ZEOCHEM®

ETHANOL

WHAT IS ETHANOL?

Ethanol (ethyl alcohol, EtOH) is a clear, colourless liquid with a characteristic, agreeable odour. In dilute aqueous solution, it has a somewhat sweet flavor, but in more concentrated solutions it has a burning taste.

AN ALTERNATE FUEL SOLUTION: ETHANOL

Ethanol is an alcohol-based alternative fuel produced by fermenting and distilling any sugar based substrate or starch crops that have been converted into simple sugars.

Ethanol is most commonly used to increase octane and improve the emissions quality of gasoline.

BENEFITS OF MFG ETHANOL

- It reduces country's dependence on foreign oil.
- Less dependence on crude oil
- It is a renewable fuel.
- It reduces air pollution, cleaner environment due to cleaner combustion.
- Helping emerge a new market
- Lower net carbon dioxide emissions
- Expanded market opportunity in the agricultural field

HOW IS ETHANOL MADE?

Ethanol can be produced from any biological feedstock that contain appreciable amounts of sugar or materials that can be converted into sugar such as starch or cellulose.

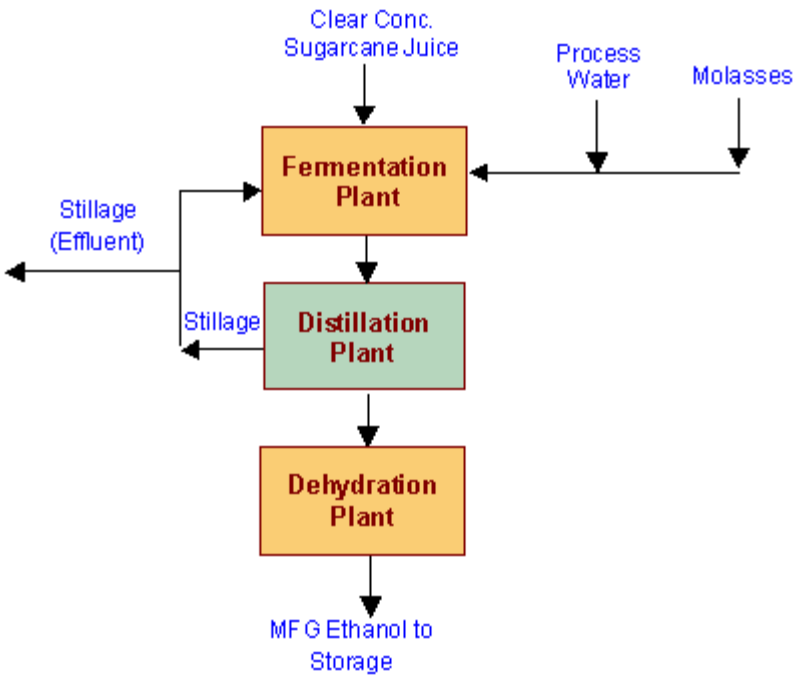
WHAT ARE THE RAW MATERIALS FOR ETHANOL?

There are in general three groups of raw material:

- Beet, Sugar Cane, Sweet Sorghum and Fruits.
- Starchy Material such as corn, milo, wheat, rice, potatoes, cassava, sweet potatoes etc.
- Cellulose materials like wood, used paper, crop residues etc.

STEPS FOR ETHANOL PRODUCTION

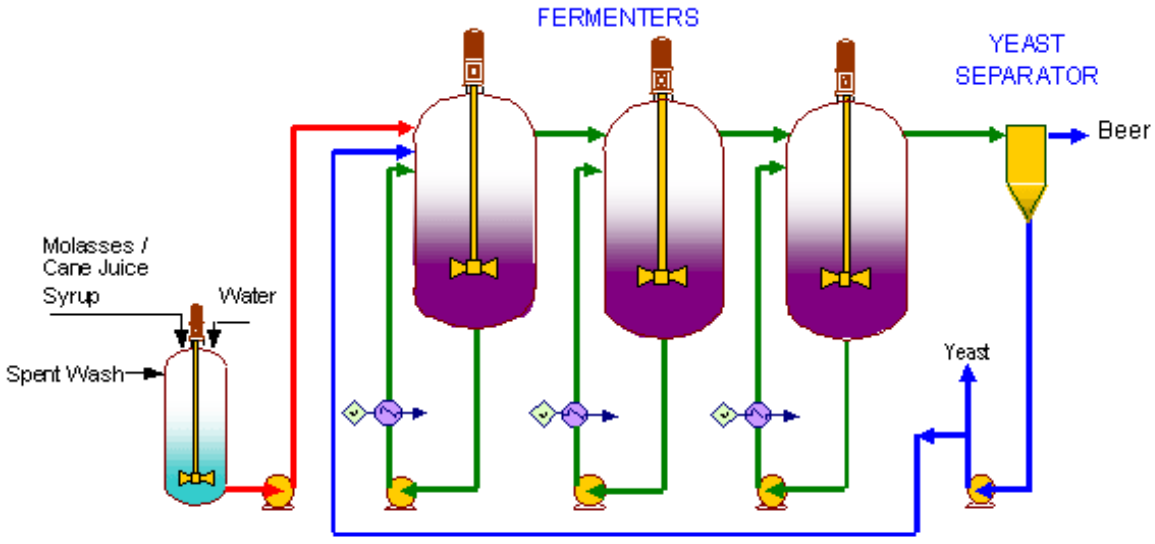
- Fermentation Process
- Distillation Process
- Dehydration Process



