IN BRIEF

HIGHLIGHTING RECENT AND COMPLETED PROJECTS AND ENGINEERING STUDIES.

- Two catalytic pilot plants for a green chemistry application
- A wastewater treatment pilot plant
- A gas-to-chemicals pilot plant
- A CO2 capture pilot plant
- A multi-train hydrotreating pilot plant with fractionation and vacuum modules
- A catalytic converter unit
- A control system upgrade for an existing demonstration plant
- A basic engineering design study for a HDPE pilot plant
- A basic engineering study for a specialty polymer pilot plant

A high-voltage chemical pilot plant

A steam naphtha cracking (pyrolysis) pilot plant

A bio-oil hydrotreating pilot plant

A continuous kilolab flow chemistry system

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

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REALIZE THE FUTURE

TECHNOLOGY HORIZONS

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SPRING 2012

IN THIS ISSUE

Horizons is also available on our website at **zeton.com**

MODULAR SMALL SCALE GTL FACILITY PASSES EXTENSIVE TEST PROGRAM

CompactGTL, a pioneer of modular gas-to-liquid solutions, has recently announced an update on its plant supplied to Petróleo Brasileiro S.A. (Petrobras) in Brazil. Petrobras' CENPES Research and Development Centre has successfully concluded its qualification test program of the world's first, modular, small-scale GTL facility, and has qualified and approved its process conception for use by Petrobras.

Zeton executed the EPC contract for the Commercial Demonstration Plant, which can produce up to 20 barrels per day of syncrude, in close cooperation with CompactGTL over an 18-month period between 2008 and 2010. The facility incorporates all aspects required for commercial application including gas pre-treatment, pre-reforming, reforming, waste-heat recovery, process steam generation, syngas compression, Fischer-Tropsch synthesis, FT cooling water system and tail-gas recycling.

Nicholas Gay, Chief Executive of CompactGTL: "We are pleased that the commercial demonstration plant has passed the program of testing by Petrobras, and the positive test results have shown the plant to be robust, with the operational availability expected of large-scale commercial facilities. I would like to thank the project team at Zeton, led by senior project manager Troy Wong, for their dedication and contribution during the engineering, procurement and fabrication of the demonstration plant, which was a key factor in its successful delivery and commissioning at site."

Zeton would like to congratulate CompactGTL on achieving this major technology milestone, and we wish the company every success in its commercialization goals.

"ZETON WAS ABLE TO FOLLOW THE YXY PROCESS DEVELOPMENT VERY CLOSELY DURING IMPLEMENTATION OF THE PROJECT." VICTOR VREEKEN, VICE PRESIDENT OPERATIONS DEVELOPMENT, AVANTIUM CHEMICALS B.V.

AVANTIUM AND ZETON REALIZE INNOVATIVE YXY PILOT PLANTS






Avantium Chemicals B.V., a leading technology company specializing in the area of advanced catalysis R&D and process development, approached Zeton in December 2010 to design and build its innovative YXY Pilot Plant. The YXY technology deployed in the pilot plant meets all key criteria in delivering the next generation of green materials and fuels. One of the applications is to produce PEF, which can be used as a direct bio-based alternative for PET in the manufacture of plastic bottles.

Early on in the partnership, discussions focused on the specific technical requirements for the design and construction of custom pilot plants operating under critical process conditions. Two of Avantium's key objectives for the YXY Pilot Plant were identified - proving the process technology at a larger scale, and producing significant quantities of bio-based material for product testing by Avantium's customers.

To date, cooperation between Avantium and Zeton has resulted in three projects. The first two pilot plants were delivered by Zeton on a fast-track schedule, and

GLOBAL**OUTLOOK**

COMMENTARY ON TODAY'S GLOBAL PILOT PLANT DEVELOPMENT TRENDS

Previously in Global Outlook, I commented on how innovation is a key driver for success in the chemical industry. In this edition of Technology Horizons, we highlight a number of projects that meet this standard, and in some cases may become game changers for their particular industry.

