

MINI-GTL TECHNOLOGY BULLETIN

Volume 4, January 2018

INTRODUCTION

This bulletin represents a 2017 year-end review of technology and commercial developments in the emerging small-scale GTL industry. There have been comings and goings and the field is consolidating. A key highlight is the first application of a micro-GTL plant to a flare in North Dakota by GasTechno.

STATE OF THE MINI-GTL INDUSTRY

Only one of the 5 commercial plants currently under development came on line in 2017, namely the ENVIA Energy's GTL plant on the Waste Management landfill in Oklahoma. The plant, partially fed with landfill gas, announced its first finished, saleable products on June 30, but has not yet reached the 250 bpd design capacity. However, they are close: on October 30, they announced achieving 200 bpd production. Unfortunately, Velocys, the technology leader and partner in the project has announced that they will focus on renewable feedstocks only, taking them out of the gas flare monetization business for the time being.

The start-up of the other 4 plants (Greyrock 1, Juniper GTL, Primus 1 and Primus 2) will now happen in 2018. The new owner of Juniper GTL, York Capital, will likely target future plant sizes of more than 5000 bpd (consuming 50 MMscfd of gas), clearly outside the gas flare range. However, both Greyrock and Primus GE continue strong business development efforts in the gas flare arena.

Haldor Topsoe has joined forces with Modular Plant Solutions (MPS) and has designed and engineered a small-scale methanol plant called "Methanol-To-Go™". The size of the plant is similar to the Primus 1 and 2 plants with a gas feed rate of 7 MMscfd versus 5 MMscfd for the Primus GE plants.

BgtL is a new player in the micro-GTL arena. However, their patented technologies are based on 2 decades of R&D work in research institutes. Their portfolio of products includes plant modules that convert gas volumes as small as 2 Mscfd into a range of products including oil, diesel, methanol and others. These remotely controlled, inexpensive "machines" are ideally suited for many flares.

The current leading GTL technology providers with commercial offers for gas flares are:

Micro-GTL: Unattended operation units below ~1 MMscfd and below ~US\$ 10 mln

Greyrock: Robert Schuetzle, rschuetzle@greyrock.com; +1 (916) 290 9350

GasTechno: Walter Breidenstein at walterb@gastechno.com; +1 231 535 2914

BgtL: Dr. Zhijun Jia at zhijunjia@bgtl-llc.com; +1 608 461 1356

Mini-GTL: Small modular plants with some operators and a cost >US\$ 10 mln

Greyrock: Robert Schuetzle, rschuetzle@greyrock.com; +1 (916) 290 9350

EFT/Black and Veatch: Mark Agee at markaagee@gmail.com;

INFRA: Zoya Volkova at volkova@infratechnology.com; +1 (346) 701 5230 ext 1006.

Primus GE: George Boyajian at gboyajian@primusge.com; +1 908 281 6000

Topsoe/MPS: David Townsend at david.townsend@modularplantsolutions.com; +1 281 450 3679

Expander Energy: James Ross at jross@expanderenergy.com; +1 403 475 4146

NORTH DAKOTA GAS FLARE MONETIZATION

GasTechno Energy & Fuels (GEF) LLC started operation of their commercial scale Mini-GTL 300 plant at the New Haven, Michigan site on November 19, 2016 as reported in Volume 3 of this bulletin series. The plant went through various commercial testing operations and was then moved to its "GasTechno Dimond" site in North Dakota in October 2017. This site is flaring up to 400 Mscfd. The current GasTechno NGL operations is producing up to 1000 gallons per day of LPG and condensates during peak flaring operations from 10 wells tied into a central battery facility. The "methanol in a box" trailer is expected to begin operation in January, making up to 40 bbls/day of their liquid crude methanol blend from the remaining dry gas. The CEO, Walter Breidenstein, personally oversees the operation. In this "Build-Own-Operate" (BOO) business model, Walter pointed out the importance of the NGL revenue stream along with the methanol sales for an overall economically attractive project. GEF has also developed its own NGL separation technology designed for integration with their GTL technology. The 1st mini-NGL plant is being constructed and is scheduled for commercial start-up in April 2018.

GasTechno also received permitting approval from North Dakota Industrial Commission (NDIC) in September 2017 for operations of an NGL-GTL combined system at a flare location that is scheduled to deliver up to 1 MMscfd associated gas in the spring-summer of 2018.