BLOCK FLOW DIAGRAM OF ETHANOL PLANT

Fermentation:

Ethanol can be made by the fermentation of sugars. Simple sugars such as sugar cane juice or molasses are the raw material. Zymase, an enzyme from yeast, changes the simple sugars into ethanol and carbon dioxide. The enzymatic reaction carried over by the yeast in Fermentation produces mainly ethanol, CO_2 and heat. The fermentation reaction is actually very complex. The impure culture of yeast produces varying amounts of other substances, including glycerine, methanol and various organic acids.

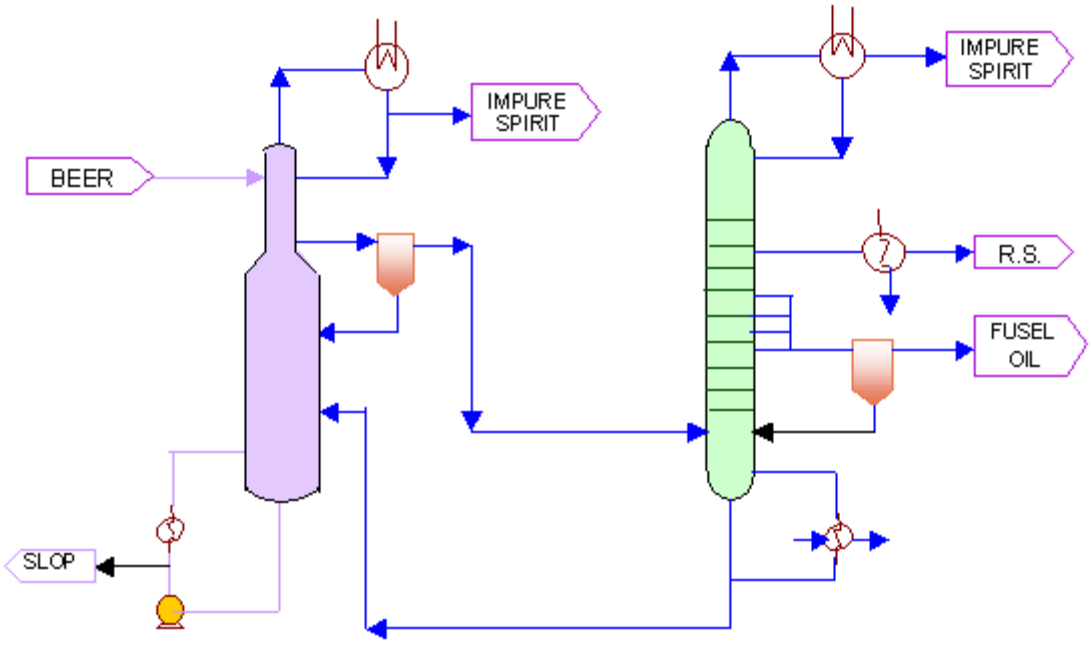


PRELIMINARY PFD OF FERMENTATION OF MOLASSES

Distillation:

The ethanol produced by fermentation ranges in concentration from a few percent up to about 14 percent; balance being water and other components.

The boiling point of ethanol (78.4°C) is significantly lower than the boiling point of water (100°C). These materials cannot be separated completely by distillation. Instead, an azeotropic mixture (i.e. a mixture of 96% ethanol and 4% water) is obtained. Azeotropic mixture of alcohol cannot be further concentrated by distillation. Distillation is used to produce Rectified Spirit (RS).



