



MINI-GTL TECHNOLOGY BULLETIN

Volume 3, February 2017

INTRODUCTION

Last year we issued the first 2 volumes of the World Bank GGFR “Mini-GTL Technology Bulletin” to provide timely updates of the quickly emerging use of small-scale GTL technologies to extinguish and monetize gas flares. We continue to see an increasing pace in the development and uptake of these gas flaring reduction systems and plan 2 to 4 more bulletins this year. Furthermore, the 3rd annual EFI/GGFR Gas Conversion Technology Conference and site visits will be held at the Sheraton Downtown Hotel in Denver, Colorado, on June 14-16, 2017, and will bring together all key representatives in this emerging industry. We strongly recommend attendance and participation in this most comprehensive global gathering of gas flare mitigation technologies.

STATE OF THE MINI-GTL INDUSTRY

Natural gas is a very important feedstock for fuels and chemicals. Thousands of large-scale plants exist around the world producing hydrogen, methanol, fertilizer, diesel fuel, and many other liquid fuels and chemicals. Obviously, the conversion of gas flares into synthetic crude oil, a refined diesel/gasoline fuel, or a valuable liquid such as methanol or DME, is an attractive technical and environmental solution for the extinction of flares. The question has been whether simple, robust, modular plants could be economically built and operated in the field.

We have reported on the rapid progress over the last few years in developing smaller and smaller plants that now cover the gas flare range of interest from about 100Mscfd to 25MMscfd! We also see the development of plants that are specifically engineered for gas flares, an effort that was accelerated by the World Bank GGFR goal of “Zero Routine Flaring by 2030” initiative as mentioned in our last bulletin.

In this bulletin we want to highlight 3 major developments:

1. Final demonstration of the GasTechno solution
2. Completion of INFRA demonstration plant
3. Completion of ENVIA commercial plant (Velocys technology)

1. FINAL DEMONSTRATION OF GASTECHNO SOLUTION

After more than 6 years of development, GasTechno Energy and Fuels (GEF) is ready for 1st commercial deployment and business. Their 3rd generation plant with a capacity of 300Mscfd of gas has been and is still going through rigorous testing at a commercial gas production site in New Haven, Michigan. Plans call for a final commercial deployment of this plant to a flare in the Bakken Formation, North Dakota, later this year.

Background: The GasTechno process converts natural gas into methanol and some other liquid products. It is different and much simpler than conventional conversion processes since the costly syngas step is avoided. It is a direct, one step process that uses no catalysts, a true breakthrough technology. Stringent gas purity requirements to prevent the fouling of catalysts are not an issue with this process. Results are simplicity, robustness, and low cost. Experts in the field (the authors included) had doubts about the efficiency of the process as well as concerns about the market value of the product mixture. GEF has informed us that test results showed very good efficiencies, and the liquid product has multiple valuable fuel and chemical outlets.

GEF has ambitious plans to build dozens of plants over the next few years. The main bottleneck is capital, and GEF is in the midst of raising up to \$15 MM.

Sam Price, President and CEO of SEI Tech, Inc, is a partner of GEF, responsible for the instrumentation, operation, and automation of the process. He emphasizes the following advantages of the GasTechno solution:

1. **Simplicity of process:** the actual mini-GTL plant is contained in a single 40ft shipping container, as shown in the picture on next page, which is obviously easily deployable and moveable. It consists mainly of pipes and processor-controlled valves and instrumentation. In addition to the "Methanol in a Box" container, one needs either bottled oxygen for the smaller plants or an air separation unit (the process requires oxygen), a feed gas compressor, a generator set, and liquid product tanks. Total space required is about 150x150 ft.
2. **Ease of operation:** The New Haven plant has been put through numerous start-ups and shut-downs. Quick and easy responses have been reported as well as long-term stable operation. Complete automation will be available soon allowing unattended, operation of the units from off-site.
3. **Service and Training:** SEI Tech will be providing on site commissioning, calibration, start-up, operation, training and maintenance.

Future deployment will include larger scales of 1 and 10MMscfd of gas and beyond. GEF's business model is flexible; GEF will consider sale/lease of units and would be happy to discuss other arrangements. We recommend to contact GEF for more information on specific gas flare applications or on investment opportunities.

