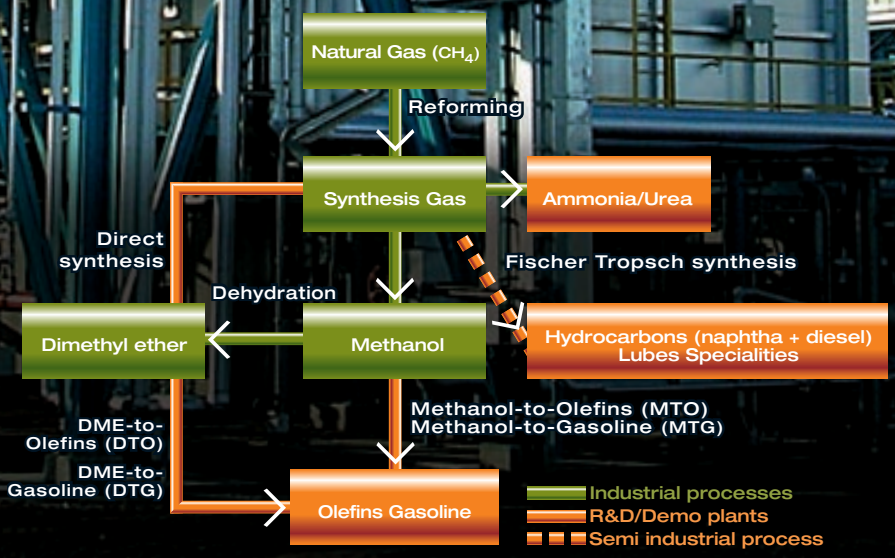
A HIGHLY EFFICIENT GTL PROCESS

Among the various processes for chemical conversion of natural gas, direct synthesis of DME "destroys" the least amount of gas, making it highly efficient. The thermal efficiency of the process developed by Japan's JFE is 65 to 70%, higher than the conventional Fischer Tropsch process.



Dimethyl Ether (DME)
Energy for the Future

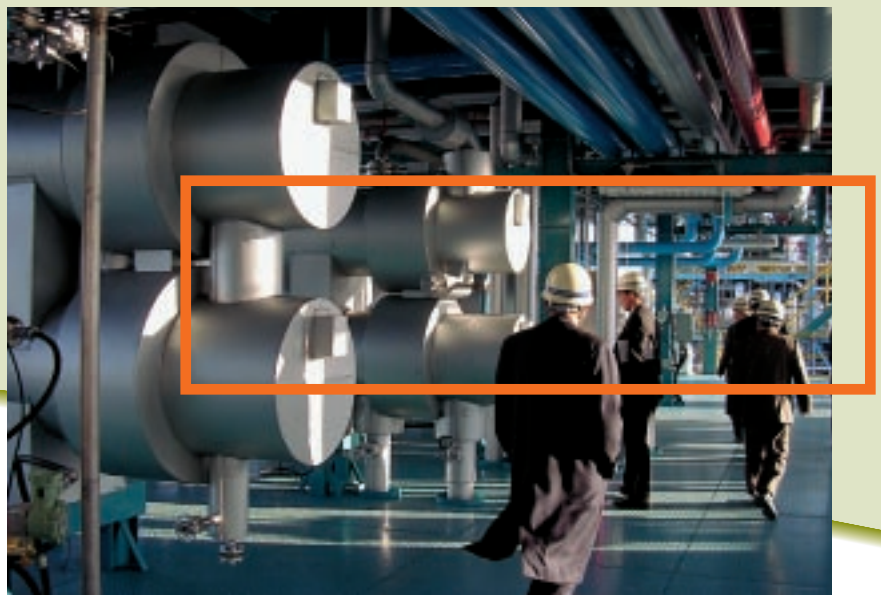
TOTAL S.A.
2, place de la Coupole
La Défense 6
92400 Courbevoie, France
www.total.com

Dimethyl Ether (DME)
Energy for the Future

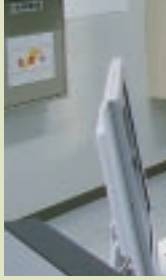
Total is an active participant in research to develop new gas-to-liquids (GTL) processes to obtain automotive fuel, olefins and other liquids from natural gas.

