

TECHNOLOGY HORIZONS

A publication by Zetron, the pilot plant specialists

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IN THIS ISSUE

Demonstration phase key to Monolith Materials' commercialization plans

Zetron and Air Company develop novel carbon dioxide to ethanol pilot plant

Celebrating founding employee Chris Brown's retirement!

In Brief

AND MORE!



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Seaport, Redwood City. The Monolith Seaport Project was the first carbon black plant to be built and permitted in the U.S. in the past 30 years.

SUCCESSFUL DEMONSTRATION PROGRAM UNDERPINS MONOLITH MATERIALS' COMMERCIALIZATION PLANS

Background/Early Project History

Monolith Materials (formerly Boxer Industries), a 100% private equity funded start-up, approached Zetron in early 2013 to discuss a new demonstration plant project. The process technology converts methane into carbon black and hydrogen.

Traditionally, carbon black is produced by the partial combustion of heavy petroleum feedstocks (decant oil), in a low yield process. With the price of oil (in 2013) at over \$90 per barrel and an abundance of cheap natural gas in North America, the economics favored

Monolith's process, which directly converts methane (75% carbon) into carbon black at high yield. Furthermore, the process produces a valuable co-product, hydrogen, while greatly reducing emissions - a true win-win for industry and the environment.

Monolith assembled a team of experts in carbon black to support Zetron's project team through the Basic Engineering Study phase of the project. During that study, Zetron worked collaboratively with Monolith's staff and experts to find innovative solutions to some of the

challenging problems associated with a high temperature process generating both solid and gaseous products. Working collaboratively, a lump sum proposal for the demonstration plant was presented in August 2013, and a rapid decision to proceed to the build phase was made.

Shop Fabrication

Following project sanction, the detailed design, procurement, fabrication and factory testing phase of the project began

Continued on Page 2

"HAVING A PARTNER LIKE ZETON HAS BEEN INSTRUMENTAL TO OUR SUCCESS THESE PAST 5 YEARS. HANDS DOWN, THE BEST IN THE BUSINESS."

ROBERT HANSON, CO-FOUNDER AND CEO, MONOLITH MATERIALS

in September 2013. Fabricated in Zeton's Burlington, ON shop, detailed design, procurement and fabrication were executed in parallel to accelerate the overall project schedule. The plant itself occupied 8 skids. Each skid was standalone mechanically and electrically to minimize reassembly work at site. Following factory testing, the individual skid modules were shipped to Redwood City, CA in June 2014.

Demonstration Program

Starting in June 2014, Monolith operated the plant to demonstrate the performance and reliability of the process, and to help design its first commercial plant, currently under construction in Hallam, Nebraska. The carbon black produced was evaluated for a wide range of end markets.

In October 2018, Monolith decommissioned the demonstration plant in Redwood City, CA, and brought the site back to its original condition. The team of engineers, scientists, technicians, and operators who ran the demonstration plant relocated to Nebraska to support construction, commissioning, and eventual operation of Monolith's first commercial plant.

Monolith's First Commercial Plant

Monolith is now in late stage construction on the first commercial unit of an eventual world-scale carbon black facility located just south of Lincoln, Nebraska. The first unit will come on line in 2019, with subsequent phases being planned through the early 2020s. The plant is ideally located next to natural gas and electrical infrastructure. There is Class 1 rail on site, and several carbon black customers are within a few hundred

miles. Monolith has partnered with the Nebraska Public Power District who agreed to purchase Monolith's co-product, hydrogen, and refuel an existing coal-fired power plant with clean burning hydrogen. This has the potential to significantly reduce greenhouse gas emissions.

When fully built, Monolith's Nebraska facility will support hundreds of high paying manufacturing jobs, have over \$500M of annual economic impact, and improve the local airshed while helping to reduce global climate change.