For more information: Walter Breidenstein, CEO; walterb@gastechno.com; +1 231 535 2914



Figure 1 GasTechno Mini-GTL® commercial plant



GEF offers the Micro-GTL®, Mini-GTL®, Methanol In A Box®, Mini-GTL In A Box®, GTL In A Box® and small scale GasTechno® process technology which provides an excellent environmental compliance solution while converting flared gas into high value, commercially saleable liquid fuels and chemicals.

2. COMPLETION OF INFRA DEMONSTRATION PLANT

INFRA Technology is an international company with Russian roots that is now headquartered in Houston, TX. We have evaluated and reported their technology and their technology development program for the last few years. The final step before commercialization, a demonstration plant converting 1MMscfd of gas into 100bpd of liquid hydrocarbons, has been completed in Wharton, TX, late November 2016. On December 30, 2016, INFRA held a Grand Opening of the plant hosted by the CEO Kaan Akyalcin and attended by over 40 people.

The highly modular plant, called an “M100” or “Mark 100” model, which came in 14 pre-fabricated, skid-mounted modules, is now going through final commissioning and should come on line very soon. Congratulations!



In a nutshell, the INFRA GTL technology allows the direct conversion of synthesis gas (derived from a n SMR) into high-quality diesel, gasoline and jet fuel, eliminating the need of a product upgrading step. (Greyrock is another technology provider in this field with a “direct” GTL-FT process). INFRA’s bi-functional Fischer-Tropsch GTL catalyst is also touted as having record-high activities with the potential to further lower capital cost.

The M100 plant is designed to convert 1MMscfd into 100bpd of products, and will cost less than \$10MM. Refined final numbers for both product yields and capital costs will become available from actual performance data of the plant. Plants will be self-sufficient in power and water needs.

INFRA’s longer-term business plans include larger-scale plants ranging from 1000bpd (M1000) to world-scale plants (>35,000bpd). They see cost reductions of more than 50% from today’s \$100,000 per daily barrel capacity for such plants. Should such cost reductions materialize, it could have a profound impact. Operating costs (everything but the gas feedstock) are claimed to be less than \$10/bbl.

With extensive and successful testing of their M100 plant in Texas this year, INFRA will now be in a position to offer commercial solutions to customers. Projects are being pursued in Russia and Asia. For more information, we encourage GGFR members to contact Zoya Volkova at volkova@infratechnology.com or +1 (346) 701 5230 ext. 1006.

3. COMPLETION OF ENVIA COMMERCIAL PLANT (VELOCYS TECHNOLOGY)



A press release on September 21, 2016 announced the completion of the construction of the ENVIA GTL plant in Oklahoma City. ENVIA is a partnership of Waste Management (WM) and NRG with Velocys as technology provider and Ventech as the EPC contractor. The plant will be converting landfill gas (rich in methane) into liquid products such as diesel, jet fuels and chemicals. It is considered a “reference plant” for both the Velocys micro-channel GTL technology and the utilization of WM landfill gas emissions across the country. Today, landfill gas is being flared similar to associated gas. Therefore, this plant, which is designed to eliminate flaring at the Oklahoma City landfill, is of special interest to the gas flaring community. The plant is in commissioning, and on February 6, Velocys reported that first Fischer-Tropsch product had been successfully produced. Focus is currently on ramping up production to full capacity and prepare for performance test runs of the plant.

Velocys has been at the forefront of mini-GTL technology developments, and their micro-channel technology reactors are ideally suited to small, modular plants. Velocys managers, engineers and operators play leading roles in the commissioning, start-up, and operation of the plant and will gain additional operational experience for additional commercial plants.

In January 2017, Velocys signed an MOU with Japanese Morimatsu Heavy Industry Company to establish a JV for module engineering and fabrication of mini-GTL plants. Morimatsu has unique skills in modular fabrication, has manufacturing facilities in Japan and China, and is expected to help in driving down costs. This JV is a part of Velocys’ new strategy to deliver with partners “**a one-stop shop offer to customers for a fully integrated and FINANCED, cost-effective and operations-ready plant solution**”.