DME, Energy for the Future

Natural gas is already used as a feedstock in a variety of chemical conversion applications, in particular to produce ammonia, urea and methanol. Dimethyl ether, or DME, is currently produced by dehydration of methanol from natural gas. At present, it is used on a very small scale – around 150,000 metric tons a year – mainly as an aerosol propellant in the cosmetics industry.



DME is a clean, colorless gas that is easy to liquefy and transport. It has remarkable potential as a fuel for power generation, in domestic applications, or for diesel vehicles. Total is therefore working to develop a more energy-efficient, environmentally-friendly direct synthesis process and a comprehensive supply chain. This process is part of an assertive strategy to find new outlets for our natural gas resources and to develop the automotive and other fuels of the future.



Significant Potential in Three Major Markets

Power Generation

Already approved by manufacturers such as Mitsubishi, Hitachi and General Electric as a fuel for their gas turbines, DME is an efficient alternative to other energy sources for medium-sized power plants, especially on islands or in isolated regions where it can be difficult to transport natural gas and where the construction of liquefied natural gas (LNG) regasification terminals would not be viable.

DME is transported at a temperature of -25°C, making it easier to handle than LNG, which is shipped at -163°C. Its use would reduce costs across the supply chain because existing LPG infrastructure could be utilized.

Domestic LPG Substitute

Likely to have a generally more attractive price structure than LPG, DME can be blended in a proportion of 15 to 20% in LPG, without necessitating modifications to equipement or distribution networks.

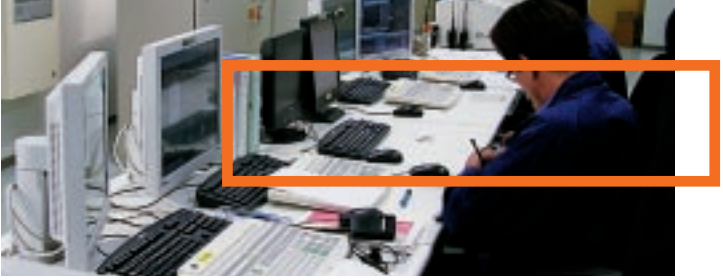
Automotive Fuel

Often described as “diesel LPG,” DME is a future automotive fuel solution. Promoting its use in captive corporate and public fleets would initially reduce the problems of developing a clean distribution network, while taking advantage of its high cetane number and its environmental benefits, such as no particulate or sulfur emissions. In addition, few engine modifications would be required.

Taking a Technical and Marketing Approach to Developing DME

The only international oil company that is a stakeholder in the project, Total has acquired an interest in two joint ventures led by Japan’s JFE (formerly NKK), with eight other co-venturers[1] . The first joint venture, DME Development Co. Ltd., is working to validate a direct synthesis process in a demonstration plant in Kushiro, on the island of Hokkaido in Japan. The second, DME International Corp., is identifying and building the potential DME market in order to determine the economic feasibility of an industrial unit near gas resources.

[1] Nippon Sanso, Toyota Tsusho, Hitachi, Marubeni, Idemitsu Kosan, INPEX, LNG Japan and Japan Petroleum Exploration



Three Years of Tests to Optimize the Production Process

With a capacity of 100 metric tons per day, the demonstration unit is already much larger than existing production facilities for the cosmetics industry. It will be used to define the design parameters of a future industrial unit and the most appropriate operating procedures.

The current focus is on:

- Validating the natural gas reforming process, which uses recycled CO_2 as a feedstock.
- Optimizing the reaction and the cooling of the synthetic gas produced by the auto-thermal reformer.
- Validating catalyst performance in order to ensure long-term operation.
- Determining optimum operating procedures to ensure continuous operation.

