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Where Minds Pollinate

Class 11
Chemistry

Chapter 18
Alcohol
Handwritten Notes

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Chap: 18 Alcohols

Q. What are alcohols. How are they classified?

Alcohol
or
Alkanols:- **(R-OH)** When hydrogen atom of alkane is replaced by hydroxyl group (O-H) compound formed are called alcohol.

$C_nH_{2n+1}OH$ = general formula
or
$C_nH_{2n+2}O$

Classification:- Monohydric Alcohols
Polyhydric Alcohols. (no further types)

Monohydric Alcohols:-

=> ① Alcohol containing only one OH group

Types:-
- Primary alcohol (1° - ")
- Secondary alcohols (2° - ")
- Tertiary alcohols (3° - ")

- **Primary Alcohol:-** (1° - ") Alcohol in which OH group is bonded with primary carbon.

Primary carbon :- Def

E.g: CH_3-CH_2-OH ethyl alcohol (C.N)
or ethanol (IUPAC)

$\overset{①}{C}H_3-\overset{②}{C}H_2-\overset{①}{C}H_2-OH$ Pri-propyl alcohol (C.N)
1-propanol (IUPAC)

- **Secondary Alcohol:-** (2° - ")

Secondry carbon :- Def

Eg:- $CH_3-\underset{\underset{OH}{|}}{CH}-CH_3$ sec-propyl alcohol (C.N)
or
iso propyl alcohol (C.N)
or
2-propanol (IUPAC)

(3° - ")
Tertiary alcohol:- Defi.

Tertiary carbon:- Defi:-

Eg:- $CH_3-CH_2-\underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3$ Ter-pentyl alcohol
or
2-Methyl-2-butanol

Polyhydric:- Alcohols containing more than one OH group in their structure are called polyhydric alcohol.

Eg:- $\underset{\underset{OH}{|}}{CH_2}-\underset{\underset{OH}{|}}{CH_2}$ 1,2-Ethanediol.
glycol or ethylene glycol

$\underset{\underset{OH}{|}}{CH_2}-\underset{\underset{OH}{|}}{CH}-\underset{\underset{OH}{|}}{CH_2}$ 1,2,3-propanetriol
Glycerine or glycerol

$\underset{\underset{OH}{|}}{CH_2}-\underset{\underset{OH}{|}}{CH}-CH_2-CH_3$ Butylene glycol

$CH_2-\underset{\underset{OH}{|}}{CH}-CH_3$ propylene glycol
$\underset{OH}{|}$

Method of preparation of Alcohols:-

① Hydration of alkene or Electrophilic Addition :-

$$CH_2=CH_2 + H-OH \xrightarrow[100^\circ C]{H_2SO_4} CH_3-CH_2-OH$$

② Reaction of alkene with $KMnO_4$ or potassium manganate (VII)

$KMnO_4$: $+1+Mn+4(-2)=0$, $Mn=+7$

Hydroxylation:-

most often used in basic medium

$$3CH_2=CH_2 + 4H_2O + 2KMnO_4 \xrightarrow{H_2SO_4} 3CH_2(OH)-CH_2(OH) + 2MnO_2 + 2KOH$$

ethylene glycol

Also known as Baeyer's reagent:-

③ Reaction of alkyl halide with aq NaOH:-

Nucleophilic substitution of haloalkanes:-

$$CH_3-CH_2-Cl + NaOH_{(aq)} \rightarrow CH_3-CH_2-OH + NaCl$$

④ Reduction of Carbonyl compound:- (Aldehyde or ketone)

ALDs Aldehyde => pri - alcohol

ketone => sec - alcohol

more strong ↑

Reducing agent: $NaBH_4$ Sodium borohydride , $LiAlH_4$ Lithium aluminum hydride

source of hydride ion $[H]^+$

$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-H \xrightarrow{NaBH_4} CH_3-CH_2-CH_2-OH$

$CH_3-\overset{O}{\overset{\|}{C}}-CH_3 \xrightarrow{NaBH_4} CH_3-\overset{OH}{\overset{|}{C}}H-CH_3$

2-propanone → 2-propanol

⑤ Reduction of carboxylic acid :-

carboxylic acid reduce to pri-alcohol

$CH_3-\overset{O}{\overset{\|}{C}}-OH \xrightarrow{LiAlH_4} CH_3-CH_2-OH + H_2O$

ethanoic acid
acetic acid

$CH_3-\underset{CH_3}{CH}-\overset{O}{\overset{\|}{C}}-OH \xrightarrow{LiAlH_4\ (\text{four hydrogen})} CH_3-\underset{CH_3}{CH}-CH_2-OH + H_2O$