Robert Hanson, Co-Founder and CEO, Monolith Materials:

"Having a partner like Zeton has been instrumental to our success these past 5 years. They are experienced, intelligent, rigorous, and understand the nuance of designing demonstration plants that both validate core process innovations as well as demonstrate operational reliability. Hands down, the best in the business." ■



ZETON AND AIR COMPANY DEVELOP NOVEL CO₂ TO ETHANOL PILOT PLANT

Chris Brown, recently retired VP of Engineering at Zeton, worked collaboratively with Dr. Stafford Sheehan, CTO of Air Company and author of over 35 scientific publications and patents, to design and build a CO₂ to Ethanol Pilot Plant. Dr. Sheehan, who is recognized internationally for his research converting carbon dioxide to alcohol that landed him a spot on Forbes' 30 under 30, has developed a high yield catalyst that efficiently produces ethanol from CO₂ for use in the food and beverage, flavours and fragrances, and cosmetics industries. A net user of CO₂, Dr. Sheehan's process has marketing appeal to companies that use this high purity intermediate in their consumer products. The evolution of Air Company from a small start-up laboratory, through to the completion of this milestone pilot plant, was achieved on a shoestring budget made possible through visionary investors, matching funds from the Ontario Centres of Excellence (OCE) for engineering

development and Zeton's creative approach to value engineering and fabrication.

As is often the case with start-ups pursuing catalyst technology development, scaling the process from the laboratory to the pilot plant, and fundraising, are the main challenges Air Company faced on its way to commercialization. Kenneth Agee and the team at Emerging Fuels Technology (EFT) worked closely with Staff to understand his technology, completing contract R&D work that characterized catalyst performance and yields on EFT's fixed bed reactor equipment. Following successful completion of this test work, Zeton completed a full process design, translating catalyst yield information, the process model and conceptual reactor design into a practical pilot plant design. Taking advantage of Zeton's Basic Engineering project execution methodology, Dr. Sheehan worked closely with Chris Brown to distill the core objectives of the pilot plant, minimizing the scope and cost while meeting the

program objectives. The completed 1 L/h pilot plant, photographed during factory testing in Zeton's shop, will be operated at a location in Brooklyn, NY. It will be a central instrument for collecting process data, and will take Air Company one step closer to technology commercialization. ■



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

CONGRATULATIONS TO CHRIS BROWN ON HIS RETIREMENT

On March 5, 2019, the staff at Zeton in Burlington held a celebratory lunch to honour the retirement of Chris Brown, VP Engineering, one of the seven founding employees of Zeton Inc.

From the Company's inception in February 1986, Chris' uniquely creative designs for small fixed bed reactors, pumps with remote check valves for high temperature slurry service, ebullated bed reactors, fluidized beds, lock hopper feeding systems and automated sampling systems, among others, proved key in solving difficult technical

challenges for Zeton's customers. This naturally led to more projects, and happy customers, establishing Chris as a world expert in pilot plant design, and Zeton as the global leader in its industry.

In recognition of Chris' special talents, he was awarded the Petrobras Inventor of the Year prize for 2014 for the invention of a non-mechanical biomass feed valve for the Gasification Pilot Plant project. The awards are given to Petrobras employees and partners whose past inventions led to successful patent applications by Petrobras.

To Chris and Moira, all the very best for a long and happy retirement from your friends at Zeton in Canada and The Netherlands.



Pictured L-R: Founding employees Sean Murray, Paul Gailey, Chris Brown, David Beckman, Brendan McDonald and John Grieve

IN BRIEF

HIGHLIGHTING RECENT AND COMPLETED PROJECTS AND ENGINEERING STUDIES

- A lab scale multiple CSTR system in high viscosity polymer service
- A custom membrane housing for chemicals separation service
- A basic Engineering study for a biobased chemicals demonstration plant
- A basic design study for an Olefin demonstration plant
- In-line blending process plants
- An engineering study for a leaching pilot plant
- A solid Pyrolyzer pilot plant
- A hydrotreater pilot plant
- Several continuous, low flow pump modules for a pharmaceutical application



A Lithium purification pilot plant



A custom fluid cat cracking pilot plant



A mini hydraulic wash column skid



Five individual skid modules for a nuclear industry gas cleanup application



CONTACT US

TO DISCUSS YOUR PROJECT REQUIREMENTS,
OR ITEMS IN THIS ISSUE OF HORIZONS, PLEASE CONTACT:

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