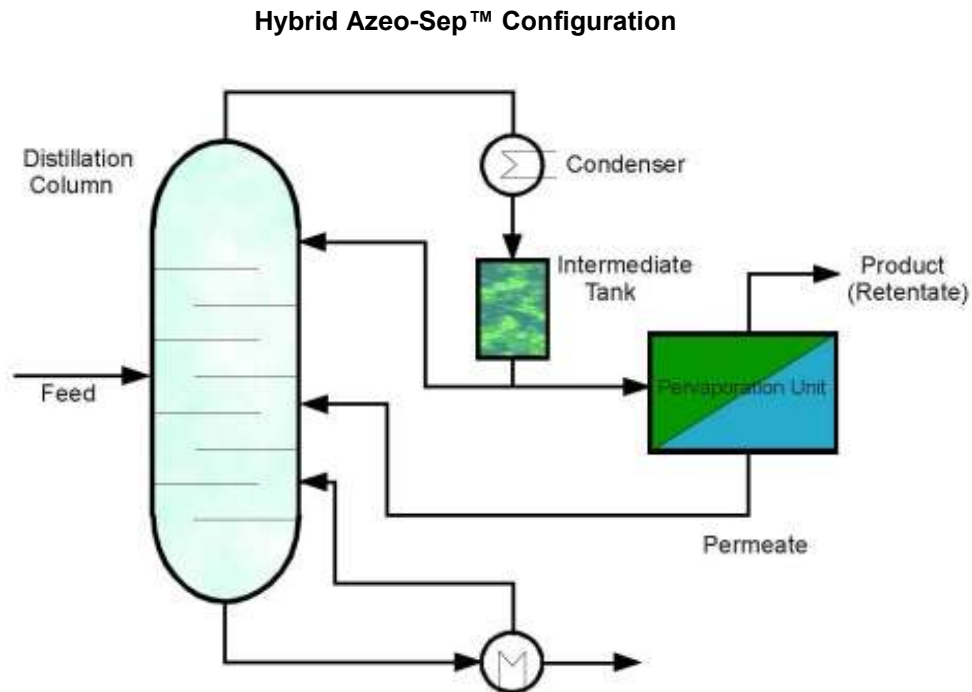


**Lehan Chemical is a distributor of state-of-the-art hollow fiber membranes with superior separation qualities - based on its proprietary and patented technology - for use in a wide variety of applications. For more information contact Brian F. LaFontaine at (800) 276-2344 or [brian@lehanchemical.com](mailto:brian@lehanchemical.com)**

## Azeo-Sep™ - The Technology Driver

Azeo-Sep™ is a pervaporation process. Its prime functions are to easily, efficiently and economically separate compounds that are difficult to separate by other means. The main markets for this product are chemical, petrochemical, pharmaceutical industries and synthetic fuel producers.



Because of the limitations of conventional distillation, Azeo-Sep™ is an excellent add-on system to increase the profitability of traditional distillation processes. Distillation is a conventional fluid mixture separation technology that can separate components with different volatilities and markedly different boiling points (e.g. benzene/toluene mixture). However, distillation is extremely costly when concentration of the separating components is similar in the liquid and vapor phase, called the azeotropic point (e.g. ethanol/water or IPA/water mixtures). Distillation alone cannot perform any further separation beyond the azeotropic point.

Azeo-Sep™ hybrid units can now be utilized in conjunction with conventional distillation columns to extract greater quantities of water and provide higher purity chemicals and fuels. A portion of the overhead product from the column passes through the Azeo-Sep™ membrane modules. In doing so, the azeotrope is broken and a pure product is produced.

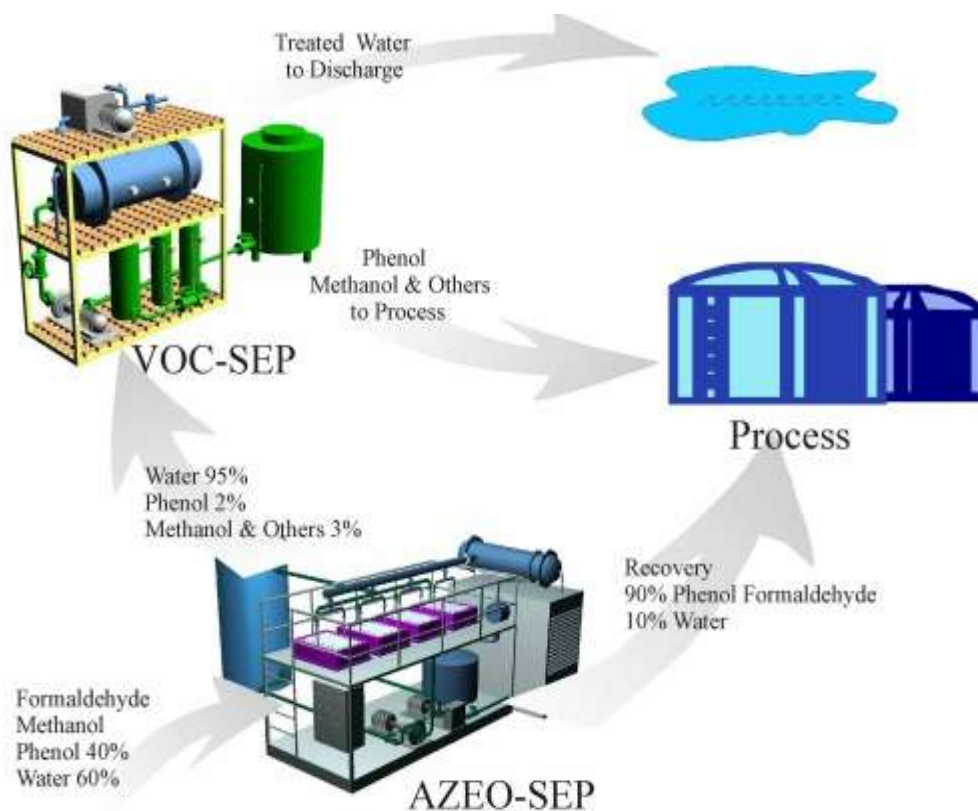
The permeate can then be returned to the column/molecular sieve for “polishing” or left on the Azeo/Sep. This process is used to de-bottleneck the overall dehydration process by achieving the desired level of separation. It has the added benefit of not displacing pre-existing technology.