A number of tests are scheduled through 2005 before optimization in 2006.
Two-thirds of the corresponding budget of approximately $200 million is provided by the Japanese Ministry of Economy, Trade and Industry (METI).

An attractive price structure

"Creating a complete, stable DME chain should meet the legitimate concerns of end users in terms of supplier relationships and of availability and security of supply. In particular, it would provide Japan and other Asian countries where demand is fast-growing, such as China and India, with greater long-term visibility on the price of imported fuel than is currently the case for LPG."

Jean-François Rondenay
Asia Projects Manager, Total Gas & Power

REMARKABLE PHYSICAL AND ENVIRONMENTAL PROPERTIES

With a calorific value comparable to liquefied petroleum gas (LPG), DME (CH_3-O-CH_3) is generally suitable for similar applications. Biodegradable and non-corrosive, as a diesel fuel it has a higher cetane number than conventional automotive diesel.

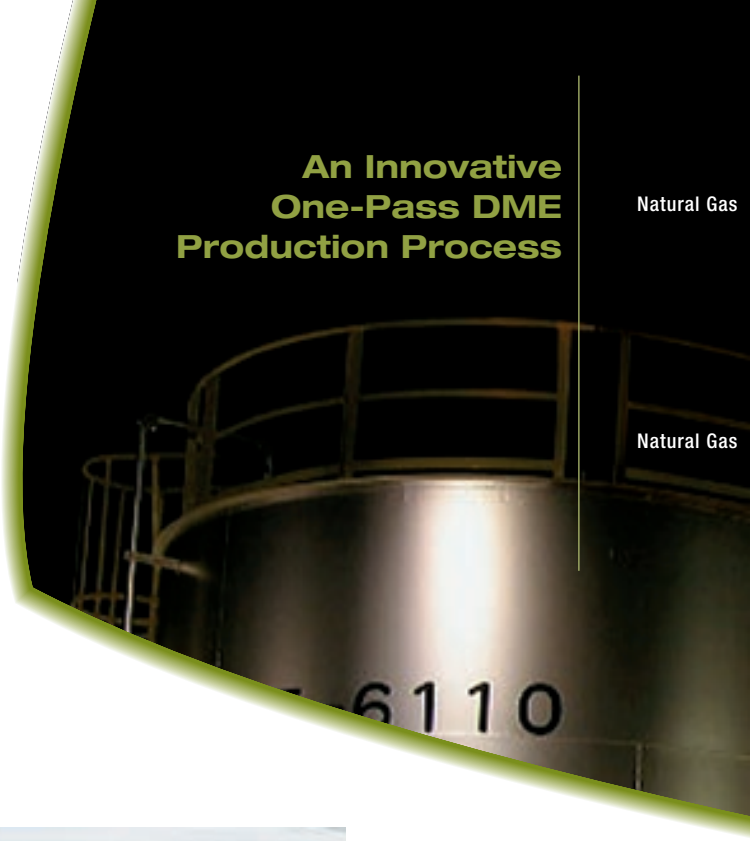
PROPERTIES	DME	PROPANE	N-BUTANE	METHANE	DIESEL
Net calorific value (Kcal/Ncu.m.)	14,200	21,800	28,300	8,600	-
Cetane number	55 to 60	5	10	-	40 to 55
Liquid density (g/cu.m at 20°C)	0.67	0.49	0.57	0.42	0.84
Boiling point (°C at 1 atm.)	-25	-42	-0,5	-162	180 to 370

Cross-functional expertise

"In addition to our financial participation, our other significant contribution to the DME project is validating the technical and marketing options tested. We are also providing our partners with expertise that spans the entire gas chain, from production to consumption, as well as recognized skills in the areas of project management, process development and optimization, and production unit operation.
The technical cooperation between Total and our partners is based on internal coordination of the combined capabilities of our various businesses."

