

THE PROCESS OF OBTAINING ANHYDROUS ALCOHOL THROUGH THE APPLICATION OF MOLECULAR SIEVE TECHNOLOGY

Molecular Sieves

Molecular Sieves are micro-porous substances made of clay-like materials (such as crystalline alumino-silicates belonging to the zeolite class) which can be completely dried out without affecting their crystal structure. They occur in the form of tiny ceramic beads of varying sizes. The size generally used in the Ethanol industry varies between 3mm and 4.5



mm. The surface of the beads have tiny pores of a precise and uniform size. Molecules that are small enough to pass into the pores are adsorbed while larger molecules are not. *It is different from a common filter in that it operates on a molecular level.*

They form millions of regularly spaced pores (also called cages, cavities, or channels) with precisely the same diameter within a particular material but varying among different materials generally between 3 to 10 Angstrom (\AA) units. Like the pores of

activated carbon, these pores serve as a screen (sieve) by allowing only the molecules of a certain diameter to be absorbed or pass through. Molecular sieves are used in drying and deodorizing, in cracking of petroleum, and in filtering water and other liquids and gases. Molecular Sieves are ideal for Ethanol dehydration due to its great desiccating power and its active surface area of $800\text{m}^2/\text{gr}$.

Working Principle

The principle of obtaining anhydrous alcohol via Molecular Sieves consists of using columns or vessels filled with the ceramic beads. Molecular sieves separate molecules by size and polarity. There are two distinct phases:

1. Dehydration under pressure
2. Regeneration under vacuum

Dehydration

Hydrous alcohol is pre-heated, vaporised and superheated before being admitted to the vessels containing the molecular sieve material. In this superheated, excited, vapor phase at a controlled temperature and pressure, adsorption of the water molecules by the sieve is optimized, while the alcohol molecules pass through.

This adsorption occurs due to the forces of attraction that interact to attract the water molecules with a diameter of 2.8\AA present in the vaporised hydrous alcohol into the pores of the ceramic beads, while the ethanol with molecules of 3.2\AA is unable to enter these pores and pass through the sieve. For the case of the ethanol we are describing, molecular sieves with pores of approximately 3\AA diameter are used. Water molecules of diameter 2.8\AA enters the pores while Ethanol molecules cannot and the separation of the molecules takes place.



The concentrated Ethanol vapor stream (>99.5%) is then condensed and cooled before being stored. Molecular sieves can produce industrial grade, pharmaceutical grade or fuel grade ethanol.

Regeneration

In the regeneration phase, the water accumulated in the molecular sieve is removed by means of a vacuum applied to the vessels or columns, reducing the partial pressure of the water, making it evaporate again and leave from inside the cavity where it was lodged, allowing the molecular sieve to be re-used in the next cycle. When regeneration is complete, the sieve vessel is returned to the production mode. This process of dehydrating under pressure and regenerating under vacuum is repeated for continuous operation and is sometimes referred to as **pressure-swing dehydration**.

PROCESS FLOW DIAGRAM