## ADVANCED MEMBRANE TECHNOLOGY

Azeo-Sep™ systems can be used in a host of different industrial applications. Many aqueous solutions of organic chemicals that form Azeotropic mixtures (i.e. mixtures of chemicals or chemicals and water that have similar boiling points and therefore cannot be separated using conventional distillation methods) can be readily separated using Azeo-Sep™. In some cases, these systems can separate one organic chemical from another thereby allowing two chemicals to be recycled and reused. Some examples of industrial applications follow:

### (a) Separation of Azeotropic Mixtures in Chemical Process Industries

Many commonly used solvents form Azeotropes with water, and distillation alone cannot separate them. Azeo-Sep membranes are not affected by Azeotropic formations and can therefore separate, recycle and refine many more spent chemical combinations than the traditional distillation process.



*Example of Turnkey Solutions for Industry  
(Using Combined Azeo-Sep™ and Voc-Sep™ Processes)*

### (b) Increasing Distillation Column Efficiency for Low Volatility Feeds

Distillation columns operating with low volatility differences of the feed components require a high reflux ratio. Azeo-Sep fluid separation is independent of volatility differences. A hybrid Azeo-Sep unit attached to a distillation column will increase throughput and significantly reduce operating costs.

### (c) Solvent Recovery in Pharmaceutical, Chemical and Semi-Conductor Industries

In-house recovery of spent solvents is difficult for any fractional distillation process as the solvents used form Azeotropes with water. Azeo-Sep units minimize the disposal of used solvents by allowing them to be economically separated, refined and reused. This process is not only environmentally more beneficial than incineration but also provides huge savings for manufacturers who can now reuse the same used chemicals and/or purified water many times over.

### (d) Increasing Reaction Yields

In some chemical reactions, the product yield is limited by the formation of water. Continuous water removal from an equilibrium controlled reaction mixture by an Azeo-Sep distillation hybrid unit will improve the reaction yield. An example is the process of formation of esters from acids and alcohols. In a study currently being carried out for one of KmX's prospects, it was determined that by using the Azeo-Sep process as described, the column efficiency improved by a factor of four to five times and resulted in similar increases to their output.

### (e) Dehydration of Solvents Recovered from Activated Carbon Beds

Solvent vapors in effluent air from various industrial drying processes are often captured in activated carbon beds. These solvents are subsequently desorbed using steam. The recovered solvents with high water content can be dehydrated using Azeo-Sep at a much lower cost of energy and more rapidly.

## Azeo-Sep Solutions

Azeo-Sep systems are available as a system sale on a per liter basis including maintenance and operational support and can be custom designed to optimize performance on an application specific basis. Examples of applications include chemical recycling, the production of energy grade ethanol and esterification.

### Azeo-Sep Membranes:

**2000 Series:** Dehydration of Organic Solvents

**3000 Series:** Solvent/Solvent Separation

**4000 Series:** Highly Acidic Applications

**5000 Series:** Strong Alkaline Solution Dehydration



## **VOC-SEP WATER MEMBRANE TECHNOLOGY**

Lehan Chemical offers state-of-the-art hollow fiber membranes with superior separation qualities based on proprietary technology. These water membranes can be purchased as part of systems for the removal of VOC's and other compounds - or can be incorporated by OEM customers into their own unique solutions.

### **VOC-Sep Solutions**

VOC-Sep systems are the only solution on the market for cost effectively removing volatile organic compounds from water to very high levels of purity; superior to those achievable with micro-filtration or biological systems. The VOC-Sep solution is a closed loop skid-mounted system scalable to meet the specific requirements of our customers, complete with maintenance services including membrane replacement.

### **VOC-Sep Membranes:**

**100 Series:** Removal of volatile VOC's from water

**200 Series:** Removal of aromatics and heavier VOC's from water

**300 Series:** Removal of polar heavier hydrocarbons from water

*Azeo-Sep and VOC-Sep systems provide you with advanced membrane technology that can be utilized in a wide variety of industrial applications. The hollow fiber membranes are unique in their ability to economically recycle the harshest of waste chemicals, gases and fuels, returning them virtually to their original pristine state. These materials can then be resold for high value or reused in the manufacturing process.*

*For more information contact Brian F. LaFontaine at (800) 276-2344 or [brian@lehanchemical.com](mailto:brian@lehanchemical.com)*