INDUSTRIAL DEMONSTRATION: Whitefox Technologies' membrane distillation is being tested at Pacific Ethanol's plant in Madera, California. Delivered flat on a semi-trailer, it was set up alongside the distillation and will be treating a portion of the regen stream from the molecular sieves, reducing energy load and addressing a cooling water limitation.

PHOTO: WHITEFOX

Drilling into **Distillation, Dehydration**

Companies aim to tweak and transform key systems to reduce energy use and resolve bottlenecks.

By Susanne Retka Schill

Optimization efforts most often look at boosting yield, but as finely tuned and balanced as ethanol plants are, any increase in ethanol has to be matched by increases in the multiple systems that follow. Distillation and dehydration are two that often create bottlenecks. Two companies introduced systems aimed at relieving that bottleneck at the International Fuel Ethanol Workshop & Expo in June, although many others have taken up the challenge.

Whitefox Technologies Ltd. has developed a membrane technology that has been used in Europe for more than a decade, explains Stephan Blum, chief technology officer. Primarily used for potable alcohol and integrated into chemical processes for things like perfumes, the company is now introducing it to the fuel ethanol industry. "We had to adapt our technology so that it can survive in the larger scale and rougher environment that we see in the biofuels industry," he says. "When the plants get larger, the technology has to become more robust." Whitefox has developed a bolt-on application that can treat part or all of the regen/recycle stream in the molecular sieves. "If you take regenerate or recycle streams out, and eliminate the feedback loop into distillation, the whole system should run quite a bit more stably," he adds. With about 21 percent of the mole sieves' capacity taken up by the regen/recycle stream, moving that forward through the Whitefox membrane technology could increase capacity through the sieves. During the summer, he adds, it could also address the need to slow the sieves down because of the limitations in cooling capacity due to high heat and humidity.

Whitefox began commissioning its first system in June at one of Pacific Ethanol's facilities. Blum described it as an industrial-scale demonstration plant. "There we will treat a portion of the regen stream in order to give them a capacity increase of roughly 7 percent or reduce energy consumption by avoiding their cooling water limitation." The goal is to help the company continue to reduce its energy use, and thus its greenhouse gas emissions. The skid is designed to verify the technology and, based on those results, decide the best size and integration strategy to meet the plant's needs.

A membrane system could ultimately replace the current distillation and dehydration systems in a plant, Blum says, but Whitefox's approach has been to design a bolt-on that doesn't require major changes to a plant. "We can treat the side streams and it doesn't interfere with the main product stream. It's easier to integrate." As the technology becomes better understood and known, he envisions multiple ways it can be integrated. "The thing is, distillation in itself is not energy inefficient. Even though you add steam and evaporate, you reuse that heat somewhere else in the process so your net energy consumption is quite low. The distillation process is also a cleaning process, which helps to keep the entire process reliable. A combination with distillation is often an intelligent procedure."

Hydroheater Application

Hydro-Thermal Corp., well known in the ethanol industry for its jet cookers, has turned its experience into finding a solution to the molecular sieve bottleneck. Gary Bymers, international sales manager, described the company's 200 proof vapor depressurization system in a presentation at the FEW in Min-

neapolis. "The idea is to debottleneck and, in the process, there are energy savings. The total amount of cooling water is reduced and the total amount of heat that's used in the system is also reduced."

Rather than recycling vapors through the mole sieves, piping is modified, he explains. "The piping changes the direction so the 200 proof vapors come down and are mixed with the flow in a recirculation area through our low-pressure hydroheater. You increase the total amount of product recaptured instead of recycling back through the sieves." The change adds approximately 2 gallons per minute (gpm) to product flow and, by adding plates to the 190 proof heat exchange, the heat recovery from the 200 proof product is used to increase the temperature of the 190 proof sieve feed from between 130 to 140 degrees Fahrenheit to about 185 degrees. The main savings come from reducing the load on the cooling water heat exchanger and condenser and increasing the temperature to the vaporizer, but the most significant benefit comes from the boosted flow rate of 200 proof product.

The company has one installed at Dakota Ethanol LLC, a 50 MMgy ethanol plant in Wentworth, South Dakota, Bymers told the audience at FEW. In addition to installing Hydro-Thermal's depressurization vapor hydroheater skid and adding plates to the 190 heat exchanger, the system involves upsizing the existing 200 proof pump from 15 to 25 horsepower with a variable frequency drive.

The bottom line benefits can be significant, Bymers adds. In a 100 MMgy plant, the steam usage can be reduced by 2.9 million Btu, which at a natural gas cost of $4 per MMBtu works out to an annual savings of approximately $126,000. The big benefit, though, is from the 2 gpm increase in product flow, which works out to about 5 percent increase in throughput. In addition, fusel oil upsets are minimized. "That's a positive operational impact that's hard to quantify," he says.

Other companies are working on improved distillation and dehydration technologies as well. India-based Praj Industries Ltd. spoke at FEW in Minneapolis about its patented EcoSmart technology, which could be used by corn ethanol plants interested in diversifying and adding beverage or industrial alcohol capability while lowering energy and water use. Two years ago at the FEW, California-based Membrane Technology and Research Inc., a well-established California-based company in separation technologies for refineries, hydrogen separation and gas clean-up, described its research and trials on a low-energy membrane distillation. And Zeochem AG, which says 70 percent of the plants in North America use its molecular sieve technology, is reportedly working on improvements that will be introduced in the next couple of years. In Japan, Hitachi Zosen Corp. has developed a dehydration technology using a zeolite separation membrane.

Novel Distillation

In addition to those looking at ways to improve existing systems and reduce the load on molecular sieves, there are a two companies developing radically different technologies.

In Kansas, brothers Dick and Sam Burton have formed the startup company Distillation Technologies Inc. to commercialize