Skid-mounted system for recovery of ethanol from brewery waste streams

Home and dry

Waste streams can be a major expense for breweries, wineries, and distilleries. In many cases, these streams are trucked away for processing at off-site waste treatment facilities. The transportation and treatment costs can be substantial.

However, what one company views as an ongoing expense, another forward-thinking group sees as a lucrative revenue stream. One such company, a global biotechnology company who is a leader in the supply of animal feed supplements, contacted Vogelbusch USA to assist them with building a facility, located near several commercial breweries, that recovers yeast from one of these waste streams.

In a brewery, enzymes in barley are utilised to convert the starch in barley (and sometimes other grains) into sugar. Yeast and wort (the liquid extracted from the mashing process) are combined in a fermenter where the sugar is consumed to produce ethanol and carbon dioxide. After all available sugar has been consumed, most of the yeast falls out of solution and becomes sediment on the bottom of the fermenter. This sediment layer is separated from the beer and trucked to the yeast recovery facility.

The yeast in the sediment stream is separated and dried for sale as an animal feed supplement. The remaining ethanol/water stream requires further treatment. Because ethanol and water form an azeotrope, limiting how much water can be removed with conventional distillation, a combination of unit operations is required to efficiently separate the two so that the ethanol can be sold as a clean-burning, oxygenated fuel additive.

Modules assembled and tested prior to shipment

The recovery package supplied by Vogelbusch USA was designed as a PLC-controlled, two-stage process that consists of a two-column distillation, which produces an ethanol/water vapour that is then dried in the Molecular Sieve Unit (MSU).

The feed, containing approximately 15% ethanol, is fed to the bottom section of a rectifier. A small purge

System is installed and ready for operation

stream generated during the regeneration of the MSU is also fed to the lower section of the rectifier for recovery of ethanol.

Alcohol is concentrated to about 90% in the top of the rectifier. The bottom of the column contains a small amount of alcohol. This stream is pumped to a stripping column to recover this alcohol. The alcohol-free stream leaving the bottom of the stripping column is cooled and pumped outside the battery limits for disposal.

The rectifier is driven by overhead vapours from the stripping column and operates with reflux, obtained by condensing the rectifier overhead vapours to maximise alcohol concentration. A portion of the overhead vapours from the rectifier is directed to the MSU.

Molecular sieve material

The MSU is made up of two beds packed with 3A type molecular sieve material (zeolite). These beds are operated in a pressure swing cycle such that at any given time, one bed is in adsorption mode, while the other bed is in desorption or regeneration mode.

As the ethanol/water stream flows downward through the bed of zeolite, water is preferentially adsorbed into the pores of the beads, allowing ethanol to flow through. The dehydrated ethanol vapour leaving the desorbing bed is condensed, filtered, and then used to preheat the MSU purge stream. Finally, the dehydrated product is further cooled with cooling water and sent to product storage.

The off-line bed is regenerated by desorption, accomplished by maintaining a vacuum on the desorbing bed and passing a portion of the dehydrated alcohol vapour stream exiting the adsorbing bed upwards through it. This stream, called purge, acts to sweep water vapour that has desorbed from the bead pores out of the bed, thus regenerating the beads. The MSU purge stream is condensed, collected, and pumped back to the rectifier to recover the ethanol. The vacuum required for purging is maintained by a liquid ring vacuum pump.

Modular process skids are often a cost-effective alternative to traditional construction where process components are shipped individually and installed at the site. They provide the advantage of parallel construction, where a system is built and pretested at an off-site fabrication facility while civil work is simultaneously completed at the plant site.

Additional benefits include: single point construction responsibility, minimal interruption to existing operations, reduced construction infrastructure at the site, improved site safety, higher quality workmanship, ease of future relocation, and ability to construct modules to fit on ships for export.

In this case, the two modular skids were loaded onto trucks. A third truck was loaded with columns, miscellaneous components, and piping. When the trucks arrived at the site, the bottom skid was placed on a prepared foundation, then the second module was stacked on top. Columns were set, and cartridge trays were installed. Connections between the two modules were made, and zeolite was loaded into the MSU beds. Process, utility, and electrical connections were completed. Finally, after equipment and piping were insulated, the system was ready for commissioning and startup.

For more information:
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