PFD OF DISTILLATION OF ETHANOL

Dehydration of Alcohol:

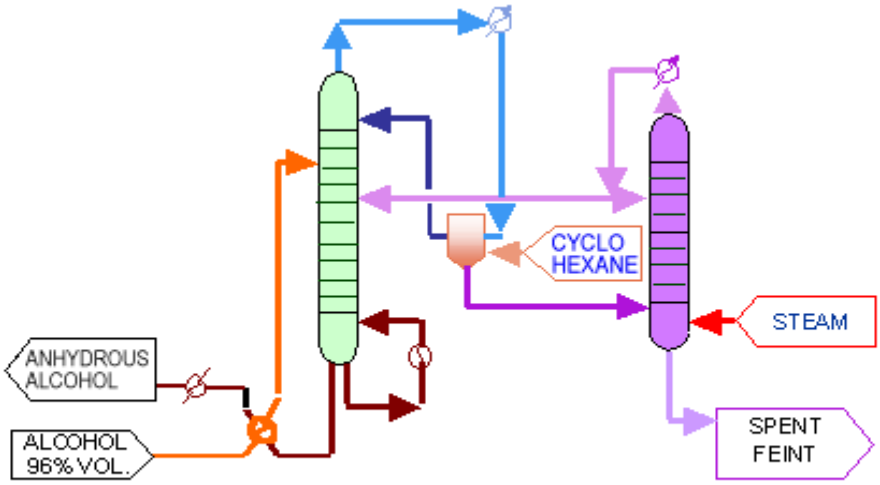
Pure Alcohol can't be obtained from distillation since it forms azeotrope with water at 96% (v/v). Fuel ethanol or absolute alcohol is produced by dehydration of rectified spirit.

Commercially available technologies for dehydration of rectified spirit are:

- Azeotropic Distillation
- Molecular Sieve Technology

Azeotropic Distillation:

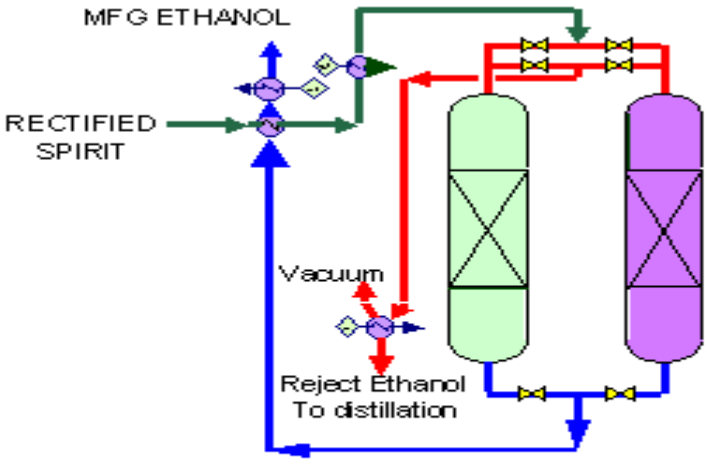
To dehydrate ethanol from azeotropic concentration, a third substance called Entrainer (trichloro ethylene, benzene, toluene, cyclo-hexane etc.) is added to the mixture of ethanol and water. Entrainer breaks the azeotropic point of ethanol and water, i.e. it alters the relative volatility of water making it more volatile. The ternary azeotropic mixture, formed at the top of dehydration column, allows the removal of water and thus dehydrates alcohol. The azeotropic mixture is heterogeneous and the "heavy" phase, which is high in water content, is extracted by decantation. The regeneration column allows water extraction from the "heavy" phase and entrainer recycling



PFD OF AZEOTROPIC DISTILLATION PROCESS

Molecular Sieve Technology:

Molecular sieve technology works on the principle of Pressure Swing Adsorption (PSA). Here water is removed by adsorption on surface of `molecular sieves' under pressure and then cyclically removed it under low pressure at different conditions. This process carries out dehydration of mixed ethanol and water by adsorption of water into zeolite balls, which are molecular sieves. The dehydration unit operates with two adsorbers according to alternate steps of adsorption and desorption. Adsorption occurs in the vapor phase and under pressure. Desorption regenerates water saturated molecular sieves. This step is performed under vacuum. Part of the dehydrated alcohol is used for the molecular sieve desorption. Alcoholic effluent from desorption is regenerated within the distillation column.



PFD OF MOLECULAR SIEVE DEHYDRATION PROCESS

- Optimum energy utilization
- Enhancement in plant capacity
- Fully automatic operation