The company is in negotiation for yet another location that will exceed 2 MMscfd and the company has two new Mini-GTL plants being manufactured by Optimization Inc in New York. Those plants (Mini-GTL 300 and Mini-GTL 750) will be ready in early 2018. The picture shows the M300 plant in transition from the Michigan site to the new site in North Dakota.

Congratulations to GEF and its CEO, Walter Breidenstein!

FLARECATCHER BY PIONEER

Nearly all flared gas contains valuable heavier hydrocarbons including LPG and condensates. Although the GTL technologies can convert these components as well, it often makes much more economic sense to separate these valuable products from the flare before converting the dry gas (methane/ethane) into liquids. There are many natural gas processing providers, and a number of these are summarized in a technology overview available on the GGFR website.

<http://pubdocs.worldbank.org/en/495311492808037862/GGFR-Technology-Overview-April-2017>

One such gas processing provider is Pioneer Energy, whose mobile “Flarecatcher”™ units are at the forefront of flare gas fractionation. Participants at the EFI/GGFR symposium in Denver in July (including one of the authors) had the opportunity to see such a unit in operation at a flare outside Denver.

Pioneer Energy is a Colorado-based technology developer and original equipment manufacturer for the oil and gas industry. The founder is Dr. Robert Zubrin, the well-known NASA engineer, Mars enthusiast and book author. The Flarecatcher is a truck- or skid-mounted natural gas processing system. It has great performance compared to most conventional technologies because of its advanced refrigeration and separation technologies. Most importantly, all processes are integrated into a mobile platform that can be trucked to the well site, hooked up and then remotely operated. The mobile units come in different sizes capable of processing from 400 (picture below) to 4000 Mscfd. The process captures nearly 90% of propane and higher hydrocarbons, uses ethane as an operational fuel and produces a very dry natural

gas suited for power generation, CNG, LNG or as feedstock to a mini-GTL plant. Pioneer Energy is interested in business development worldwide.



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MEOH-TO-GO™

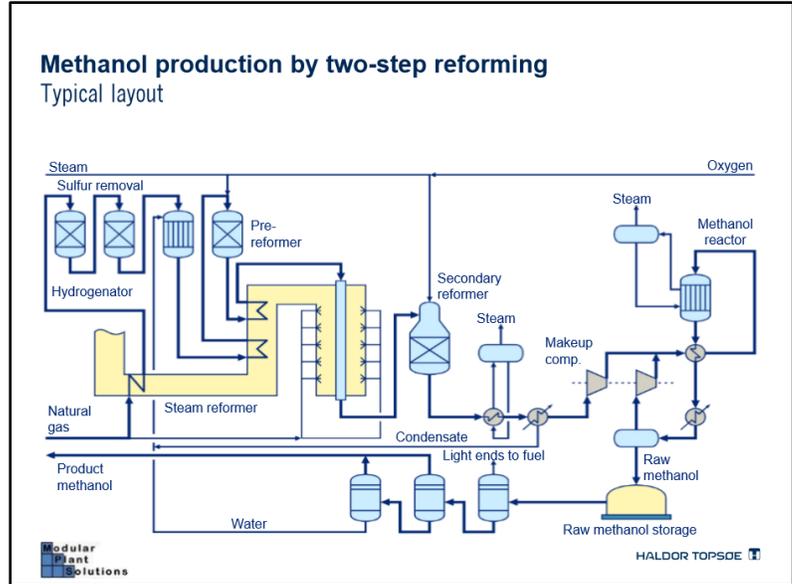
On September 28, 2017, Topsoe announced a partnership with Modular Plant Solution (MPS) and their joint development of a modular mini-GTL plant. The announcement was made at the Energy Frontiers International (EFI) Gas-To-Market symposium in Houston. MeOH-To-Go offers cost-effective, small-scale methanol production similar to the Primus GE process discussed in previous bulletins. MeOH-To-Go is a great small-scale GTL addition to the growing technology option portfolio. The author has challenged Topsoe for years to develop such an option and join the group of small-scale gas conversion technology providers.

Haldor Topsoe has been among the leaders in methanol technology for more than 40 years. Their technologies and catalysts are proven with state of the art performance. MPS brings modularization skills to the table and will lead the business development efforts.

