

Global Dimethyl Ether Emerging Markets

April 20, 2007



DME (dimethyl ether) Pros & Cons ...

Pros

- It's a clean burning synthetic fuel that can be substituted for liquefied petroleum gas (LPG), as a blended fuel, or reformed into hydrogen for fuel cells. DME is currently used as an aerosol.
- Excellent thermal efficiency among all syngas-to-products.
- Economical for transportation and storage in the case where large LNG investment is not economical.

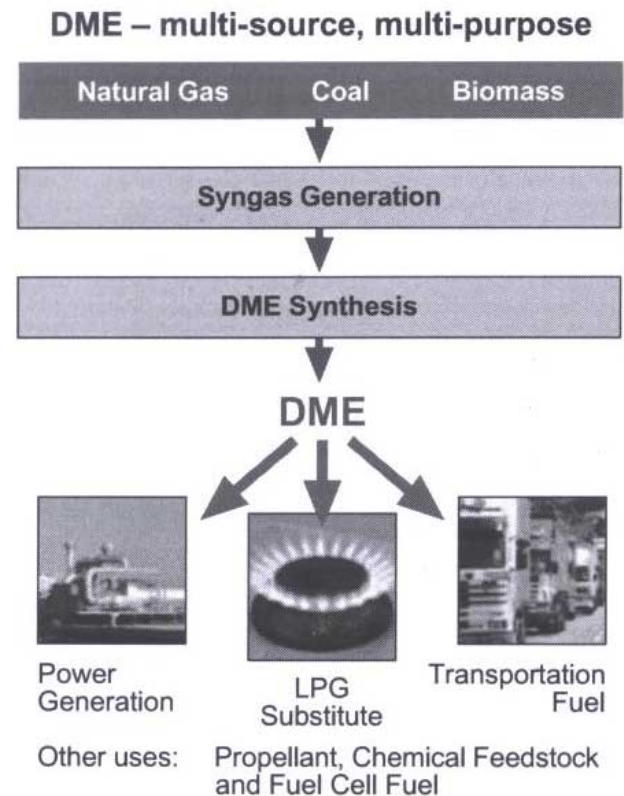
Cons

- Compared to diesel and/or gasoline it's lower density and energy value make it less desirable as a transport fuel.
- Production cost via 1 or 2 step MeOH dehydration is higher than for MeOH.



Markets for DME ...

- Aerosol – current market (1993)
- LPG – commercial alternative
- Diesel – emerging market (>2010)
- Power Generation – development stage
- Fuel Cells – development stage
- Petrochemical Feedstock – development stage



Future Potential Markets for DME ...

DME to Olefins

- JGC, Idemitsu (DTO), Lurgi, UOP/Arkema (MTO) projects in development
- Idemitsu has an interest in DTO development for petrochemical plants

Asia has the largest potential DME market as a domestic fuel

- Chinese government regulations from the NDRC in July 2006 have banned any coal-based DME projects with a design of capacity lower than one million tons.
- The largest market for DME is Asia where the capacity has steadily increased and will continue to grow with new plants constructed for the domestic fuel market. Plans for construction of new plants in Japan, Iran, and New Guinea are currently under consideration.



Existing Onstream DME Capacity...

Company	Location	Capacity	Start Up Date	Use	Engineering
Shanxi Yuci Jiaxin New Energy Chemical Co (1)		10,000 mt	1993	Domestic Fuel	
Henan Qingyang Nitrogenous Fertilizer Plant (2)		10,000 mt	1993	Domestic Fuel	
Guangdong Zhongshan Kaida (3)		10,000 mt	1994 (December)	Aerosol	
Luthianhua Group (4)(61)	Luchang	10,000 mt	2003	Domestic Fuel	Toyo Engineering
Shandong Jiutai Science and Technology Co (17)(53)	Linyi, Shandong	30,000 mt and now 150,000	2003 onstream and capacity increased to 150,000 ton in 2005	Domestic Fuel	
XinAo Group (7)	Bengbu, Anhui	10,000 mt	2005 (December) Pilot Plant	Domestic Fuel	



PRC Onstream Projects ...

