Understanding the Sorbex™ Process

Aromatics

Sorbex technologies

The term Sorbex is used to refer to a family of processes which simulate a moving bed of adsorbent with continuous countercurrent flow of a liquid feed over the adsorbent bed. This method of contacting enables the recovery of high-purity chemical isomers which are difficult to obtain by other means. UOP's commercially proven processes based on Sorbex technology include:

- **Parex™ process** for separation of *para*-xylene from mixed C_8 aromatic isomers
- **Ebex™ process** for separation of *ethyl*-benzene from mixed C_8 aromatic isomers
- **MX Sorbex™ process** for separation of *meta*-xylene from mixed C_8 aromatic isomers
- **Molex™ process** for separation of linear paraffins from branched and cyclic hydrocarbons
- **Olex™ process** for separation of olefins from paraffins
- **Cresex™ process** for separation of *para*-cresol or *meta*-cresol from other cresol isomers
- **Cymex™ process** for separation of *para*-cymene or *meta*-cymene from other cymene isomers
- **Sarex process** for separation of fructose from mixed sugars

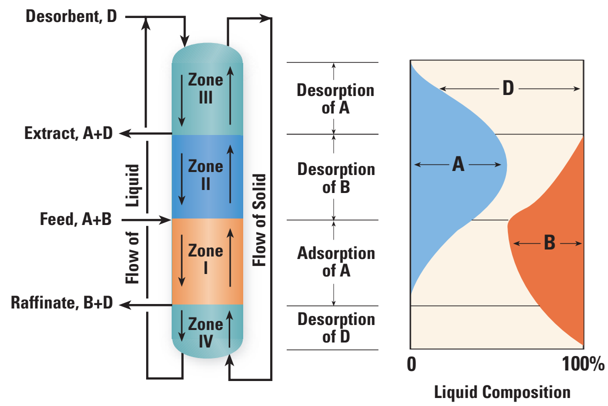
Each uses a specific adsorbent/desorbent combination uniquely tailored to the specific separation. The principles of Sorbex technology, however, are the same regardless of the desired separation product.

Understanding Sorbex technologies

The easiest way to understand the Sorbex process is to visualize a countercurrent flow of liquid feed and solid adsorbent. For simplicity, assume the feed is a binary mixture of components A and B, with component A being selectively attracted to the adsorbent. In practice, the feed to a Sorbex unit may contain a multitude of components from which one would be selectively recovered. In addition to A and B there is also a liquid desorbent, D, used to displace A and B from the solid adsorbent.

As can be seen from the diagram, the positions of injection and withdrawal of the four net streams divide the adsorbent bed in four zones:

Moving Bed Analogy

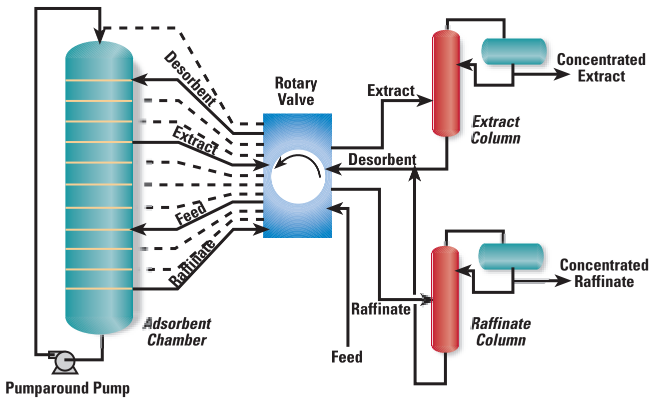


Zone I, adsorption of A, is between the point of feed injection and raffinate withdrawal. As the feed flows down through Zone I, countercurrent to the solid adsorbent flowing upward, component A is selectively adsorbed from the feed into the pores of the adsorbent. As A is adsorbed, desorbent D is displaced from the pores of the adsorbent to the liquid stream in order to make room for A.

