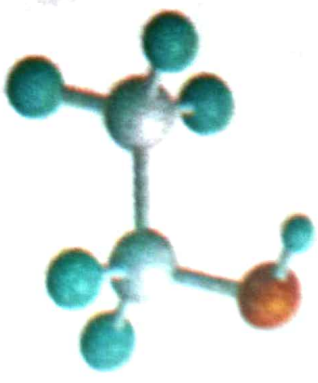


amounts can cause irreversibly...
 by even a small spark. Chemically it behaves like a hydrocarbon...
 general reactions mentioned before.
 Uses: Methyl alcohol is used; (1) as a solvent for paints and varnishes;
 automobile radiators; (2) to denature ethyl alcohol; (3) as a motor fuel;
 and (5) in the manufacture of...
 alcohol and gasoline makes a good motor fuel.

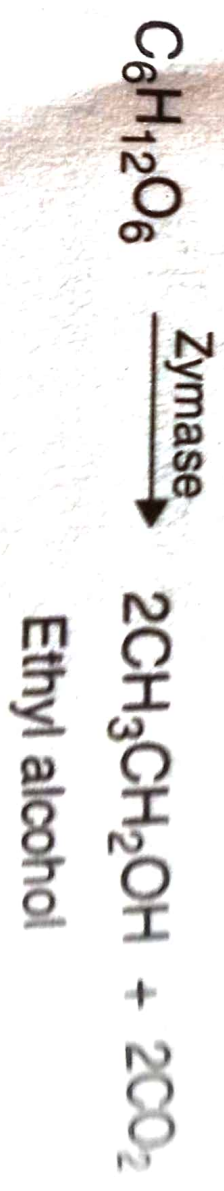
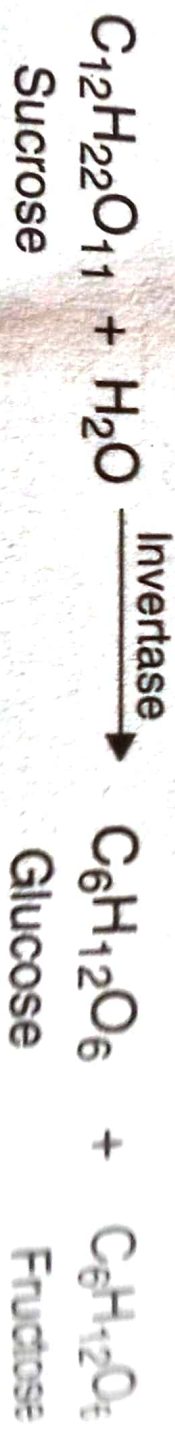
ETHYL ALCOHOL, Ethanol, CH_3CH_2OH



Ethyl alcohol is the alcohol of wine, beer, whiskey, and similar beverages. It is often simply 'alcohol'. Ethyl alcohol is also known as **Grain Alcohol**, since it can be prepared from grains.

Manufacture. Ethyl alcohol is manufactured by the following methods:

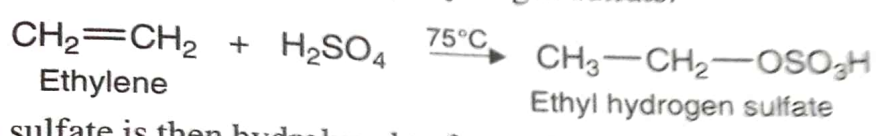
(1) **Fermentation of Sugars.** Ethyl alcohol has been made for centuries by the fermentation of sugars in the presence of yeast.



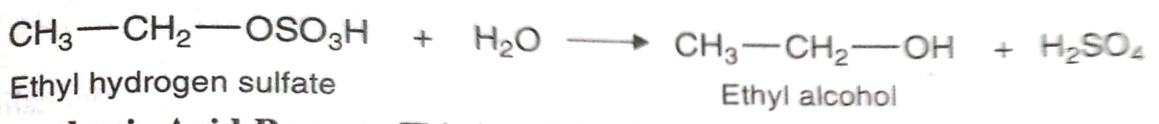
Molasses is a cheap source of glucose, fructose, and sucrose and it forms an excellent raw material for making ethyl alcohol. Ethyl alcohol is also produced from cheap starchy materials such as maize and barley. The starchy material is first converted into sugar which is then fermented.