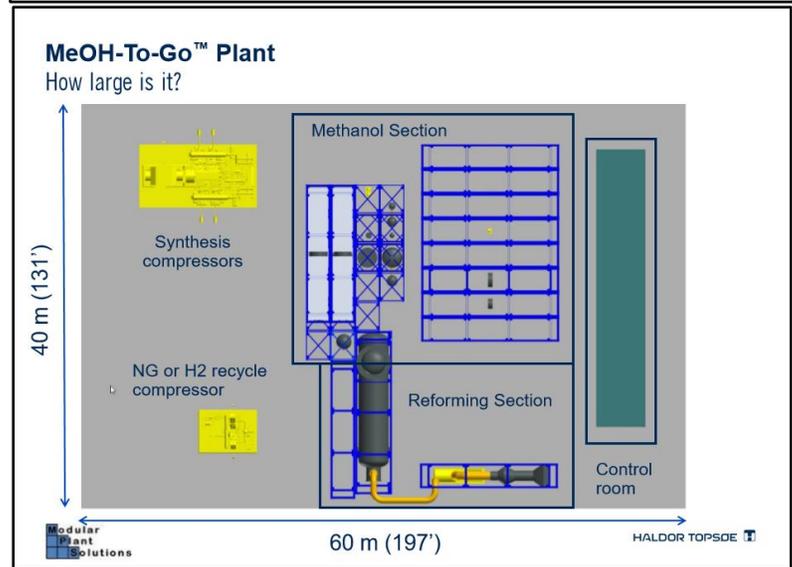
The plant comes in just one(!) size: It will produce 215 tpd of chemical grade methanol and will be fed by 7.1 MMscfd of natural gas. This plant size is in the same ball park as Primus GE, but is slightly larger. (The Primus GE plants produce 160 tpd methanol from 5 MMscfd of gas.)



The technology is based on large-scale methanol plant technology. The 2-step reforming process includes a steam reformer combined with a high-temperature secondary reformer (HTCR), widely used for small-scale hydrogen plants. A standard boiling-water methanol reactor produces crude methanol which can then be distilled into pure chemical-grade methanol. We were told that methanol conversion units to DME and gasoline will be developed in the future.



The plant requires a plot size of about 40x60 meters or about 130x200 feet. The approximate total installed cost will be US\$50 mln to US\$60 mln.



The tallest structures are the 3 distillation columns needed for the methanol purification step. If methanol is to be used as a cooking fuel, or would be converted into DME, this process step is not needed.

The modules will be fabricated in regions of low-cost production and then assembled on site. Approximately 18 months will be needed from site selection, FEED and permit applications to mechanical completion.



BGTL: A NEW MICRO-GTL TECHNOLOGY PROVIDER

The press release below, dated July 22, 2017, introduced a new player with micro-GTL technology for gas flares. The founder and CEO of BgtL, Dr. Zhijun Jia, presented his technology solutions at the EFI conference in Houston in late September where the author met with him to discuss the status of his modular, extremely compact gas flare monetization units. This “new” company has a lot of credibility because of its deep technology roots going back for 2 decades. Here is the press release:

De Pere, WI, July 12, 2017 - BgtL LLC, based in De Pere, Wisconsin, announced today that it has successfully commissioned and completed performance testing of a one (1) barrel per day (bpd), Fischer-Tropsch (FT) syngas-to-liquids pilot conversion system, working together with a reputable, non-profit, research and technical services company (Client). BgtL’s client was testing the integration of several technologies in a coal-to-liquids process for which BgtL provided a custom designed FT gas-to-liquids system incorporating its proprietary compact technology. The system was designed and engineered by BgtL together with its sister company, CompRex, LLC, and fabricated by BgtL’s manufacturing partner, Robinson Metal, Inc.

Operation and performance tests were run over two, five-day-periods with varied feedstock compositions to produce zero-sulfur synthetic crude oil (syncrude) from BgtL’s system. The results showed even higher than expected conversion and productivity as well as low FT wax output. By altering the operating conditions, BgtL’s system is capable of making different mixes of hydrocarbon liquids and high value waxes, and with the addition of a simple product-upgrading module, jet, diesel and gasoline fuels can also be generated.

“We are pleased with the successful test results of the 1 bpd pilot system which exceeded our customers’ requirements. Performance of our compact FT reactor was critical in maintaining exceptional temperature control and optimal system performance during this highly exothermic reaction. These test results proved that our system can efficiently produce FT liquid fuels at a high conversion rate of over 70% in a single pass with low methane selectivity and mostly syncrude and low wax output. The tests further proved that BgtL’s compact technology and its modular approach can provide a suitable solution for FT and other applications requiring efficient heat addition or removal with tight temperature control requirements. They include applications such as process intensification and conversion of various feedstocks, such as natural gas, coal, biomass, and municipal solid waste, to liquid fuels.” commented Dr. Zhijun Jia, CEO of BgtL.

