Greenhouse gas to liquid asset

Converting gas to methanol can commercialise stranded gas fields, including fields with high CO_2 content, while also providing relatively clean fuels. By **STEVE ROTHERHAM**

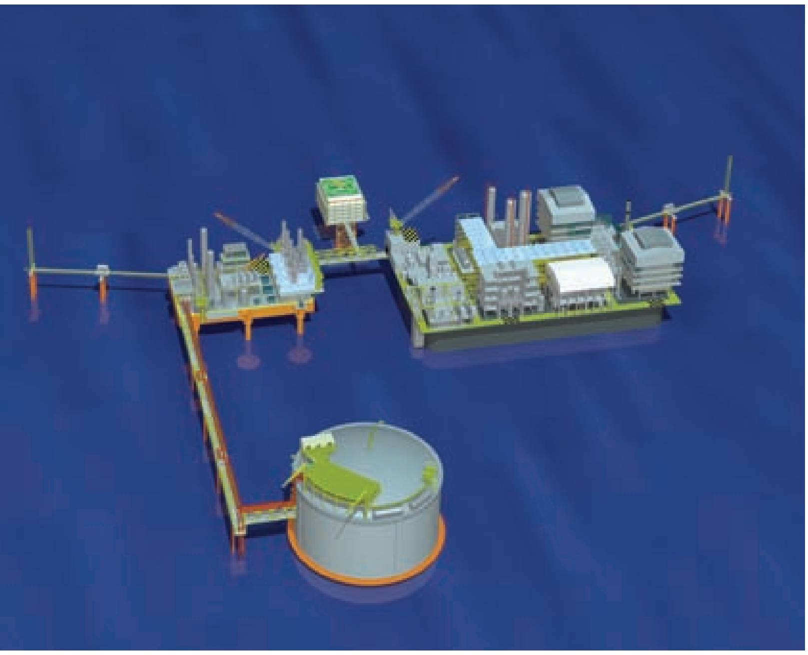
Methanol synthesis, the least complex and least expensive gas-to-liquids technology, produces a versatile and in-demand liquid product.

Methanol's most common use is as a chemical feedstock in manufacturing products such as adhesives for medium density fibre (MDF) and plywood, paints, resins, PET bottles, plastics, silicones, solvents, window cleaners and synthetic textiles. About 60% of the world's methanol is used in this way. The bulk of the balance is used in various fuel applications.

Methanol is a clean fuel with zero-sulfur that can be economically burned in gas turbines to generate electricity. It can also be used as an octane enhancer in petrol and is necessary in the production of biodiesel. As the world's use of biofuels rises, so does the demand for methanol.

The growing fuel cell market is another promising application with potential for substantial future growth, according to MEO Australia, a Melbourne-headquartered firm previously known as Methanol Australia.

Methanol holds a lot of energy by weight and volume, and being a liquid it's easy to transport and store.



An artist's impression of MEO Australia's planned Tassie Shoal Methanol Plant project

"As a liquid at ambient temperature and pressure, methanol carries more hydrogen per unit volume than liquid hydrogen, and unlike LNG [liquefied natural gas], doesn't need extremes of high pressure or low temperature for compact storage", MEO managing director and chief executive Jürgen Hendrich said. "This simplifies and reduces the cost – not only on board a vehicle but also in the fuel distribution system."

A commodity whose time has come

There has been a lot of talk about a future hydrogen economy, but little recognition that a partial methanol economy could be an important stepping stone towards the goal of improved energy security, especially for transport fuels.

Methanol is considered to be much safer than hydrogen – while hydrogen is notoriously combustible, methanol is not nearly as volatile or as flammable as gasoline. A methanol fire releases heat at a much lower rate than hydrogen or gasoline and can be extinguished with water. This has led several associations administering high-risk motor sport events, such as the Indianapolis 500, and US sprint car, dirt track and drag racing series, to require that the vehicles be fuelled by methanol.

This doesn't mean that methanol will be a common vehicle fuel in the near future. Like its chemical cousin, ethanol, it is corrosive to some metals, including aluminium (but not steel), as well as rubbers and some plastics. While pure methanol can't be used in standard cars without major modifications, around 4 million tonnes per annum (about 10% of the global market) is currently being blended into petrol in the rapidly growing Chinese market.

Fuel requirements are expected to grow from the current 10% to around 25% by 2011, boosting total demand for methanol to more than 50MMtpa. The development of methanol fuel cells could one day see methanol being used in many new applications, including consumer electronics and perhaps eventually vehicle engines.

