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COMPUTER ENGINEERING (19/ENG02/054)
CHM 102 (Chemistry Assignment)
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1) Give the IUPAC names of the following organic compounds

CH_3OCH_3 ⟶ Methoxymethane

$CH_3CH_2OCH_2CH_3$ ⟶ Ethoxyethane

$(CH_3CH_2CH_2CH_2)_2O$ ⟶ Ethoxypropane

$CH_3CH_2OCH_3$ ⟶ Ethylmethylether / Methoxyethane

$CH_3CH_2CH_2OCH_2CH_3$ ⟶ 1-Ethoxypropane / Ethyl Propyl ether

2) PROPERTIES OF ETHERS

The properties of ethers can be divided into its physical properties and its chemical properties.

* PHYSICAL PROPERTIES

(i) Physical states: At room temperature, ethers are colourless, neutral liquids with pleasant odours. The lower aliphatic ethers are highly flammable gases or volatile liquids.

(ii) Solubility: Ethers are less soluble in water than are the corresponding alcohols. Lower molecular weight ethers are fairly soluble in water since the molecules are able to form hydrogen bond with the water molecules. They are also miscible with most organic solvents.

(iii) Density: Most of the simple ethers are less dense than water, although the density increases with increasing relative molecular mass and some of the aromatic ethers are in fact, denser than water.

(iv) Boiling points: The boiling point of ethers is comparable to the alkanes but much lower than that of alcohols of comparable molecular mass, despite the polarity of the C-O bond. The miscibility of ethers with water resemble those of alcohols.

v Reactivity : Ethers are inert at moderate temperature. This inertness at moderate temperature results in their wide use as reaction media.

* CHEMICAL PROPERTIES

(i) Cleavage: (a) Heat decomposes ethers especially in the presence of alumina catalysts to form olefins and water as principal products.

$$CH_3CH_2OCH_3 \xrightarrow[Heat]{Al_2O_3} CH_3CH=CH_2 + H_2O$$

(b) Ethers undergo carbon-oxygen fission on heating with strong acids such as nitric acids. This cleaves one or both of the carbon-oxygen linkages to form alkyl derivatives and in cases in which only one bond is cleaved, an alcohol is one of the products.

$$CH_3CH_2OCH_2CH_3 \xrightarrow[reflux]{HI} CH_3CH_2I + CH_3CH_2OH$$

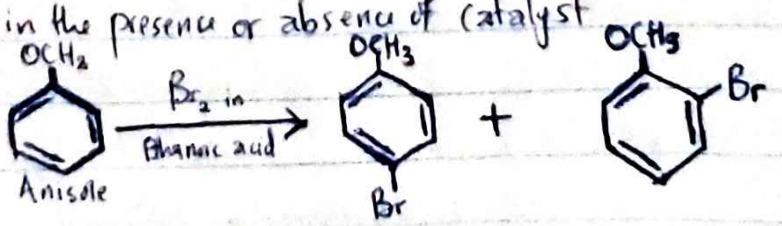
$$CH_3CH_2OCH_2CH_2CH_3 \xrightarrow[reflux]{2HI} CH_3CH_2I + CH_3CH_2CH_2I + H_2O$$

(ii) Autoxidation: In the presence of oxygen, ethers undergo self-oxidation to unstable peroxides and this reaction may create the danger of explosion in stored ether. For this reason, ethers should be stored in dark bottles (amber bottles) and should contain an antioxidant.

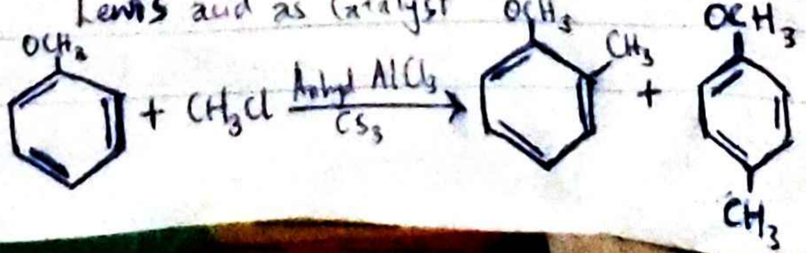
$$CH_3CH_2OCH_2CH_2CH_3 + O_2 \longrightarrow CH_3CH_2-O-CH(OOH)CH_2CH_3$$

(iii) Electrophilic Substitution: The alkoxy group in ether activates the aromatic ring at ortho and para positions for electrophilic substitution. Common electrophilic substitution reactions are halogenation, Friedel craft's reaction etc.

(iv) Halogenation of Ethers: Aromatic ethers undergo halogenation upon the addition of halogen in the presence or absence of catalyst.