⑥ Hydrolysis of Esters :-

$CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + H-OH \xrightarrow[\Delta]{H^+\ (\text{any acid})} CH_3-\overset{O}{\overset{\|}{C}}-OH + C_2H_5OH$

ethyl acetate

$CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + NaOH \xrightarrow[\Delta]{H_2O} CH_3-\overset{O}{\overset{\|}{C}}-ONa + C_2H_5OH$

(soap)

also called **saponification**

Acidity of Alcohols:-

$$R-O-H + Na \rightarrow R-ONa + \frac{1}{2}H_2$$

$$H-O-H + Na \rightarrow NaOH + \frac{1}{2}H_2$$

Water is more acidic than alcohol.

$$R \xrightarrow{} \overset{-\delta}{O} - \overset{+\delta}{H}$$

Alkyl grap
weak electron
donor group

→ less polar

Concept Assessment 18.1

$$CH_3-CH_2-OH + Na \rightarrow CH_3-CH_2-ONa + \frac{1}{2}H_2$$

Reaction of Alcohols:-

1) **Combustion:-** Burning of compound in the presence of oxygen is called combustion.

$$CH_3-OH + \frac{3}{2}O_2 \xrightarrow{\text{Flame}} CO_2 + 2H_2O + \text{heat}$$

$$CH_3-CH_2-OH + 3O_2 \xrightarrow{\text{Flame}} 2CO_2 + 3H_2O + \text{heat}$$

2) **Reaction of alcohol with thionyl chloride ($SOCl_2$):-**

$$CH_3-CH_2-OH + SOCl_2 \xrightarrow{\text{(O, N)}} CH_3-CH_2Cl + HCl\,(g) + SO_2\,(g)$$

3) **Reaction with phosphorus halide:-**

$$3\,CH_3-CH_2-OH + PCl_3 \rightarrow 3\,CH_3CH_2-Cl + H_3PO_3$$

phosphorous acid

$CH_3-CH_2-OH + PCl_5 \rightarrow \underset{Cl}{CH_3CH_2} + HCl + POCl_3$

phosphorus oxy chloride

4- Reaction of alcohol with halogen acid :- (Acid Halide)

$CH_3-CH_2-OH + \underset{(conc.)}{HCl} \xrightarrow[\text{no water}]{\text{Anhydrous } ZnCl_2} CH_3-CH_2-Cl + H_2O$

v.Imp **Lucas test:-** or Identification test for primary, secondary and tertiary alcohol :-

i) Tertiary alcohol form oily layer /insoluble layer immediately.

ii) Secondary alcohol form oily layer with in five to ten minutes.

iii) Primary alcohol form insoluble layer only on heating.

Lucas reagent / mixture of HCl and $ZnCl_2$

reactions:-

i- $CH_3-\underset{OH}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH_3 + HCl \xrightarrow[\text{Immediately}]{\text{anhyd } ZnCl_2} CH_3-\underset{Cl}{\overset{CH_3}{\underset{|}{\overset{|}{C}}}}-CH_3 + H_2O$ (conc.)

ii- $CH_3-\underset{OH}{CH}-CH_3 + HCl \xrightarrow[5\text{-}10\ min]{\text{anhyd } ZnCl_2} CH_3-\underset{Cl}{CH}-CH_3 + H_2O$ (conc)

iii- $CH_3-CH_2-\underset{OH}{CH_2} + HCl \xrightarrow[heat]{\text{anhyd } ZnCl_2} CH_3-CH_2-\underset{Cl}{CH_2} + H_2O$ (conc.)

Q) How will u disting b/w 1-propanol, 2-propanol, 2-methyl 2propanol

5- Reaction of alcohol with potassium bromide:-

$CH_3-CH_2-OH + KBr + H_2SO_4 \longrightarrow CH_3-CH_2-Br + H_2O + KHSO_4$

6- Dehydration of alcohol:-

Best dehydrating agent H_2SO_4 140-170°C

Def:- Removal of water from alcohol is dehydration.

$CH_3-CH_2-OH \xrightarrow[180°C]{H_2SO_4} CH_2=CH_2 + H_2O$

$CH_3-CH_2-OH + CH_2-CH_3-OH \xrightarrow[140°C]{H_2SO_4} CH_3-CH_2-O-CH_2-CH_3 + H_2O$

Temp = 140°C-170°C or 180°C = reaction 1

exact 140°C = reaction 2 / if mole not given consider it 2-mole

7- Esterification:- (Preparation of Ester)

Reaction of alcohols with carboxylic acid:-

Def:- When alcohol is reacted with carboxylic acid in the presence of H_2SO_4 as a catalyst ester is formed, this process is called esterification.

Ester has fruity smell.