Just prior to World War II, the fermentation of molasses accounted for about 75% of total world ethanol production. Today less than 10% of ethanol is made by this method. Over 90% is synthesized from ethylene gas which is a by-product of petroleum industry. In India, molasses is still the major source of ethyl alcohol.

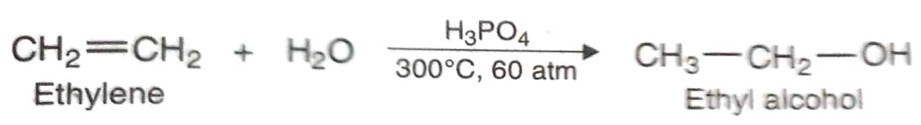
(2) **Sulfuric Acid Process.** This involves indirect hydration of ethylene. Ethylene is treated with concentrated sulfuric acid at 75°C to form ethyl hydrogen sulfate.



Ethyl hydrogen sulfate is then hydrolysed to form ethyl alcohol. The yield of ethyl alcohol is 90 per cent.



(3) **Phosphoric Acid Process.** This involves direct hydration of ethylene. Phosphoric acid is used as a catalyst.



Phosphoric acid process was first used commercially by Shell (USA) in 1947. Ethylene and water are preheated to 300°C and then passed under high pressure into a reactor. The reactor is a stainless steel vessel containing solid phosphoric acid catalyst. The reaction products are then cooled and passed into the scrubber where ethyl alcohol is dissolved in water. The aqueous solution of alcohol is sent to the distillation tower to get pure alcohol (Fig. 15.4). The yield of ethanol is 95 per cent.

