

TECHNOLOGY HORIZONS

A publication by Zetron, the pilot plant specialists

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Using hydrothermal liquefaction to transform biomass into bio-oil

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Pictured L-R: Jake Wargo, Bill Charlton, Ken Pennisi (CMS), Marissa Bonanno and Robert Somich (Braskem)

ZETON DELIVERS COMPACT DESIGN FOR CMS

Compact Membrane Systems (CMS), an advanced materials company based in Wilmington, Delaware, chose Zetron to build a pilot plant to test one of their Optiperm™ membranes. In refineries, paraffins are normally separated from olefins through a process known as cryogenic distillation. This process involves reducing the temperature close to -190°C in order to liquify both gases and later boil one of them from the mixture. Unfortunately, this system is costly and energy inefficient and capacity constrained. After developing a breakthrough membrane, Optiperm, to separate light olefins from paraffins in the vapor phase for a more efficient and less costly process, CMS looked to Zetron to design a scaled-up rig to validate their innovative membrane system in an industrial setting.

One of the main challenges of the design of the pilot unit was the sensitivity to temperature changes of the process. Ideally, the unit would have been situated in an indoor location that allowed for a controlled temperature space, but that was not possible since the plant will be run directly in an operating refinery. One of the proposed alternatives was having the plant built inside a shipping container, isolating it from the elements, but due to the nature of gases used in the process, there were safety concerns with enclosing the unit. After considering the different options, Zetron's project team designed a set of plastic curtains that can go around the skids and cover the plant from the weather outside but are also flexible and can be moved out of the way to access the equipment and instrumentation inside. This curtain design has proven

to be an excellent alternative where traditional skid screens or panels are not possible.

Zetron was also able to tackle the challenges presented by COVID-19 induced logistical interruptions. The delivery of a key piece of equipment was delayed for several months. However, Zetron was able to work around the missing equipment and the rest of the plant was nearly complete by the time the final piece arrived and the project was minimally delayed.

It was a pleasure to work with an experienced and understanding customer like CMS, and the Zetron team wishes them success for the commissioning, start-up, and operation of their new pilot plant. ■

WORKING UNDER PRESSURE

These days renewable fuel developments are a hot topic. The time pressure for scaling up new processes is high, in order to be able to enter the market fast. The Scandinavian countries are investing a lot to remain frontrunners.

That is where Silva Green Fuel DA, a company owned by Statkraft (Norwegian hydropower company) and Södra (Swedish forestry company), comes in! After a thorough investigation of several technologies, Silva Green Fuel selected hydrothermal liquefaction (HTL) as the most promising. HTL is a thermochemical process that uses supercritical water to decompose biomass into a bio-oil that can be further refined to transportation fuels. As this technology was only proven on pilot scale, an intermediate scale up to demonstration scale was crucial in the process to scale-up to the first commercial scale plant in Tofte, Norway.

The demonstration facility was completed in 2021. The plant is designed to verify the technology in continuous operation and is the largest HTL plant for conversion of lignocellulosic biomass to renewable fuels. The raw material for this technology is residual biomass from the forest and wood processing industry. Advanced biofuels produced from residual forest biomass reduces emissions by up to 95 per cent.

Zeton was the preferred partner to design and build the separation unit of the plant. The HTL reactor product is received at high-temperature and high-pressure and separates into oil, process water and process gas. All three phases are further processed in subsequent processes, making the separation plant a pivotal unit.

The success of a project like this is highly dependent on good alignment between the expectations of Silva Green Fuel and the chosen project approach. Ingo Machenbach (Senior Engineer, Silva Green Fuel) commented on this: "We had a flying start into the Basic Engineering; Zeton captured the essence of the plant and developed draft solutions quickly including cost estimates. There was a smooth transition from Basic Engineering into Detail Design with overlapping personnel, realising a fast-track engineering with a

constant focus on the client's needs, safety quality and costs."

Although the contract had been signed on the very first day of the COVID-19 lockdown, Zeton and Silva Green Fuel managed to adapt swiftly to the new situation. Due to travel restrictions, no physical meetings were possible from the start of the detail design until delivery. Throughout all the complex design phases communication remained excellent. Furthermore the Factory Acceptance Testing and other inspections at Zeton were conducted successfully via videocalls, ensuring delivery of a unit in full compliance with the specification and the expectations of our customer. The efficiency and quality achieved during this whole process also impressed the Notified Body! As travel restrictions meant Zeton could

not participate in the reassembly at site, an "IKEA"-like instruction was provided which ensured efficient reassembly without Zeton, on time and trouble-free for Silva Green Fuel.