The heart of the BgtL technology are extremely compact reactors and heat exchangers based on a micro-channel-like layered configuration. These patented systems were developed over the last 2 decades in research organizations that remain R&D partners of BgtL (see top 3 circles on right). BgtL and CompRex are the two newly founded companies which, together with Robinson Metals, will commercialize these technologies and offer turnkey solutions to gas flare customers.



The picture shows the 1-2 bpd pilot skid of a fully integrated GTL-FT unit which delivered a high-quality FT syncrude in high yields. This unit was designed and built in less than 9 months. BgtL has standard designs for 20, 50, 100 and 200 bpd corresponding to gas flare feed rates of 0.2 MMscfd to 2 MMscfd.



They even offer custom designs like the 3-5 bpd unit shown on the right with dimensions of only 8x20x12 feet.

BgtL also has a broad product offering. In addition to the products from a GT-FT unit (syncrude, diesel, jet fuel, wax), they also offer alcohol reactors including for methanol, DME and higher alcohols.

BgtL is a welcome addition to the gas flare monetization options. Their technology is sound and tested at pilot scale. The scale-up to first commercial units (20 to 40 bpd) is straight forward.

Website: www.bgtl-inc.com



INFRA UPDATES

The INFRA M100 demonstration plant in Texas (north of Houston) had a grand opening in December 2016 (see Volume 3). The author had the opportunity to visit the plant late September 2017. Thank you, INFRA! Picture shows the author in discussion with Dmitry Popov, VP Commercial, at the plant site. The plant is quite impressive but is still in commissioning phase because of technical issues and even flooding! The purpose of demonstration plants is the identification and correction of such problems and we should be seeing first production soon.



In an update presentation by Dmitry Popov, it was revealed that the much-touted DIRECT conversion of syngas into high quality diesel without an upgrading step is not working. Standard upgrading steps will be required for both diesel and gasoline production from the synthetic oil. Thus, the predicted large capex reductions will likely (unfortunately) not be realized.

EXPANDER ENERGY PLANT

Expander Energy Inc is a Calgary based GTL company with a long record of developing enhanced GTL technologies and pursuing large-scale GTL projects from coal and gas. More recently, they are also looking at the potential of smaller-scale gas-based plants. In September 2015, they formed a partnership with Greyrock, one of the leaders in micro- and mini-GTL.

In July 2017, the CEO James Ross announced that they had received the Alberta Energy Regulator's approval for their first plant. This plant is based on their EGTL™ technology, consumes 5 MMscfd of gas and produces about 500 bpd of syndiesel. The location of the plant will be in Carseland, Alberta. Expander Energy has secured long-term gas supply and product offtake agreements which makes for a financeable project. We wish them good luck in reaching financial closure and a FID soon. This would be Expander's first GTL plant. They have limited experience in modularization, but we expect that they will lean heavily on Greyrock's experience and leadership in this arena.

COMPACTGTL

The CEO Edmund Buckley informed us that CompactGTL continues to pursue attractive opportunities in the former CIS. Their focus is on slightly larger plants such as their project in Khazakistan at 25 MMscfd feed rate.

PROTONVENTURES

The Dutch company ProtonVentures has been discussed many times in our reports. It is the only company with ammonia technology which would allow the conversion of flare gas into fertilizer. We have learned from Bob

Weehuizen, who is in charge of business development, that the Government of Saskatchewan in Canada is working with them to build a 4000 tpd ammonia demonstration plant on pipeline gas, with the intent to buy 9 more units to be supplied by flare gas if the demonstration is successful.

GREENWAY

Greenway Innovative Energy (GIE), a fully owned subsidiary of UMED Holdings, issued a few press releases on building and testing a fully integrated model of their proprietary GTL process at their lab at the University of Texas, Arlington.

EFI GGFR CONFERENCES

Bjorn Hamso delivered the keynote lecture at the annual Gas Flare Monetization Forum and Site Visits in Denver hosted by EFI in June 2017. All members of GGFR have access to all presentation via the website www.energyfrontiers.org.

Theo Fleisch reviewed “The Small-Scale Gas Conversion Landscape A cin 2017: Monetization of Challenged Gas Resources Via Mini-Micro-GTL”.

We hope you enjoy the reading! Feel free to contact either of us:

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