GTL Tech Converts Methane to Ethylene without Fischer Tropsch

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A Texas company has developed gas-to-liquids (GTL) technology designed to convert methane to ethylene without using the Fischer Tropsch (FT) process. The firm claims that its GTL system can perform at a level of efficiency rivaling conventional methane conversion technologies.

"Our focus is actually on monetizing abundant, remote or flared gas," said Edward Peterson, Chief Engineer with Dallas-based Synfuels International.

"Synfuels technology is useful whenever we can access low-value gas to make high-value products," continued Peterson.

"We can offer a service ... to 'handle' gas by converting it into gasoline and blending it back into the crude. We can process dry gas, which contains little C2+ [heavier hydrocarbons], into gasoline and make a valuable and easily transported liquid. When the local market is advanced and there are ethylene converters nearby, even relatively high gas prices will lead to a profitable gas to ethylene [GTE] facility."

Synfuels' technology stems from a 1998 invention by researchers at Texas A&M University that converts natural gas to acetylene and then to ethylene. Synfuels International either directly owns or holds exclusive licenses to the intellectual property for the process. In addition, the company controls all of the technology -- including process, design and catalyst patents -- required to build and operate a Synfuels plant.

"The Synfuels process ... is not limited to associated gas because we do make useful final products," continued Peterson. "For associated gas, we can make gasoline that can be sold as a finished product as well as enable liquids production by combining it with crude."

Two- or Three-Stage Process

The process first phase exposes methane to high energy levels in a pyrolysis reactor, cracking the methane into ethylene, acetylene and hydrogen. In the next phase, called liquid phase hydrogenation (LPH), the acetylene and some of the hydrogen undergo catalytic conversion in a reactor to become ethylene -- a valuable building block in petrochemicals.

"The LPH step is the cornerstone of our technology and the basis of our success because it is highly efficient yet is very tolerant of carbon monoxide, a major component of the gas produced in the first reactor," Peterson explained. "Not having to separate the acetylene from the other gas components prior to reaction is a huge savings in operating and capital cost."

Peterson said the process can end after hydrogenation, which yields ethylene, or proceed to a third step: oligomerization. The oligomerization phase yields a 100-percent liquids first-pass gasoline blend grade. He pointed out the capability to produce unfinished gasoline, also known as gasoline blendstock, differentiates Synfuels' process from GTL technologies based on FT. In contrast, FT yields synthetic crude oil that must undergo processing before becoming marketable products.

"The product composition is independent of the feed material," Peterson said of Synfuels' technology. "The intermediate products can be isolated as finished products. The gasoline blendstock is obtained without need for a separation operation such as distillation."

According to Synfuels, the gasoline blendstock boasts a research octane rating from 90 to 95.

Peterson said a simple two-phase separator allows gasoline blendstock to be moved to storage. The remaining gases -- carbon monoxide, hydrogen and unreacted methane -- can be used within the process for power and energy generation.

"Carbon dioxide, which is also present, is removed from the process gas before returning it to the first reactor,"

added Peterson.

Peterson said his company's technology also can produce an ethylene-derived jet fuel that commercial and U.S. Military labs have found meet or exceed all jet fuel specifications.

"Synfuels ethylene-derived jet fuel can be made from 100-percent renewable feedstocks such as plant derived-ethanol," explained Peterson.

He said the ethylene-derived jet fuel exhibits a very low freeze point, making it well-suited for high-altitude or arctic flight. He added the jet fuel has not yet been fully qualified but is projected to be a 100-percent renewable jet fuel replacement.

Better Economics than FT?

Synfuels also contends that its technology overcomes a much lower economic threshold than FT. FT installations need natural gas feed rates of at least 300 million standard cubic feet per day (MMscf/d) to achieve cost-effectiveness, which suggests why there are only four GTL plants in the world built by Shell and Sasol, two in Qatar, and one each in South Africa and Malaysia, Peterson said.

