

When it comes to making the most of hydrocarbon resources, diversify and prosper is the best policy, argues **Andrew Jamieson**.

Qatar is blessed with huge hydrocarbon resources. After Russia and Iran, its gas resources are the third most abundant in the world. And even better, much of the gas is concentrated just off Qatar's northeast coast in the North Field, a field contiguous with the Iranian South Pars field. Together these fields constitute the single largest reservoir of non-associated gas – gas not associated with oil production – on the planet.

The North Field alone is estimated to contain more than 900 trillion standard cubic feet of recoverable reserves. And because it is located in relatively shallow water in the Gulf, the development of the field was relatively straightforward.

But getting the gas out of the ground is one thing. Moving it to the markets where it is needed is quite another. Two of the most popular gas transport options are pipelines, and liquifying the gas to produce liquefied natural gas (LNG), which can be shipped by sea in specially designed tankers. The choice of which option to select is largely down to basic economics.

The cost of building and maintaining pipelines is dependent on the terrain. It costs a lot to build a pipeline that has to travel over mountains, for instance. When pipelines have to cross over several countries to reach their destination, geopolitics can also come into play.

But where markets are fairly local – say, less than 2000 kilometres away – pipelines are often used. For example, pipeline gas now travels from Qatar to Dubai. Pipelines are also considered to be a good option when the gas reserves are located far from any seaport. Russia, for instance, relies on pipelines that travel over thousands of kilometres to transport gas from its vast onshore fields in Siberia, to markets in western Europe, because its main marine exits are a long way north of the Arctic circle, where ports are often ice-bound in the winter.

Like pipelines, the LNG option also requires significant capital investment, both to liquify the gas and to transport the product

to markets. LNG plants consist of one or more LNG trains – or production lines – where impurities are removed and the purified gas is condensed into a liquid by cooling it to temperatures lower than minus 160°C.

Qatar began establishing LNG production in the early 1990s to tap the gas from the North Field. LNG production in Qatar is now handled by two companies, RasGas and Qatargas.

RasGas, established in 1973, operates seven LNG trains, including two mega trains, along with a dedicated fleet of 27 LNG carriers.

Qatargas was originally formed in 1984 to operate three LNG trains. Its subsidiary, Qatargas Operating Company Limited, established in 2005 to form joint ventures with a number of foreign hydrocarbon companies, now operates a total of seven trains and a fleet of 42 LNG carriers.

Qatar began exporting LNG from the North Field in 1997. Today it is the world's biggest producer of LNG – and a major force in the world of hydrocarbon. In December 2010, Qatar celebrated achieving an LNG production capacity of 77 million tonnes per annum.

However, although LNG provides a convenient way to transport gas, the energy density of LNG is only 60 percent that of diesel and 70 percent that of petrol (gasoline). To take full advantage of the hydrocarbon market, diversification is important. Selling gas alone – even vast quantities of gas – is not the only way forward. The big potential for market growth is in oil products where oil-related pricing can be achieved.

DIVERSIFY AND PROSPER

This is why another transport and process option, gas to liquids (GTL), offers a such an attractive prospect for the Qatar hydrocarbons industry. Like LNG, GTL 'densifies' the energy to make it cheaper to transport.



KEEPING THE OPTIONS

OPEN

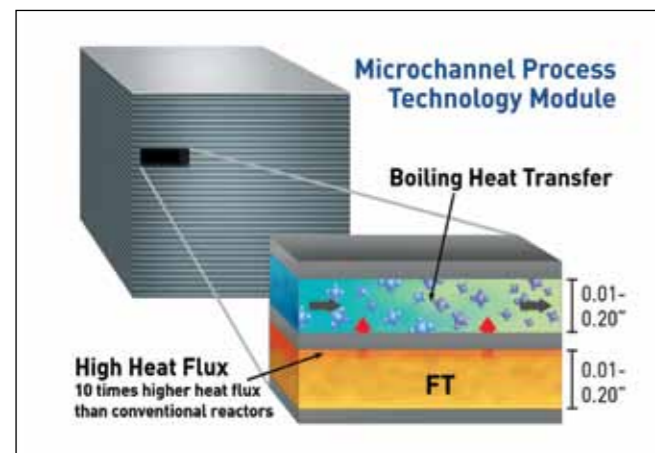
In principle, GTL products can be transported via existing petroleum infrastructure. But the main advantage of the GTL process is that it produces a synthetic crude oil that can be processed to make premium hydrocarbon products. These include very high quality waxes, high quality base oils for lubrication, a petrochemical feedstock that is used to make plastics, and normal paraffin, which is used to produce detergents. It can also be used to produce cleaner burning diesel and kerosene. Unlike conventional brown liquid diesel, the diesel produced from synthetic crude is highly paraffinic and very clear. It has a higher cetane number, giving better performance with low aromatic and sulphur content, and its excellent combustion properties means that it commands a premium price.

For Qatar, GTL has a lot to offer. It provides a way to diversify the use of Qatar's abundant gas resources while at the same time producing higher value petroleum products. This helps to explain why Qatar is now home to two new GTL plants, the Sasol Oryx plant, which began operation in 2007, and the Pearl plant, the largest GTL project in the world.