To enable such innovation, it is essential that all parties involved in complex projects bring new ideas to the table. This will result in a team where all project members, independent of their role in the project, will see the benefit of strong interaction, and will be encouraged to learn from each other. Clearly, such contributions must be made at an early stage in the project before each and every detail has been cast in stone.

A common thread for the projects highlighted in this edition is that Zeton was involved in the very early design stages of these pilot and demonstration-scale projects. This effectively combined Zeton's modular design-build know-how with the specialist process knowledge of our customer's teams, and the design and operational experience of speciality equipment manufacturers.

To stay ahead of the knowledge curve, and to compete in today's marketplace, companies need to recruit the best and the brightest minds. Zeton has developed strong ties with universities, including the University of Twente in Enschede, The Netherlands, and the University of Waterloo in Ontario, Canada. In The Netherlands, we have developed specific university programs for students to better understand the dos and don'ts of pilot plant design in a practical way, and for Zeton to have access to the ideas of the technologists of the future. A true win-win collaboration!

Another method to drive innovation is to organize meetings or symposia on selected topics. In the same way that our first symposium addressed *Process Intensification,* our second symposium will be dedicated entirely to *Resource Efficiency* and the use of **Bio-based Materials in Chemicals and Energy.** With six international speakers, all experts in their respective fields, we hope to identify opportunities and propose solutions in the future use of bio-based materials. **The symposium will be organized on October 4, 2012** in Enschede, The Netherlands. More detailed information on the venue and program will be available soon, but please feel free to contact one of the Zeton companies if you would like to join us for this special event. It would be our pleasure to welcome you.

Johan ter Harmsel, Managing Director, Zeton B.V.

were officially opened at Avantium's site in Geleen, The Netherlands on December 8, 2011.

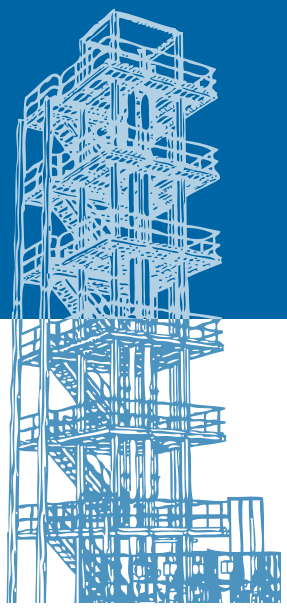
The third plant will be delivered to site later in 2012. A creative and flexible design for this pilot plant allows for various operation modes to research both chemistry and technology, in the reactor as well as in the subsequent separation/crystallization steps. Its design also allows for an additional downstream process module to be incorporated at a later date, based on the initial test results.

The pilot plant contains a number of elegant design features. Referring to the pictures, the practical combination of pilot-scale processes with industrial-scale vessels and skid design is readily apparent. Originally envisaged as several smaller process plants and modules, the complete plant was designed and built as one large module, with an associated reduction in site installation time, cost and facility utilities and building modifications.

The successful completion of the three pilot plant projects is a strong driver for the further joint development of state-of-the-art pilot plants for new, innovative, bio-based processes. The complementary size of both companies, the ability to make key decisions at an early stage, and the strong technical know-how in both organizations provides a solid foundation for future success. ■

"We are very satisfied with our current collaboration with Zeton as they were able to follow the YXY process development very closely during implementation (engineering and construction) of the pilot plant project."

Victor Vreeken, VP Operations Development of Avantium Chemicals B.V.



CASE **STUDY**

A BEHIND-THE-SCENES LOOK AT A RECENTLY COMPLETED PROJECT

NMR/MRI CATALYST TESTING SYSTEM

PROJECT DESCRIPTION

In 2011, Zeton was invited by the University of Cambridge's Department of Chemical Engineering and Biotechnology to discuss and review the options for using magnetic resonance techniques in a lab scale catalyst testing system.

The ultimate goal was to develop magnetic resonance techniques that can be used to spatially map chemical composition, concentration gradients, temperature, and gas and liquid flow profiles within a working reactor. The system was to be capable of testing scaled-down industrial reactors as well as microchannel reactors across a range of sizes and scales.