Direct methanol fuel cells (DMFCs) feed methanol directly into the fuel cell. Current DMFCs are limited in the power they can produce, but they can effectively store a lot of energy in a relatively small space and light weight. This means they can produce a small amount of power over a long time, making them suitable for energy-efficient consumer electrical products such as laptops, mobile telephones and cameras.

Numerous organisations are working on refining DMFCs. Earlier this year, Sharp said its latest prototype DMFC had a longer continuous-use life span than a same-size lithium ion battery. In the same week, Massachusetts Institute of Technology said researchers had managed to boost the power output of a methanol fuel cell by 50% by improving the membrane material that sits between the cell's anode and cathode. SFC Smart Fuel Cell AG sells DMFC auxiliary power packs for boats, caravans and other mobile and remote applications, including military battlefield communications.

DMFCs are not yet well suited for powering vehicles, but several major corporations, including Mercedes and Chrysler, are working on addressing this.

But even if advances in DMFC technology come more slowly than expected, world methanol demand is strong enough to support a number of major new projects.

Emerging markets

Another and probably larger potential market is for conversion of methanol to olefins (MTO) for poly-ethylene (PE) and poly-propylene (PP) manufacture.

The bulk of olefins (ethylene and propylene) are currently produced by catalytic cracking of naphtha (derived from crude oil and condensate associated with some natural gas fields) and ethane (a component of some natural gas fields).

Feedstock supply of ethane is of great concern to the plastics industry. Supplies are diminishing due to production decline of ethane-rich gas fields and the blending of ethane with liquefied natural gas to enhance its heating value.

Methanol can readily be converted to ethylene and propylene without producing complicated by-products. Several plants using this route are being built in China.

Another final emerging large new market for methanol is dimethyl ether (DME), which is used on a small scale as an aerosol propellant, but on a much larger scale for blending with LPG (liquefied petroleum gas, predominantly propane and butane) and diesel. China's estimated DME production of 4.4 million tonnes in 2008 (up from 2.2MMt in 2007), will require more than 6MMt of methanol.

Market prices

Methanol prices are currently at about $US500 per tonne, up from about $US300/t two years ago, and MEO argues high prices are here to stay.

"Methanol projects around the world have been facing increasing competition for low-cost gas feedstock, even in remote locations, from LNG projects which have product selling prices approaching oil energy parity," Hendrich said.

"This has restricted new supplies of methanol while demand growth of between 4 and 5 per cent per year has been well above world average GDP. The main growth in production has been in China where coal-based plants are now being squeezed by higher coal prices."

Offshore methanol production

MEO and another Australian petroleum player, Coogee Resources, are making separate plans for innovative methanol projects.

While other companies are planning or developing floating liquefied natural gas (FLNG) production systems, Coogee would prefer to convert gas to methanol before offloading it to shuttle tankers, as methanol production is less complex and therefore less expensive than LNG production. It is also cheaper to transport than LNG because it doesn't require specialised refrigerated shipping.

Coogee's sister company, Coogee Chemicals, has a decade of experience in methanol production at its Laverton, Victoria, plant.

Floating processing, storage and offtake (FPSO) technology has been used in deepwater oil production for three decades and Coogee says this concept of a ship-based production and processing system (MFPSO) could be adapted to exploit stranded gas fields.

Coogee Chemicals and Mogal Marine (in conjunction with Mitsubishi Corporation) own the intellectual property for an MFPSO and are actively pursuing opportunities for the commercial application of this technology to offshore stranded gas fields.

Tassie Shoal Methanol Project

Australia's most advanced offshore methanol project is MEO's Tassie Shoal Methanol Project (TSMP), which is planned to be located about 275km north-northwest of Darwin in an area of shallow water known as Tassie Shoal.

Most discovered gas resources in the eastern Timor Sea have high carbon dioxide content. This has always hampered the economics of conversion to LNG, which will be further exacerbated by the looming carbon tax. The company says methanol production will allow it to commercialise large quantities of the region's CO_2-rich gas.

TSMP is targeting exports to rapidly growing Asian markets. With its main competitors being in Chile and the Middle East, TSMP has a significant competitive advantage in terms of shipping times and transport costs, according to MEO. Its location in the heart of the CO_2-rich gas fields avoids the need for a billion dollar gas pipeline to shore which would kill the economics of any gas project including LNG.

Syngas production benefits from CO_2

To make methanol, one must first produce "synthesis gas". Producing this gas from methane results in a relative shortage of carbon atoms and a relative excess of hydrogen atoms.

Three molecules of hydrogen are produced for every molecule of carbon monoxide, but methanol synthesis consumes only two molecules of hydrogen for every one molecule of carbon monoxide. One way of using this excess hydrogen is by injecting CO_2 into the methanol synthesis reactor where it will react with the hydrogen to form methanol.