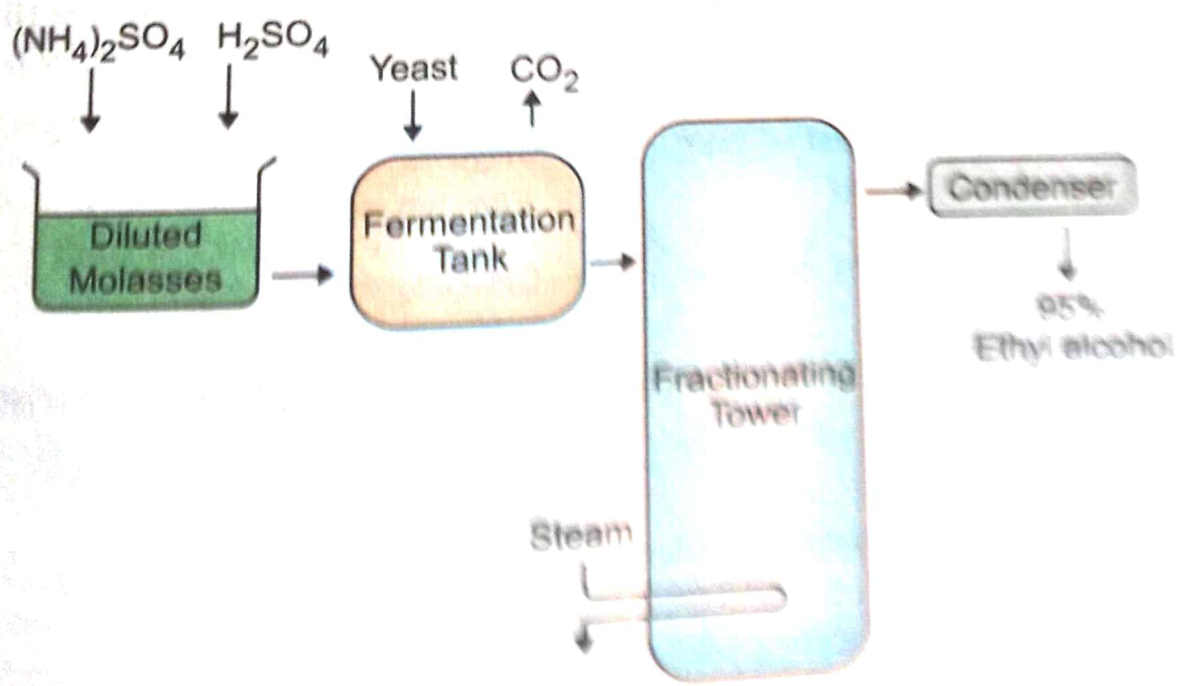
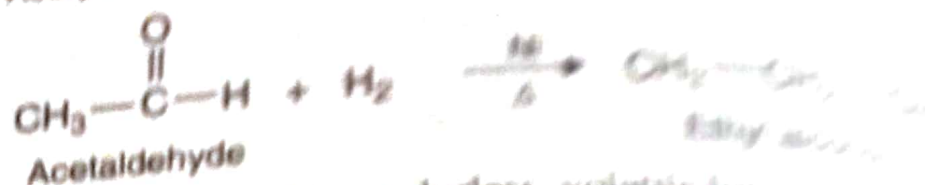
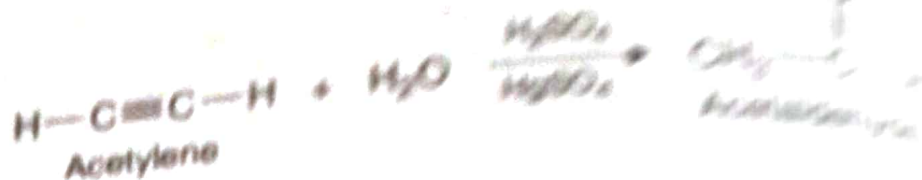


Fig. 15.4. The manufacture of Ethyl alcohol.



Properties. (Physical). Ethyl alcohol is a colorless, volatile liquid with a characteristic odor, bp 78°C . It mixes with water in all proportions. Thus, water is effective in diluting ethyl alcohol. Water dilutes ethyl alcohol to the point that it can be used as a volume of flammable vapor.

(Chemical). Ethyl alcohol gives all the general reactions of the class.

(1) **Reaction with Sodium or Potassium.** Ethyl alcohol reacts with sodium or potassium to form the corresponding ethoxides.



(2) **Reaction with Phosphorus Halides.** Ethyl alcohol reacts with phosphorus ethyl halides.



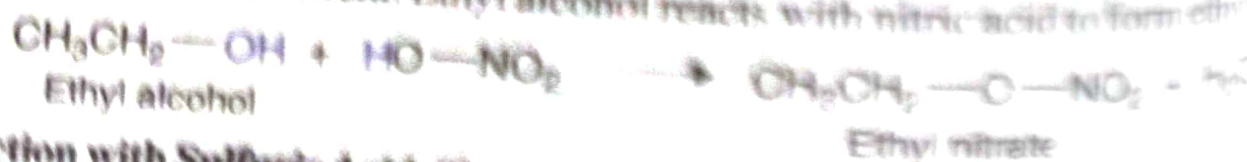
(3) **Reaction with Thionyl Chloride.** Ethyl alcohol reacts with thionyl chloride to form ethyl chloride.



(4) **Reaction with Hydrogen Halides.** Ethyl alcohol reacts with HBr , HI , etc. to form corresponding ethyl halides. HCl reacts in the presence of ZnCl_2 catalyst. No reaction in the case of HBr or HI .



(5) **Reaction with Nitric Acid.** Ethyl alcohol reacts with nitric acid to form ethyl nitrate.