The catalyst testing system consists of a traditional trickle-bed reactor design with three gas feed systems, each equipped with parallel mass flow meters for high rangeability of gas feed rate. The liquid feed is delivered by a HPLC pump under mass flow control. The system design allows for connections to a wide range of different gas and liquid feeds. The reactor is operated at elevated temperatures and pressures in either up or down flow configuration. A gas/liquid separator and product collection vessel are installed downstream of the reactor.

DESIGN AND BUILD SUMMARY

The University of Cambridge invited Zeton to participate in early stage discussions. In Phase I of the project, both parties worked collaboratively to develop the P&IDs based on a preliminary PFD and process description provided by the university.

While the design of the feed, separation and the product collection sections was relatively straightforward, an extra degree of attention was required to solve the reactor design challenges presented by this project.

When integrating a reactor section into a NMR spectrometer, several design criteria have to be met. Firstly, there is the temperature difference between the NMR spectrometer and the process area. For kinetic experiments, it is essential to accurately control this temperature difference. The second, and more difficult challenge, is the non-metallic/non-magnetic requirements in the near vicinity of the NMR magnet. Only through the close and innovative collaboration between the University of Cambridge, Zeton and several key equipment suppliers were these challenging design criteria met.

To minimize the interference between the process section and the magnet, the process system was built separately from the reactor section, with the two being connected via a "pipe bridge." Non-magnetic stainless steel tubing and tracing was used as far as possible into the NMR magnet. However, the centre of the magnet had more stringent restrictions, requiring both non-metallic and non-magnetic materials. After an intensive study of alternatives, the team designed and built a special ceramic reactor for use under high pressure and high temperature conditions. This is the first time that the University of Cambridge or Zeton has implemented this type of reactor design in a lab scale system.

Once the reactor fabrication technology to be used in the project had been agreed, the NMR/MRI catalyst-testing system was completed using Zeton's fast-track project execution methodology.

"This is a very exciting development in our collaboration with the University of Cambridge. For the first time we can use NMR techniques to follow a catalytic reaction under real operating conditions, and gather information on catalyst performance across a range of length scales," said Dr. Andrew York, Johnson Matthey Technology Centre. ■

TECHNICAL SPECIFICATIONS

- A wide range of gas and liquid feeds
- Liquid feed flow rate 2.5 - 125 ml/h
- LHSV Max/min 10 - 0.2
- GHSV Max/min 5000 - 5
- Design pressure 30 barg
- Design temperature 350 °C
- Control system is LabVIEW from National Instruments

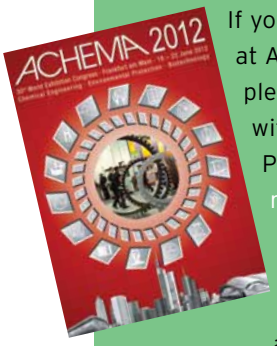
"Zeton has exceeded our expectations with their interactive design approach, and the implementation of novel solutions to overcome a number of major technical challenges."

Andy Sederman, Project Manager, University of Cambridge

FREE ENTRY TICKET TO ACHEMA 2012

Zeton will once again be present at the 30th World Exhibition Congress on Chemical Engineering, Environmental Protection and Biotechnology (ACHEMA 2012) in Frankfurt am Main, Germany from June 18 – 22, 2012. We extend a warm invitation to existing and future customers to visit us at **Stand F30, Hall 9.1.**

Our convention booth will pay special attention to the different scales of products and solutions that Zeton provides – lab scale systems, and pilot and demonstration scale plants – in combination with our integrated, modular engineering and construction capabilities.



If you would like to visit Zeton at ACHEMA 2012, we will be pleased to provide you with a free entry ticket. Please send an email to marketing@zeton.nl, stating "free entry ticket" in the subject line, and provide your mailing address. We will send you a complimentary ticket by return mail.