$CH_3-\overset{O}{\overset{\|}{C}}-OH + C_2H_5OH \underset{\text{Δ}}{\overset{H_2SO_4\ (conc.)}{\rightleftharpoons}} CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5 + H_2O$

ethyl acetate

3. Oxidation:-

- Best oxidizing agent for alcohol is $\underbrace{K_2Cr_2O_7 + H_2SO_4}$ (source of nascent oxygen)

other oxidizing agent acidified $KMnO_4$

- **Primary alcohol** is oxidized into aldehyde which is further oxidized into carboxylic acid

$$CH_3-CH_2-\underset{OH}{CH_2} + [O] \xrightarrow[H_2SO_4\ (50°C)]{K_2Cr_2O_7} CH_3-CH_2-\underset{O}{\overset{\|}{C}}-H + H_2O$$

(B) To stop hard put reaction in ice

$$CH_3-CH_2-\underset{O}{\overset{\|}{C}}-H + [O] \xrightarrow[50°C]{K_2Cr_2O_7 + H_2SO_4} CH_3-CH_2-\underset{O}{\overset{\|}{C}}-OH$$

- **Secondary alcohol** is oxidize into ketone which is not further oxidize.

$$CH_3-\underset{OH}{CH}-CH_3 + [O] \xrightarrow[50°C]{K_2Cr_2O_7 + H_2SO_4} CH_3-\underset{O}{\overset{\|}{C}}-CH_3 + H_2O$$

acetone
2-propanone

- Tertiary alcohol does not oxidize due to absence of α - hydrogen. Under same condition it undergo elimination reaction.

$$CH_3-\overset{\beta}{CH_2}-\underset{OH}{\overset{CH_3}{\overset{|}{\overset{\alpha}{C}}}}-\overset{\beta}{CH_3} \xrightarrow[50°C]{K_2Cr_2O_7 + H_2SO_4} CH_3-CH=\overset{CH_3}{\overset{|}{C}}-CH_3$$

Sets F rule
remove H where H are less on β carbons

⇒ In this reaction $K_2Cr_2O_7$ is ineffective
⇒ only H_2SO_4 will act as dehydrating agent and undergo dehydration also known as elimination reaction

Q) How will you distinguish between [illegible] — I no reaction

balancing Code 46 55

Iodoform reaction or Haloform reaction

① In primary alcohols only ethanol undergo haloform reaction.

$CH_3-CH(OH)-CH_3 + 4I_2 + 6NaOH \rightarrow$

$CHI_3 + HCOONa + 5NaI + 5H_2O$

3 fix products

Iodoform (yellow ppt)

② Secondary alcohol containing $CH_3-CH(OH)-$ group undergo halo form reaction.

$CH_3-CH(OH)-CH_3 + 4I_2 + 6NaOH \rightarrow$ (yellow ppt) $CHI_3 + 5NaI + 5H_2O +$ CH_3COONa

Q) How will u distinguish b/w

① Methanol & ethanol Iodoform test

② 1- propanol and 2- propanol

③ 2- Pentanol and 3- pentanol

④ Acetaldehyde and formaldehyde

give same reaction — no reaction

Lucas test will distinguish dif groups pri-sec-ter

This test distinguish b/w similar groups i.e pri and pri

sec- sec

MCQs :- (i) oxidation | (iv) methanol

(ii) oxidation

(iii) ter

Short Q / A :-

(ii) Step : 1 $CH_3-CH_2-\ddot{O}-H + H^+ \longrightarrow CH_3-CH_2-\overset{\oplus}{O}(H)-H$

(from acid (H_2SO_4))

Step : 2 $CH_3-CH_2-\overset{\oplus}{O}(H)-H + CH_3-CH_2-\ddot{O}-H \longrightarrow$

$CH_3-CH_2-\overset{\oplus}{O}(H)-CH_2-CH_3 + H_2O$

Step : 3

$CH_3-CH_2-\overset{\oplus}{O}(H)-CH_2-CH_3 + H_2\ddot{O} \rightarrow CH_3-CH_2-O-CH_2-CH_3 + H_3O^+$

H_3O^+ also known as catalyst = H^+

$H_3O^+ = H^+$

Ex (10) Imp

Case (I)

$CH_3-\overset{O}{\overset{\|}{C}}-CH_3$ ≠ + Same as below

or

Case (II)

$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-H + [O] \xrightarrow[50°C]{K_2Cr_2O_7 + H_2SO_4} CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OH$

(A) (B)

$CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OH + 7[O] \xrightarrow[50°C]{K_2Cr_2O_7 + H_2SO_4} 3CO_2 + 3H_2O$

Best ans

OR

$$CH_2=CH-CH_2-OH \xrightarrow[50^\circ C]{K_2Cr_2O_7 + H_2SO_4} CH_2=CH-\overset{\overset{O}{\|}}{C}-H + H_2O$$

(A) (B)

$$CH_2=CH-\overset{\overset{O}{\|}}{C}-H \xrightarrow[30^\circ C]{K_2Cr_2O_7 + H_2SO_4} CH_2=CH-\overset{\overset{O}{\|}}{C}-OH$$

(C)