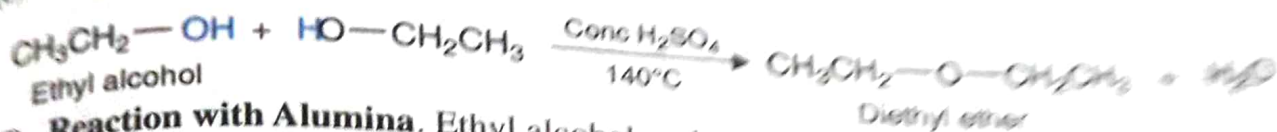


(6) **Reaction with Sulfuric Acid.** The reaction of ethyl alcohol with sulfuric acid depends on reaction conditions.

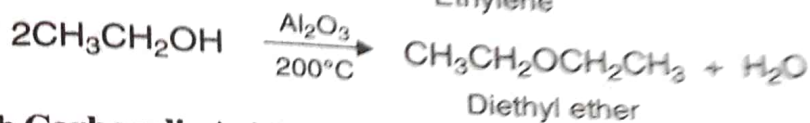
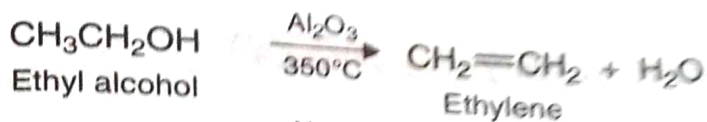
(b) Reaction at 170°C gives ethylene.



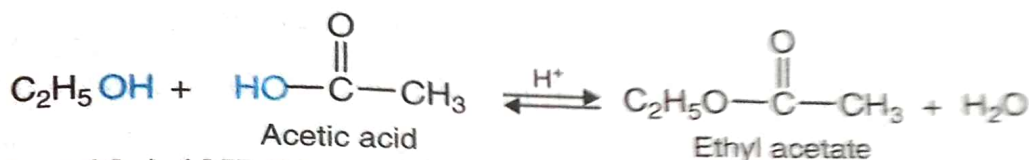
(c) Reaction at 140°C gives diethyl ether.



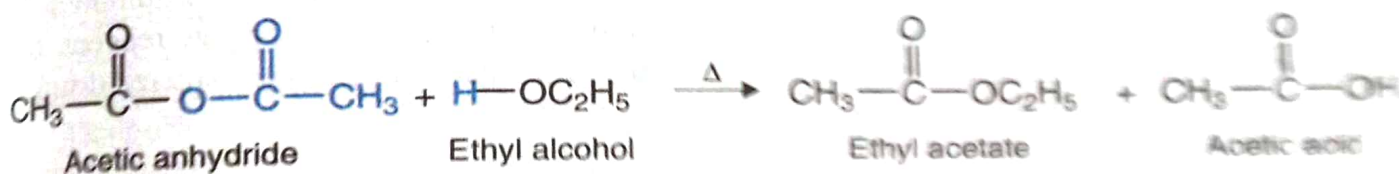
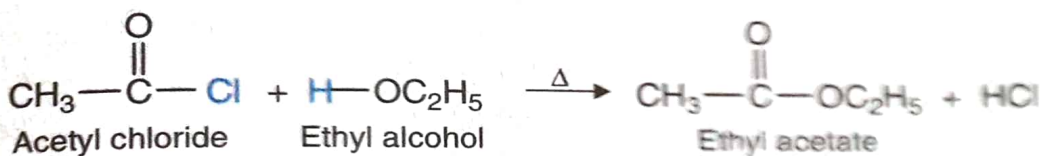
(7) **Reaction with Alumina.** Ethyl alcohol undergoes dehydration when its vapors are passed over heated alumina (Al_2O_3) catalyst.