If you have any questions, or wish to make an appointment to meet during the ACHEMA Exhibition Congress, please contact Mrs. Esther Lagerwaard at +31 (0)53 4284100 or marketing@zeton.nl

We look forward to meeting you! ■

ZETON DELIVERS PILOT PLANT TO HUNTSMAN FOR HAZARDOUS DUTY

Early in the conceptual design stage of the project, engineers from Huntsman and Zeton came together for "white board" technical discussions. These preliminary discussions grew into a joint cooperation effort, and a highly innovative plant design for an inherently hazardous process.

The specific project involved a large-scale modular plant with several separation columns. This downstream processing section had to be connected and integrated into an existing, outdoor pilot plant at an industrial site. As a consequence, both industry and site standards, and ATEX classification requirements, applied to this project. Zeton's designers worked closely with Huntsman personnel to make the optimal selection between these requirements, the scale-specific needs of the process equipment, and the implicit requirements of a high-hazard plant.

This rigorous set of requirements and conditions demanded, at the very least, a well-thought-out project organization. Both project managers at Huntsman and Zeton worked hard on teaming up the right people at an early stage to ensure a solid foundation for the project. The team spirit developed between the project teams ensured a clear focus on the end goal, and on the important process and safety design elements of the project.

While led by Zeton, Huntsman's engineers were closely involved in the evaluation and selection of specific equipment, instruments and process solutions. In several cases, Huntsman's team accompanied Zeton's engineers for key supplier discussions and company visits. This joint approach ensured successful implementation of Zeton's scale-specific designs, and supported the decision to deviate from Huntsman's corporate standards in certain cases where safer and more practical alternatives were identified.

To eliminate and reduce the risk of misalignment at site – a key requirement for Huntsman – the process modules were fully assembled and tested in Zeton's high bay construction shop in their natural arrangement and orientation. The AC and

"ZETON'S KNOWLEDGE, EXPERIENCE AND TRUE PARTNERSHIP ARE THE COMPONENTS THAT MADE THIS PROJECT SUCCESSFUL FOR HUNTSMAN." SEGER VAN DAM, PROJECT MANAGER

DC electrical cabinets were installed in a separate non-ATEX rated container, to be located in a safe area in close proximity to the plant. Zeton's in-house expertise and know-how of the Emerson DeltaV™ control system ensured an efficient and timely implementation of the extended control system for the plant. It allowed for a more comprehensive factory test in Zeton's shop, and facilitated the smooth integration of the pilot plant into the existing site infrastructure.

Furthermore, the assembly of the complete pilot plant within a single, vertical skid module simplified disassembly, transport and reassembly at site. As shown in the picture, only a stairtower module and the single process module had to be transported. Electrical, process and utility hookups were completed quickly, with minimal interference to existing commercial operations at site.

Project Manager Seger van Dam: "As the project manager for this project, I can say that to manage and deliver a pilot plant to the Huntsman business together with an experienced company like Zeton makes for a project that everyone can be proud of. Zeton is the company to realize pilot plants – their knowledge, experience and true partnership are the components that made this project successful for Huntsman."

As a company that dares to think differently, Zeton is proud to have been chosen by Huntsman to design and build this important pilot plant, where only a narrow window was available to match the process, site and the safety requirements. Teaming up early was the key factor in successfully completing this novel, state-of-the-art, modular pilot plant project. ■

TEAM **SPIRIT**

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

HIGH FIVE FOR ZETON'S HOCKEY TEAM

Competing in the Al Reid Memorial Over-35 Hockey Tournament in Niagara Falls, Ontario has become a tradition for the Zeton hockey team. Held annually in mid-January, the tournament celebrated its 35th anniversary in 2012. A portion of the tournament proceeds are donated to local area charities each year.

Under GM Adam Whalley, the Zeton hockey team has competed in the last five seasons, gradually adjusting to the competitive intensity of the tournament, with results improving year over year. This year, the "Executive" line led the way to a win in the first game with a goal by David Beckman and assists by Chris Brown and Paul Gailey. They then combined later in the tournament for a short-handed goal scored by Chris Brown. Congratulations to Shawn Michaud for leading the Zeton hockey team in scoring. While the team has yet to make the tournament final, the future of the Zeton hockey team looks bright, as a number of talented "junior" players graduate to the first team!