"To be cost-effective, Synfuels installations must have gas feed rates of about 15 MMscf/d and on an equal product output basis, cost about one-third as much as an FT plant," Peterson noted. "Synfuels plant sizes can exceed 300 MMscf/d."

"Our technology is geared as the situation dictates," said Peterson. He explained that in cases where gas is stranded, with production as low as 10 MMscf/d, deploying the GTL process and transporting the liquids to market would make the most economic sense.

"Our most profitable size range is 20 to 300 MMscf/d for onshore monetization of stranded gas where substantial volumes of product can be offered for sale," added Peterson.

A Possible Alternative to Ethane Crackers

In cases where dry natural gas is cheap and plentiful or even routinely flared, converting it into ethylene would be the best choice because it would garner the greatest internal rate of return among available options, Peterson said.

"The gas produced and transported in pipelines in North America is nearly pure methane," said Peterson. "Synfuels can take this lean gas and make ethylene."

Peterson pointed out that high production rates of North American shale gas are keeping the price of pipeline-quality natural gas in the $2 to $3 range. Noting that ethane is approximately twice the price of methane on a volume basis, he said the Synfuels process can compete economically with ethane crackers.

Peterson reasons that most of the ethylene produced in the U.S. East Coat region is derived from naphtha, which is becoming more expensive because it is linked to the price of crude oil.

"Many of these plants have been grandfathered with respect to emissions and other environmental standards, but many states on the East Coast are considering eliminating the statues that allow these older plants to bypass current environmental regulations," said Peterson. "Therefore, both price and government pressure may shut many of these plants down."

Ethane, a component of natural gas liquids, is another source of ethylene. The U.S. petrochemicals industry has big plans for increasing the country's ethane cracking capacity in the Gulf Coast and Appalachia, but Peterson points out that ethane constitutes only approximately 5 percent of natural gas.

"It can meet some of the anticipated naphtha replacement, but not all of it," Peterson said of ethane. "Ethylene from methane can meet the demand and more."

In fact, he predicts that his company's process will help to keep the cost of ethylene more in line with natural gas prices than oil prices. Moreover, Synfuels contends that its patent-pending "GasRich" process technology will help to bring ethylene to gas-poor regions where the building block is more expensive.

"Simply put, we propose that ethylene can be transported as a liquid in a common liquid carrier with LNG, as either separate components or as a blend," Peterson said. Peterson said Synfuels' concept would take advantage of -- but not be limited to -- excess shipping and production capacities of existing LNG plants around the world or LNG production plants to be built in the U.S. In this scenario, a Synfuels GTE plant would send ethylene to an LNG production facility.

"The ethylene is cooled and optionally blended with the LNG and loaded aboard the LNG tanker," Peterson explained. "That tanker unloads at the receiving terminal where, if a blend, is cryogenically separated into pure ethylene and pure gasified LNG. The LNG, now natural gas, enters the natural gas supply system. The ethylene is conveyed to a chemical plant that converts the ethylene into various products or in some cases is conveyed to an ethylene distribution pipeline very similar to a natural gas distribution pipeline."

Peterson said the LNG liquid separation plant would need only slight modifications. In the case of ethylene blended with LNG, a cryogenic separation tower would be needed.

"The cost of operation is much less than a typical cryogenic separation tower because the fluid entering the separation system is already cooled to its normal cryogenic boiling point such that the cryogenic separation requires little or no additional refrigeration," added Peterson. "It will operate much like a typical liquid distillation tower."

Raising Money for Commercial-Scale Plant

Synfuels International has deployed the GTL technology at its 35,000-SCFD demonstration plant near Bryan, Texas. The facility has operated continuously for two weeks as a fully integrated process. Peterson said the Dallas-based technology assessment engineering firm Baker and O'Brien has vetted the process technology.

"The GTE process is simply taking an intermediate stream in the process and refining it with known technology," added Peterson. "The Houston engineering and construction firm that completed the design for the GTL process also designed the GTE process, which includes purification of the ethylene stream."

Although none of the technology has been deployed commercially to date, Synfuels is raising funds for a 140 MMscf/d GTL plant in Texas.