Luckily, the Site Acceptance Testing took place during a period in which the COVID-19 measures were relaxed, and allowed Zeton personnel to be on site to finish this phase successfully in record time. During design, assembly and site work Zeton fulfilled all HSE standards, and personnel integrated seamlessly into ongoing commissioning operations. Overall we are very proud of our joint result. A success under challenging technical and fast-track conditions, for a client in a distant location, without face-to-face meetings. It was indeed under high pressure! ■



ZETON DELIVERS DISTILLATION COLUMN TO PURIFY CARBON-NEGATIVE ETHANOL

Air Company is a New York-based company that transforms CO₂ into impurity-free sustainable alcohols. After successfully building their first high-yield CO₂-to-ethanol pilot plant with Zeton, Air Company reached out to us again to scale up their current lab-sized batch distillation system to a larger, fully continuous distillation pilot plant. This new plant will separate ethanol from the mixture obtained from the first pilot plant, which also contains water, methanol, and traces of other contaminants. This clean ethanol will be further processed and used to produce a variety of products including the world's first carbon-negative vodka, fragrance, and hand sanitizer.

The 25 l/h plant, using **patent-pending** intellectual property co-invented by Mike Trainor at Zeton and Dr. Stafford Sheehan at Air Company, has three distillation columns to separate products one at a time. The first two columns separate the ethanol from most of the water and methanol, and the third column uses a novel design that removes adverse tasting contaminants. The overall ethanol recovery in the process is 99.9% and the process is broadly applicable to the spirits and fragrance industries.

Challenges during the design of the plant came from height restrictions and the dome shape of the building the plant would be located in. Several iterations of the skid design were made to consider the possibility of tipping over due to the height of the skid and complications of erection at site. In the end, a rectangular shape was chosen by the Zeton team, and the original height of the columns were reduced by two feet to conform with ceiling constraints. The design was finalized with flange breaks so the tops of the columns could be removed, shipped separately, and re-installed after erection of the plant.

Other unique requirements of the Air Company pilot plant were the special pickling and passivation that had to be done to the insides of the columns. This, combined with intensive functional testing with running water to make sure the lines were clean from possible contaminants in the vessel, confirmed a robust and functioning design prior to shipping the plant.

Working with the Air Company team again after the success of the previous plant has been a rewarding experience for Zeton, and we wish them the best during the start-up

and commissioning of their new plant.

Stafford Sheehan, Co-Founder and CTO, Air Company: "We utilize carbon dioxide to replace the products that, today, require carbon from fossil fuels. Zeton's expertise in building chemical pilot plants has helped our innovations, like this distillation system, come to life in a way that's proven and scalable, for the carbon management industry of the future." ■



TEAM SPIRIT HIGHLIGHTING THE ACCOMPLISHMENTS OF OUR STAFF IN THE DUTCH AND CANADIAN OPERATIONS

COMPETING AGAIN IN THE HEATWAVE TOURNAMENT TO RAISE MONEY FOR SICKKIDS

After a year and a half in isolation and working from home, the HEATWAVE for SickKids volleyball tournament presented the perfect opportunity for Zeton's staff in Canada to meet again while helping raise money for SickKids hospital, a local children's hospital and a global leader in paediatric healthcare.

The competition was fierce, the weather was rainy, and the opponents were talented, but that didn't stop the Zeton teams from diving for the ball when needed and spiking it at any opportunity that presented itself. Zeton's competitive team made it all the way

to the finals and played relentlessly for the championship, but, unfortunately, they fell just short by a few points! Our recreational team was also a tough competitor and put up a fight during the group stage but didn't progress to the semi-finals.

For many of Zeton's participants this was the first time meeting their colleagues, since they had joined during the pandemic and had been working exclusively from home. It was an exciting opportunity to build new friendships and reinforce the existing ones, and everyone returned home with a renewed sense of camaraderie.

Zeton is proud to be a part of this event again for the 8th time and congratulates all participants and fundraising contributors for their success both on and off the volleyball court!



IN BRIEF

HIGHLIGHTING RECENT AND COMPLETED PROJECTS AND ENGINEERING STUDIES

- A modular flow battery pilot plant
- An oxide synthesis plant
- A CO₂ bioreactor conversion plant
- An advanced catalyst activator
- A bio-aromatics pilot plant
- A lab scale lignin depolymerisation system
- A bio-chemical pilot plant
- A hydrotreater revamp and capacity increase project



An E-fuel pilot plant



A lab scale system for petrochemicals research



Zeton's recently expanded Michigan Drive facility in Oakville, ON, Canada



CONTACT US

TO DISCUSS YOUR PROJECT REQUIREMENTS,
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