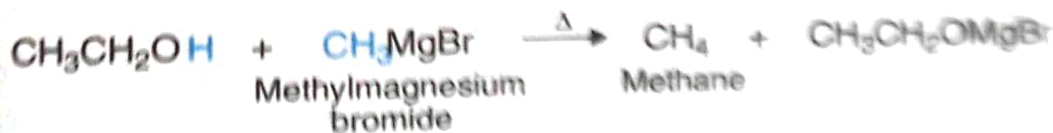
(8) **Reaction with Carboxylic Acids.** Ethyl alcohol reacts with carboxylic acids in the presence of sulfuric acid to form esters.



(9) **Reaction with Acid Halides and Acid Anhydrides.** Ethyl alcohol reacts with acid halides and acid anhydrides to form esters.



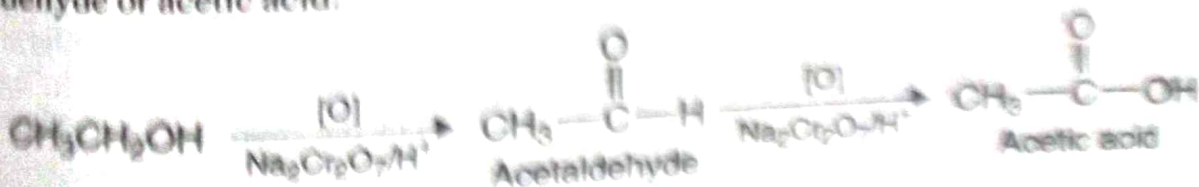
(10) **Reaction with Grignard Reagents.** Ethyl alcohol reacts with Grignard reagents to form alkanes.



(11) **Reduction.** Ethyl alcohol undergoes reduction with concentrated hydriodic acid and red phosphorus to produce ethane.

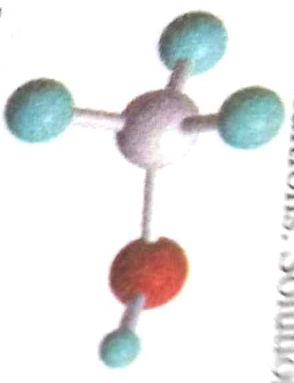


(12) **Oxidation.** Ethyl alcohol undergoes oxidation with $\text{Na}_2\text{Cr}_2\text{O}_7 + \text{H}_2\text{SO}_4$ or $\text{KMnO}_4 + \text{H}_2\text{SO}_4$ to form acetaldehyde or acetic acid.



- (a) ... the acid containing the same number of carbons. There will be a change in color of the solution from orange to green.
- (b) Secondary alcohols give a ketone containing the same number of carbons. There will be a change in color of the solution from orange to green.
- (c) Tertiary alcohols do not react under these conditions. Solution will remain orange. (Table 15.2)

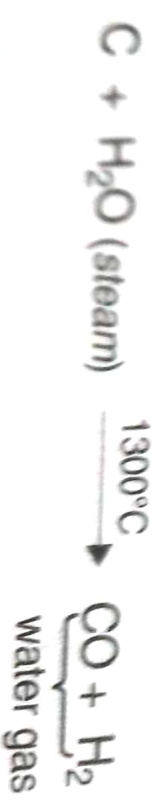
METHYL ALCOHOL, Methanol, CH₃OH



Methyl alcohol is also known as **Wood Alcohol** because it was formerly obtained by the destructive distillation of wood.

Manufacture. Methyl alcohol may be prepared by any of the general methods described before. For large scale production, the following three methods can be used :

(1) **From Water Gas.** Today, methanol is mostly manufactured by this method. Steam is passed through red-hot coke to form water gas. Water gas is a mixture of carbon monoxide and hydrogen



Water gas is mixed with half its volume of hydrogen. The mixture is compressed to 300 atmosphere. It is then passed over zinc oxide-chromium oxide catalyst at 300°C. Methyl alcohol vapors are produced which are condensed (Fig. 15.3).

