO_4$  or  $H_3PO_4$  or alumina or lewis acid produce alkenes.

$$CH_3CH_2OH \longrightarrow CH_2 = CH_2 + H_2O$$
  
 $CH_3CHOHCH_3 \longrightarrow CH_3CH=CH_2 + H_2O$ 

8. Reaction with halogen acid – Alcohols reacts with halogen acids to give haloalkanes in presence of Lewis acid or sulphuric acid. The order of reactivity of halogen acids are HI>HBr>HCl, because iodide ion is better nucleophile than bromide and chloride ion.

$$CH_3OH + HCI \longrightarrow CH_3CI + H_2O$$
  
 $C_2H_5OH + HBr \longrightarrow C_2H_5Br + H_2O$ 

9. Reaction with phosphorus halides - Alcohol reacts with phosphorus halides to give alkyl halides.

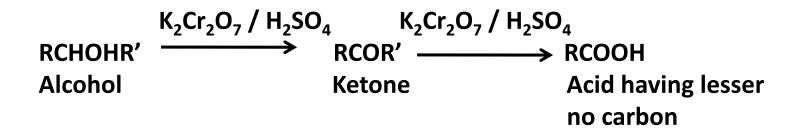
ROH + 
$$PCI_5$$
  $\longrightarrow$  RCI +  $POCI_3$  +HCI  
3ROH +  $PCI_3$   $\longrightarrow$  3RCI +  $H_3PO_3$   
CH<sub>3</sub>OH +PBr<sub>5</sub>  $\longrightarrow$  CH<sub>3</sub>Br +  $POBr_3$  + HBr  
3CH<sub>3</sub>OH +  $PI_3$   $\longrightarrow$  3CH<sub>3</sub>I +  $H_3PO_3$ 

10. Reaction with thionyl chloride – Alcohols react with thionyl chloride in presence of tertiary amine to give alkyl chlorides.

ROH + 
$$SOCl_2$$
  $\longrightarrow$  RCI +  $SO_2$  + HCI  
CH<sub>3</sub>OH +  $SOCl_2$   $\longrightarrow$  CH<sub>3</sub>CI +  $SO_2$  + HCI

- 11. Oxidation reaction On oxidation different alcohols gives different product.
  - i) Primary alcohols

#### (ii) Secondary Alcohol



#### (iii) Tertiary Alcohol

$$K_2Cr_2O_7 / H_2SO_4 \qquad K_2Cr_2O_7 / H_2SO_4$$
 $R_3COH \longrightarrow R_2-CO \longrightarrow RCOOH$ 
Alcohol Ketone Acid

# THANK YOU