

biofuels

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From waste to jet fuel

The race to reach net zero carbon emissions is on

Improving the bottom line

Alternative cleaning methods for ethanol plants

Regional focus: biofuels in Asia

Advanced membrane separation technologies help ethanol producers maintain profitability in challenging market conditions

Flexible and efficient membranes

External factors not directly linked to ethanol production, such as weather, policies and export conditions, continue to remain a challenge for the US biofuels market.

Each factor can lead to financial difficulties for ethanol producers, but when all of these issues occur at once, the impact on the producer and its surrounding community can be devastating. With this backdrop, how can process innovations and technology advancements mitigate pressure on profit margins? One technology that is making great strides in recent years,

and that producers are deploying in ethanol facilities, is membrane technology. Membrane solutions provides the flexibility and efficiency required to mitigate some of the challenging market conditions.

US fuel ethanol margins are under pressure, mainly due to three factors. Firstly, corn prices have surged following extensive spring flooding, which prevented farmers from getting corn in the ground. The shortage of corn, representing approximately 70% of ethanol production costs, has pushed the raw material cost to new high levels. Secondly, fuel ethanol

demand softened when the Environmental Protection Agency (EPA) decided, on 9 August 2019, to approve 31 new gasoline refinery waiver requests. These waivers release refiners of the requirement to buy ethanol. According to Monte Shaw, executive director of the Iowa Renewable Fuels Association, this has reduced biofuels demand by over one billion gallons. And finally, the US-China trade war is hurting the agriculture sector, as ethanol producers have lost access to the Chinese buyers of, for example, dried distillers grains (DDGS) used as livestock feed, an important co-product sold to export markets.

Oversupply of ethanol and diminishing margins push ethanol producers to take drastic actions that can negatively impact the ethanol industry for several years to come. Some ethanol facilities consider slowing down or even halting production. Other producers pursue value-enhancing strategies, aiming to improve margins through investments in technologies that deliver operational efficiencies, increase capacity, reduce water and energy consumption or enable diversification into high margin co-products.

The conventional technology used in ethanol facilities to dehydrate ethanol consumes a significant amount of energy and water. Membrane technology is more efficient than traditional techniques because membranes separate molecules through a hydrophilic membrane using

moderate steam consumption and pressures. Membrane systems, such as the Whitefox ICE™ solution, can remove bottlenecks in ethanol facilities by dehydrating water-rich recycle streams such as molecular sieve unit (MSU) recycle streams, regenerate streams and fusel oil draws. Membranes can dehydrate streams with up to 50% water content to target product in one continuous pass, which significantly reduces the load on distillation columns and MSUs. Side streams account for more than 20% of product output in conventional ethanol plants, which not only takes up distillation capacity, but also waste steam, cooling water and electricity.

Membranes in action

An example of how membranes are used to dehydrate water-rich ethanol streams is a membrane installation at Fox River Valley Ethanol (Fox River), a 60 million gallons per year facility in Oshkosh, Wisconsin in the US. Fox River produces biofuels, wet distillers grains and DDGS, which are high protein animal feed sold to local farmers, and renewable carbon dioxide, used in a variety of industries including meat, poultry and bottling.

The goal of the project was to free-up capacity in the distillation-dehydration section, increase total production capacity by up to 15%, reduce steam consumption per gallon of ethanol produced, and reduce overall water consumption



Whitefox ICE™ installed at Southwest Iowa Renewable Energy (SIRE), September 2019



Whitefox team members Sean Lorimor, Chris Chandler, Kevin Adams and James Zhou at SIRE

in the production process. From a socioeconomic perspective, Fox River wanted to reduce its energy footprint, further enhancing the production of sustainable and renewable energy for the local community.

To meet tight delivery timelines and minimise production downtime, Fox River tasked Whitefox to design and install a pre-fabricated system off-site. Using a modular bolt-on solution, Whitefox simplified the system installation, reduced on-site disruption and shortened the delivery timeline. Following a successful commissioning and start-up in December 2017, Neal Kemmet, Fox River president and general manager, said: "Following a smooth start-up of the Whitefox ICE™ system in December, we immediately noticed a positive impact. Energy consumption reduced by around 1,100 BTU [British thermal units] per gallon and operations improved by removing column fluctuations, and that's with only treating part of the regen stream. Our team seems to have got used to running with

membranes with no issues. We intend to move to full regen treatment over time to further improve capacity, efficiency and profitability."

Another recent example of a Whitefox ICE™ system using its membrane separation benefits is from a membrane installation at United Ethanol's plant in Milton, Wisconsin in the US. Since commissioning and start-up at the end of 2018, United Ethanol has experienced a reduction in plant energy consumption that has favourably impacted production in several ways. The plant experienced an increase in capacity, and now is operating at 60 million gallons per year, up from 55 million gallons per year. The plant steam demand per gallon has decreased, dropping natural gas consumption by 1,200 BTU/gallon, with the expectations that steam consumption can be further reduced through rebalancing of the plant. Cooling water requirement has reduced due to the lower plant heat input. The membrane system has also contributed to a 7% drop in the plant's electrical demand, compared to the same

period the previous year.

Before the installation of the Whitefox ICE™, United Ethanol experienced issues with high levels of fusel oils in fermentation. Fusels are more

toxic to yeast than ethanol and can, in some instances, lead to plant shutdowns when fusel concentrations reach 100 to 500 parts per million at the column bottoms. At United Ethanol, fusel oils were trapped in the stripper column below where they could be removed. Membranes are tolerant to fusels. Redirecting recycle streams away from rectifier columns and into membranes, the fusel location shifted from the stripping column into the rectifier column where the fusels could be drawn (removed). This improvement reduced the fusel oil concentration in stripping column bottoms and minimised recycling of fusels into fermentation.

Additional benefits gained at United Ethanol were the ability to lower the rectifier reflux by 26% while simultaneously increasing overheads proof. Operators also found the membrane easy to understand and run. For example, the flexibility of



Whitefox ICE™ installation at E-Energy Adams in Nebraska, US, 2019

the system allowed operators to shift some of the molecular sieves loading into the membrane system, achieving additional energy savings.

Following a successful start-up, United Ethanol's COO Chad Campbell said: "We are always looking to improve our efficiencies, reduce costs and deliver a positive impact to our local communities. The Whitefox ICE™ solution has helped United Ethanol attain its goals of being a low-cost producer of fuel ethanol. With the removal of bottlenecks, we have increased our throughput and at the same time made our plant more efficient and easy to operate. We also look forward to seeing the positive impact Whitefox ICE™ should have on the reduction in the cooling water load during the summer months."

Whitefox ICE™ membrane installations in Europe, the US and Canada have demonstrated the efficiency and operational benefits of using membranes in separation processes. General benefits seen from membranes include load reduction on rectifier/side stripper and molecular sieves, removal of fluctuation in columns, reduction in steam and improved carbon intensity levels, reduction in cooling water recirculation rate and



Aerial view of Whitefox ICE™ installation at United Ethanol in Wisconsin, US, 2019

electrical load. Membranes give producers the flexibility to optimise their plants and reduce operating costs, water usage and carbon footprint. Consequently, producers become more competitive and can withstand market fluctuations and pressure on margins, and are also able to

meet government targets on greenhouse gas emissions, energy consumption and water efficiency. Moreover, they are better able to secure and maintain local jobs and ensure that raw material suppliers can continue their regular business. Membrane-based technology is available

now and continues to play an essential role in the advancement of sustainable energy and water demands. ●

For more information:

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