(v) Friedel Crafts reaction of ethers: Aromatic ethers undergo Friedel Craft's reaction upon the reaction with alkyl or acyl halide in the presence of a Lewis acid as catalyst.



3 METHODS OF PREPARING ETHERS

(i) Preparation of Ethers by Dehydration of Alcohols

In the presence of protic acids (Sulphuris acid), alcohol undergo dehydration to produce alkenes and ethers under different conditions. ~~For example~~ The alcohol in excess and concentrated sulphuric acid is heated at a carefully maintained temperature of 140°C. This process is known as continuous etherification. If excess alcohol is not used, the temperature is as high as 170-180°C, further dehydration to yield alkene occurs.

$$2ROH \xrightleftharpoons{Conc.\ H_2SO_4/140°C} R-O-R + H_2O$$

Example: $2CH_3CH_2OH \xrightleftharpoons{Conc.\ H_2SO_4/140°C} CH_3CH_2-O-CH_2CH_3 + H_2O$

The preparation of ethers by dehydration of an alcohol is a nucleophilic substitution reaction. There are two major roles of the alcohol that we find in this reaction. One is that the alcohol molecule can act as the substrate while the other is that it acts as a nucleophile. It can follow either SN^1 or SN^2 mechanism. Generally we will find out that secondary & tertiary alcohols follow SN^1 mechanism, while primary alcohols follow the SN^2 mechanism.

*An example of when unimolecular dehydration may compete:

$$CH_3-\underset{OH}{CH}-CH_3 \xrightarrow[(170-180°C)]{H_2SO_4,\ heat} CH_3-CH=CH_2 + H_2O$$

Isopropyl alcohol (not in excess) → Propene (no ether is formed)

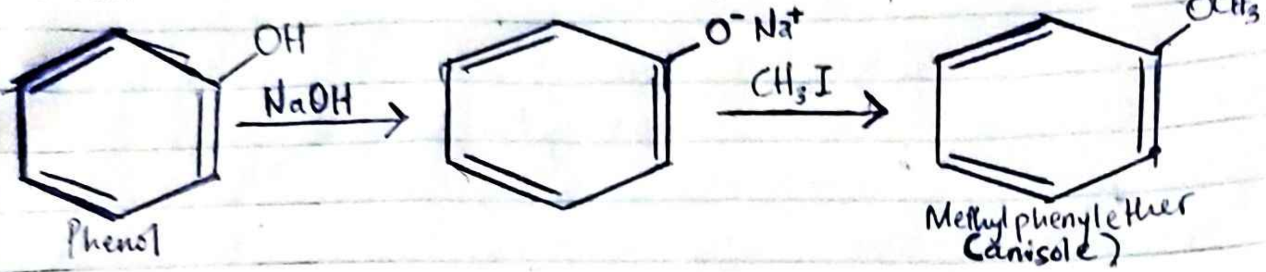
(ii) Preparation of Ethers by Williamson ether synthesis

The most versatile method for making ether is the Williamson ether synthesis, named for English Chemist Alexander Williamson, who devised the method in the 19th century. It uses an alkoxide ion to attack an alkyl halide, substituting the alkoxy (—O—R) group for the halide. The alkyl halide must be unhindered (usually primary), or elimination will compete with the desired substitution.

$$R-\ddot{O}:^{-} + R'-X: \longrightarrow R-\ddot{O}-R' + :X:^{-}$$

Examples:

CH_3OH (methanol) $\xrightarrow{Na}$ $CH_3O^-Na^+$ $\xrightarrow{CH_3CH_2Br}$ $CH_3OCH_2CH_3$ (Methyl ethyl ether) $+ Na^+Br^-$



(4) USES OF ETHYLENE OXIDE

(i) Consumer Applications

Most ethylene oxide is used as an intermediate in the production of other chemicals used to manufacture products, such as fabrics for clothes, upholstery, carpet and pillows. It is used to produce ethylene glycols for engine antifreeze that keeps our automobiles performing. Other ethylene oxide derivatives are used in household cleaners and personal care items such as cosmetics and shampoos.

(ii) Medical Applications

Approximately 50 percent of medical supplies are sterilized with ethylene oxide in the United States. Ethylene oxide sterilization processes can sanitize medical and pharmaceutical products that cannot support conventional, high-temperature steam sterilization procedures. Since high-sensitive medical devices could get damaged by steam sterilization, ethylene oxide gas is used. It is also used to sterilize other health care products as bandages and so on.

(iii) Industrial Applications

Ethylene glycol, which is derived from ethylene oxide, is used to manufacture fiberglass used in products ranging from jet skis to bathtubs to bowling balls, as well as polyethylene terephthalate (PET) plastic resin to make beverage containers and packaging film. Ethylene oxide derivatives are also used as ingredients in industrial cleaners and plasticizers