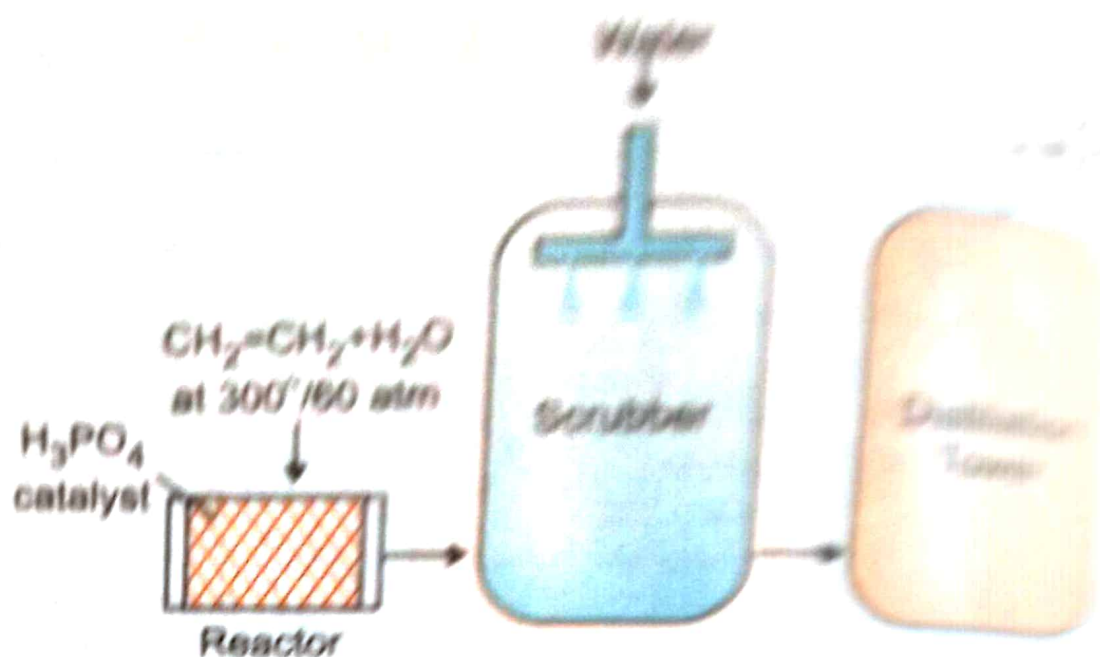
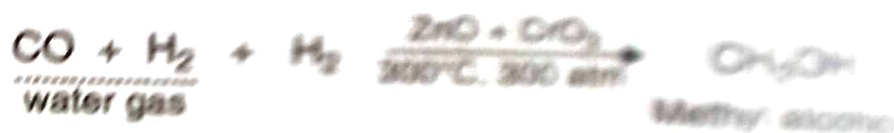
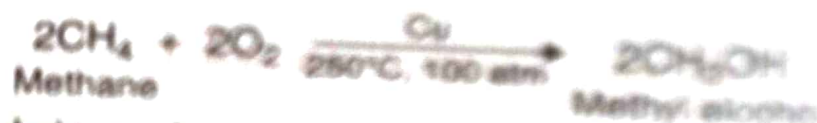


Fig. 15.3. Manufacture of Methyl alcohol from water gas



(2) **From Natural Gas.** Methyl alcohol is also manufactured from methane gas. A mixture of methane and oxygen (9 : 1) is passed over copper catalyst. Methane is oxidized to methyl alcohol.



Properties. Methyl alcohol is a colorless liquid, bp 64.5°C . It is miscible with water. When taken internally, methyl alcohol is a poison. As little as 30 ml can cause irreversible blindness. A mixture of methyl alcohol vapor and air is highly inflammable and can be ignited by even a small spark. Chemically it behaves like a typical monohydric alcohol. It undergoes the general reactions mentioned before.

Uses. Methyl alcohol is used : (1) as a solvent for paints and varnishes ; (2) as an antifreeze in automobile radiators ; (3) to denature ethyl alcohol ; (4) as a motor fuel. A 20% mixture of methyl alcohol and gasoline makes a good motor fuel, and (5) in the manufacture of formalin.