Zone II, desorption of B, is between the point of feed injection and extract withdrawal. At the fresh feed point, the upward flowing solid adsorbent contains the quantity of component A that was adsorbed in Zone I. However, the pores will also contain a large amount of B, because the adsorbent has just been in contact with fresh feed. The liquid entering the top of Zone II contains no B, only components A and D. Due to the concentration gradient, component B is gradually displaced from the pores by the preferentially adsorbed A and D as the adsorbent moves up through Zone II. Therefore, at the top of Zone II the pores of the adsorbent contain only A and D.

Zone III, desorption of A, is between the point of desorbent injection and extract withdrawal. The adsorbent entering the bottom of Zone III carries only A and D. The liquid entering the top of the zone consists of pure D. As the liquid stream flows downward, component A in the pores is displaced by D due to the concentration gradient. The liquid leaving the bottom of Zone III is therefore composed of both A and D. A portion of this liquid is withdrawn as extract, while the remainder flows down into Zone II as reflux.

Sorbex Process



Zone IV, isolation zone, is where the feed components in Zone I are segregated from extract in Zone III. At the top of Zone III, the adsorbent pores are completely filled with D. The liquid entering the top of Zone IV consists of B and D. By properly regulating the flow rate of Zone IV it is possible to prevent the flow of component B into Zone III and avoid contamination of the extract.

The desorbent liquid is selected so as to have a boiling point significantly different from those of the feed components. This allows the net stream containing A and D and the net stream containing B and D to be separated by fractionation into high-purity extract A, raffinate B and high purity desorbent for recycle back to the Sorbex. In addition, the desorbent must be capable of displacing the feed components from the pores of the adsorbent. Conversely, it must also be possible for the feed components to displace the desorbent from the pores of the adsorbent. Thus, the desorbent must be chosen so as to be able to compete with the feed components for any available active pore space in the solid adsorbent, solely on the basis of concentration gradients.

In practice, it is very difficult to actually move a solid bed of adsorbent. In the Sorbex process, the countercurrent flow of liquid feed and solid adsorbent is accomplished without physical movement of the solid. Instead, countercurrent flow is simulated by periodically changing the points of liquid injection and withdrawal along a stationary bed of solid adsorbent. In this "simulated moving bed" (SMB) technique, the concentration profile shown in the figure on the first page actually moves down the adsorbent chamber. As the concentration profile moves, the points of injection and withdrawal of the net streams are moved along with it. This movement of the net streams is done with a unique rotary valve developed by UOP specifically for the Sorbex family of processes.

Although this indexing action could in principle be duplicated with a large number of separate on/off control valves, the UOP rotary valve simplifies the operation of the unit, lowers the capital cost, and improves reliability. In the Sorbex process, simulated moving bed performance is obtained with essentially two moving parts: a rotary valve and a pumparound pump to circulate liquid through the adsorbent chambers.

The actual liquid flow rate within each of the four zones is different, because of the addition or withdrawal of the net streams. As the concentration profile moves down the adsorbent chamber, the zones also move down the chamber. The overall liquid circulation rate is controlled by the pumparound pump, which must operate at four different flow rates, depending on which zone is passing through the pump.

Commercial experience

The Sorbex process was invented by UOP in the 1960s and was the first large scale commercial application of continuous adsorptive separation. The first commercial Sorbex unit, a Molex unit, came on stream in 1964. The first Parex unit came on stream in 1971. To date, UOP has licensed more than 130 Sorbex units throughout the world.

For more information

Sorbex technology services are available upon request. For more information, contact your local UOP representative or our Des Plaines sales office:

e-mail: info@uop.com
fax: +1-847-391-2253
phone: +1-847-391-2000

UOP LLC
25 East Algonquin Road
Des Plaines, IL 60017-5017
U.S.A.
www.uop.com

UOP 4680-18 1106AR0Ad