For more information on potential gas flare applications, please contact: Philipp Stratmann, Philipp.stratmann@velocys.com, +1 (281) 753 4865

STATUS OF COMMERCIAL MINI-GTL PLANTS (JANUARY 2017)

Commercial mini-GTL plants 1/2017						
Name	Location	Technology	Capacity	Gas Feed Stock	Capex	Remarks
ENVIA Energy	Oklahoma	Velocys	700bpd?	Landfill gas	NA	In commissioning; 1Q2017 start-up
GREYROCK 1	USA	DFP--GreyCat	1000bpd?	Shale gas, ~10MMscfd	NA	2017 start-up
JUNIPER GTL	Louisiana	SGC Energia XTLH	1100bpd	Shale gas, 11MMscfd	\$100MM	Delayed start-up to 3Q2017
COMPACTGTL	Kazakhstan	CompactGTL	2500bpd	Flare gas, 25MMscfd	\$275MM	Delayed FID
PRIMUS 1	Marcellus	STG+	160t/d methanol	Shale gas, 5MMscfd	~/< \$50MM?	4Q2017 start-up
PRIMUS 2	Alberta	STG+	160t/d methanol	Shale gas, 5MMscfd	~/< \$50MM?	1Q2018 start-up

This table only shows commercial projects where a customer has made a final investment decision (FID). Therefore, demonstration plants such as the INFRA 100bpd plant in Texas or the GasTechno plant in Michigan just discussed in detail, are not included despite being exciting, final steps towards commercialization. We would expect that both companies will make the table above in 2017. The financial hurdle towards a FID is much lower for these smaller, less expensive plants in the micro-GTL/mini-GTL range.

The start-up of the **ENVIA plant** has taken place, as just discussed. The capacity of the plant has not yet been announced, but we estimate a size of about 700bpd, which would need a gas feed rate of about 7MMscfd.

Completion of the **Greyrock plant** has been delayed from 2016 to 2017. As reported previously, the plant site was changed from Texas to a better area with lower feedstock costs and higher value for the diesel product, resulting in better project economics. Plant module fabrication is essentially complete, and we look forward to the plant coming on-line soon.

Construction of the **Juniper GTL plant** has resumed after a financial hold-up in 2016. Start-up is now scheduled for 3Q 2017.

CompactGTL's Kazakhstan plant targets the conversion of 25MMscfd of flared gas into about 2500bpd of clean diesel fuel. Political and financial issues have delayed the project, but Alina Ussenko, the new business development director, emphasizes ongoing work in both obtaining all local permits and in completing detailed final engineering by Fluor. They also have a healthy prospective project pipeline in Russia, CIS, South Africa, and Iran.

The two **Primus Green Energy plants**, each consuming about 5MMscfd of gas, are progressing as planned. Both plants will run on shale gas and produce methanol, which has a high local/regional value as chemical feedstock.

OBERON FUELS/MACK DME DIESEL DEMONSTRATION

One of the mini-GTL options for gas flare monetization is the conversion of the flare into DME, a clean-burning propane and diesel alternative. The leader in this field is Oberon Fuels. AUM Energy and Maverick Fuels offer DME technologies as well. While the DME manufacturing process and the use of DME as a household fuel are well established, the use in diesel engines requires some final real-world testing. A January 12, 2017 press release by Mack Truck and Oberon Fuels announces the use of a DME-fueled truck on a landfill in NY in collaboration with the NY City Department of Sanitation (DSNY). Results of the test are expected the middle of this year.

GREYROCK UPDATES

Anglo American Platinum has become an investor in Greyrock. Together they are working on distressed gas-fed GTL projects in Africa.

They will be delivering several M-class systems in both the US and Canada this year. These systems are remotely controlled units, deployed at the well head and designed to monetize very small volumes (<1MMscfd) of gas,

especially flared gas. These are exciting developments in the “Micro-GTL” arena, which is critically important for global gas flare reduction.

Greyrock is also continuing to staff up with new senior engineering and business development staff. Commercial progress is expected in 2017.

For more information, please contact CEO Robert Schuetzle, rschuetzle@greyrock.com; +1 (916) 290 9350

GAS FLARE REDUCTION CONFERENCE BY EFI/GGFR

The most comprehensive conference on technologies for gas flare reduction will be held at the Downtown Sheraton Hotel in Denver June 14-16 of this year. This 3rd annual conference is a must-attend for people interested in monetizing gas flares. Registration information will be sent in a separate announcement. Find more information on www.energyfrontiers.org.

SUMMARY

More mini-GTL solutions have moved to the stage of commerciality. Technology choices and competition among technology providers will be good for the customers. We encourage members of GGFR to stay abreast of the emerging opportunities. We are also ready to provide more information to members of the GGFR community and help potential customers to find the most appropriate mini-GTL solution.

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