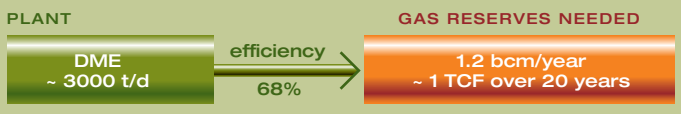
Aurélie Ménahèze
DME Project Engineer, Total

An Innovative One-Pass DME Production Process



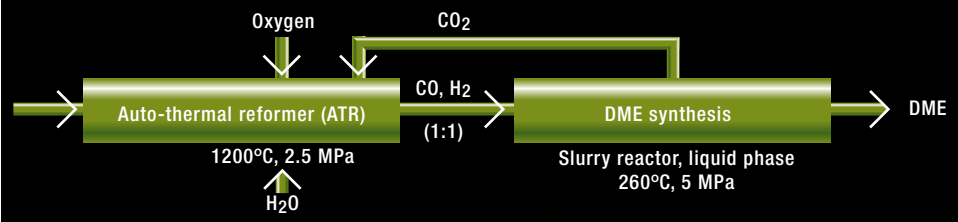
Ensuring Financial Viability to Support Success

While the technical tests are being carried out, DME International is conducting an overall feasibility study concerning the construction of a commercial unit with a capacity of 3,000 to 6,000 metric tons per day by the end of the decade. The work involves a more detailed assessment of the corresponding capital expenditure, including a comparison of the respective advantages of a number of potential sites in gas-producing countries (gas access and transportation costs, optimizing pricing formulas) and more accurate forecasts of market growth rates in the three major applications considered for DME.
Japan is expected to be the first market in which DME breaks through, given the country's geography, the public authorities' support for DME, the involvement of local partners and the deregulated energy market. Japan, which imports 80% of its primary energy, wants to diversify its energy mix and reduce the cost of supply. At present, imports account for 14 million of the 19 million metric tons of LPG consumed.
The main objective of the joint venture partners is to identify major outlets in terms of power generation or domestic applications that can be used as a foundation for an initial DME chain and to make the first production unit profitable.

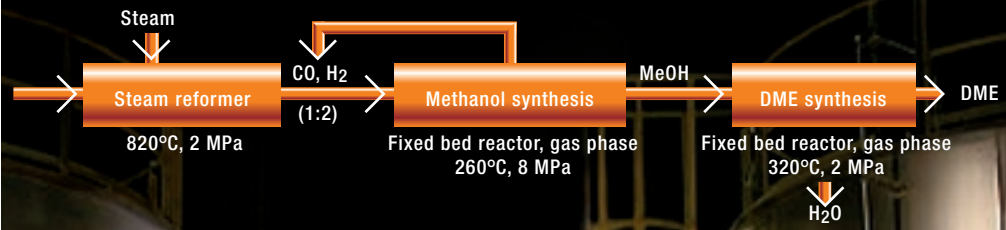


DME, which rounds out the existing product offering without radically altering current gas marketing practices, is aimed at niche markets requiring smaller-scale units than those dedicated to other GTL production and smaller gas reserves than LNG projects.

A new, patented one-step process developed by JFE



The conventional two-step process



More efficient than conventional two-stage processes entailing dehydration of methanol, the direct technology tested in the demonstration unit recycles the CO_2 and the methanol that are also produced, thereby enhancing process efficiency and reducing greenhouse gas emissions and liquid releases. In addition, using a one-pass synthesis reactor would reduce capital costs.

A promising process, developed in line with stringent standards

"Our participation in the project reflects our commitment to investing in research on fuels of the future, notably by comparing the DME and LNG chains in terms of energy efficiency, environmental stewardship and return. These two fluids have similar properties in terms of greenhouse gas emissions, and the corresponding processes are both likely to contribute to the development of natural gas. Total has significant reserves of this energy of the future.
When operating the demonstration unit and designing the planned industrial unit, we pay close attention to meeting very stringent health, safety and emission control standards. We also contribute our expertise in the area of industrial risk analysis and management."

Jean-Paul Gourlia
Health, Safety and Environment Manager, Total Gas & Power