A joint development by Qatar Petroleum and Shell, Pearl is now in the commissioning phase, and is expected to start up in 2011. It is designed to produce 144,000 barrels per day (bbl/d) of GTL product, as well as 150,000 bbl/d of associated gas liquids. In total, Pearl is expected to process about three billion barrels-of-oil-equivalent over its lifetime.

But like all major projects, development of the Oryx and Pearl plants has not been entirely plain sailing, and the capital costs associated with these huge plants are very high. The Pearl development costs, for example, are estimated to range from US\$18 billion (QR65 billion) to US\$19 billion (QR69 billion).

In addition, the demand for cleaner fuels is leading to an increased global interest in GTL production. As a result, the GTL industry in Qatar could be joined by new production from countries such as Nigeria, where a consortium led by Chevron is constructing a large GTL plant, and Australia, which has large gas reserves to exploit. Further competition could also come from the United States (US), where huge shale gas resources are causing radical changes in the



US gas scene, leading to dramatic falls in LNG imports and massive redundancy of LNG import terminal capacity.

SMALL MIGHT BE BEAUTIFUL

With these developments in mind, what is the best way forward for expanding Qatar's gas production industry?

One answer could be to think small and consider the potential advantages of technologies such as microchannel reactors. Microchannel technology is a developing field of chemical processing that intensifies chemical reactions by reducing the dimensions of the reactor systems. In microchannel reactors the key process steps are carried out in parallel arrays of microchannels, each with typical dimensions in the range of 0.1 to 5 millimetres. It also improves performance by minimising heat and mass transport limitations – factors that limit the performance of conventional GTL reactors.

The capacity of microchannel reactor systems can be increased by simply 'numbering up', or adding additional reactors. This modular structure makes microchannel reactor systems very flexible, and offers many advantages when it comes to reducing the size and cost of the chemical processing hardware. It also allows for easy expansion of facilities.

For example, rather than having to make the huge capital investment to install heavy equipment from day one, operators could build a new GTL plant in a modular way, by starting small and then increasing capacity as and when needed.

Microchannel reactors could also prove useful for debottlenecking or for improving the efficiency of conventional plants and increasing the production of high value products. For instance, a microchannel reactor could be added to an existing reactor section to increase its productivity, or even to take its place so repairs can be carried out without losing production.

Small-scale GTL plants using microchannel reactors could also be the answer for capturing the value from streams of gas that are either too small or too remote to be captured and processed by conventional means. While they may not be the answer in every processing situation, compared to conventional large-scale GTL plants, microchannel reactors offer many new possible ways to exploit stranded hydrocarbon resources or flared gas.

STAYING AHEAD OF THE GAME

In an ever-changing energy market, it is important to be able to respond flexibly to market conditions. Success requires access to a wide range of processing options. Small-scale GTL using microchannel reactors is a strong contender because it offers a relatively inexpensive, quick and flexible way of incorporating GTL into the energy mix. It could well become the next big thing in clean fuels technology. ■

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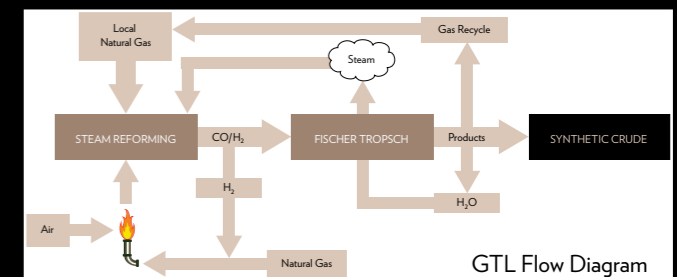
THE NORTH FIELD

The North Field, which extends into the Gulf from the northeast coast of Qatar, is the world's largest single non-associated gas field, or field that produces natural gas from a reservoir that contains only gas, rather than gas and oil. Discovered in 1971, the North Field contains more than 900 trillion cubic feet of gas, equivalent to around 15 percent of worldwide gas resources.

GTL - HOW IT WORKS

The GTL process involves two operations: steam methane reforming (SMR), to convert natural gas into a mixture of carbon monoxide (CO) and hydrogen (H₂) known as syngas, followed by Fischer-Tropsch (FT) synthesis to convert the syngas into a liquid fuel. In SMR, the methane gas is mixed with steam and passed over a catalyst to produce a syngas consisting of hydrogen (H₂) and carbon monoxide (CO). The reaction is highly endothermic, so requires the input of heat. This can be generated by the combustion of the excess H₂. The syngas is then converted into various forms of liquid hydrocarbons via the exothermic (heat producing) Fischer-Tropsch (FT) process, using a catalyst at elevated temperatures. The two conventional reactor types currently used for FT processes are fixed bed and slurry bed reactors. Shell's Pearl plant relies on fixed bed

reactors. In contrast, the Sasol plant uses a proprietary technology based on a liquid slurry bed reactor. Both reactor types have their drawbacks. The performance of fixed bed reactors is limited by heat transfer – a particular drawback for FT applications, because FT synthesis is exothermic (heat-generating) and strongly affected by temperature. In slurry bed reactors performance is limited by mass transfer. While the liquid slurry is quite efficient at heat removal, the liquid film surrounding the catalyst blocks the reactants (H₂ and CO) from quickly reaching the catalytic sites. This problem with mass transfer limits their performance. The use of microchannel reactors would help to overcome these limits.



All illustrations courtesy of the Oxford Catalysts Group.