So starting with gas that has up to 30% carbon dioxide is actually the optimal for methanol production.

"The particular process we plan to use to make methanol benefits from the presence of CO_2 in the feed gas, enabling us to monetise gas resources with high levels of CO_2 that would otherwise be non-commercial," Hendrich said.

CO_2 to methanol attracts big players

MEO's plans to use CO_2 as a positive input in producing a valuable commodity have prompted both enthusiasm and scepticism. But other companies recognise that the idea is feasible.

In August, Japan's Mitsui Chemicals announced it would invest

$US13.6 million to build a pilot facility to combine hydrogen with about 150-160 tonnes of CO_2 emitted from a plant in Osaka to produce 100t of methanol per annum and reduce greenhouse emissions. It will be the world's first such plant, the company said.

Mitsui will start construction of the plant inside the firm's Osaka facility in October this year, with the plant scheduled to be completed in February.

But Mitsui was a comparatively late convert. MEO won the support of a major corporation years ago, when industrial gases giant Air Products and Chemicals became a 50:50 partner in the TSMP.

"Air Products is well known as an LNG technology supplier, but it also has an extremely strong position in the industrial gases markets, especially hydrogen and the 'synthesis gas' technology used to make it," Hendrich said. "MEO has sought to build alliances with the world's best technology providers – like Air Products – to ensure that the risks of our projects are minimised."

MEO's and Air Products' plans for two 1.75MMtpa plants are somewhat grander than Mitsui's 100t of methanol per annum.

TSMP consists of two world-scale methanol plants placed on concrete gravity-base structures in a shallow part (about 14m water depth) of the Timor Sea known as Tassie Shoal. Essentially, these plants will be sited on artificial islands.

Each plant requires about 1.4 trillion cubic feet (Tcf) of raw gas – including carbon dioxide – to produce 1.75MMtpa of methanol for 20 years of operation.

The first plant could be commissioned and operational by 2013. The second concrete gravity structure and methanol plant could be installed about four years later subject to confirming adequate gas resources.

MEO has had environmental approvals in place for this proposal since 2002. The problem has been securing sufficient gas supplies.

The ideal gas feedstock would be the Santos-operated Evans Shoal gas field located some 7km from Tassie Shoal. MEO was a previous co-owner of the field and secured Shell as a partner to drill the successful Evans Shoal-2 well in the late 1990s. It subsequently sold the field in order to concentrate on the large gas processing projects.

Early this year, MEO declared the Heron and Blackwood gas discoveries in its NT/P68 exploration permit about 70km southwest of Tassie Shoal.

It is estimated that the Heron has the potential for up to 5.5Tcf gas-in-place with the potential for low-moderate levels of CO_2, while the greater Blackwood structure including Blackwood East holds about 2Tcf of gas in place, about 30% of which is CO_2. Further appraisal drilling is planned in 2009 to follow up these discoveries.

Following these discoveries, MEO accelerated the selection process to identify and secure a casting basin site in Southeast

MEO's proposed LNG project

Asia for construction of the concrete gravity-base structure. It also began moving towards the start of front-end engineering and design studies for the TSMP, which are expected to begin within a year.

In addition to the TSMP, the company has environmental approvals for a 3MMtpa LNG plant – Timor Sea LNG Project – to be co-located with the methanol operation. MEO says the methanol and LNG operations could complement each other in their use of CO_2 as well as sharing other process synergies.

If the company accessed gas with a CO_2 content of say 10-15%, it could use that gas to feed both the methanol and LNG operations, taking the carbon dioxide from the gas stream supplying the LNG plant – about 400 million cubic feet per day – and combining it with the raw gas stream going to the methanol plant (about 185MMcf/d) to increase the CO_2 content to the optimal level of about 25%.

MEO says this scenario would enable it to produce 3MMtpa of LNG and 1.75MMtpa of methanol with minimal CO_2 emissions. For the proposed LNG project, MEO must secure a substantial gas resource with low to moderate CO_2 levels.

Given the eastern Timor Sea is characterised by gas with moderate to high levels of CO_2, MEO's main focus remains on developing a world-class methanol operation.

"We are extraordinarily well placed to rapidly monetise any gas resource – especially high-CO_2 gas – that we confirm or access via third parties within our Timor Sea area of interest," Hendrich said.

"We can offer owners of third-party gas an attractive price for their CO_2-rich gas that would otherwise be economically challenged. Alternatively, we can sanitise their modest CO_2-content gas for LNG production at their own liquefaction facilities or use our proposed Timor Sea LNG project that has its full environmental approvals."