Company	Location	Capacity	Start up date	Use	Engineering
Luthianhua Group ⁽⁵⁾⁽⁶⁰⁾	Szechuan	110,000 mt	2006 onstream	Domestic Fuel	Toyo Engineering
Shandong Jiutai Science and Technology Co ⁽¹⁸⁾⁽⁵²⁾	Guangzhou, Guangdong	200,000 mt	2006 (December) onstream	Domestic Fuel	
Yigao Chemical Co ⁽³²⁾⁽⁶²⁾	Inner Mongolia	20,000 mt	August 2006 wet commission	Domestic Fuel	
Lantian Chemicals (Meishan Lantian Chemicals) ⁽²⁶⁾	Nanchong, Sichuan	20,000 mt	12-24-2006 onstream	Domestic Fuel	
Shanghai Coking & Chemical Corp (Shangai Huayi Group) ⁽¹⁴⁾	Shanghai	5,000 mt	Onstream 2006 (April)	Domestic Fuel	



PRC Onstream Projects ...

Company	Location	Capacity	Start up date	Use	Engineering
Hubei Cocause Industrial Group (15)(55)	Jingmen	100,000 mt	2007 operation (February)	Domestic Fuel	Advantage of having water resources in close proximity such as Han River and use of existing equipment and facilities to offset costs.



PRC Downstream Confirmed Expansion Projects ...

Company	Location	Capacity	Start up date	Use	Engineering
Shanxi Lanhua Clean Energy (75% share) and Huayang Group (25% share) <small>(12)(45)(61)</small>	Jincheng, Shanxi	140,000 mt	2007 (end year) estimated start of operations	Coal based to produce DME as domestic fuel and aerosol propellant.	Toyo Engineering is providing process design, supply catalyst and technology services.
Hubei Cocause Industrial Group <small>(15)(55)</small>	Jingmen	100,000 mt	2007 operation (February)	Domestic Fuel	Advantage of having water resources in close proximity such as Han River and use of existing equipment and facilities to offset costs.
XinAo Group <small>(9)(58)</small>	Shanghai	200,000 mt	2007 (end year)	Domestic Fuel and Methanol	
Hubei Zhongjie <small>(16)</small>	Hubei	100,000 mt	2006 (July) construction started and estimated onstream 2007	Domestic Fuel	



PRC Downstream Confirmed Expansion Projects ...



Company	Location	Capacity	Start up date	Use	Engineering
Guizhou Tianfu Chemical ⁽²⁴⁾	Machangping Fuquan, Guizhou Province	180,000 mt	2008 estimated onstream Contract award announced on January 10, 2007.	Methanol	Haldor Topsoe is licensing the DME technology that was developed in collaboration with Petrochemical Research & Technology Co (Tehran) Methanol and Ammonia will also be produced using Haldor Topsoe technology. Raw methanol from the methanol plant will be used as feed for the DME plant.



PRC Downstream Confirmed Expansion Projects ...

Company	Location	Capacity	Start up date	Use	Engineering
Shenhua Ningmei Group/Ningxia Coal Group (Ningxia Ningmei Group & Shenhua Group merged in May 2006) <small>(10)(56)(57)</small>	Ningxia, Inner Mongolia	210,000 to 830,000 mt (by 2009)	(February) expected to come onstream in 2009.	Domestic Fuel	Toyo Engineering to license, basic design and supply catalysts.Siemens gasification equipment (also first major gasification contract since Sustec acquisition)
Yunnan Riches Chemical Industry ⁽²⁵⁾	Yunnan Province China	167,000 mt	2008 estimated onstream Contract award announced 01-10-07.	Domestic Fuel	Haldor Topsoe is licensing the DME technology that was developed in collaboration with Petrochemical Research & Technology Co (Tehran). The facility will include a Haldor Topsoe sulfuric acid unit



PRC Downstream Confirmed Expansion Projects...

Company	Location	Capacity	Start up date	Use	Engineering
XinAo Group Corp ⁽⁸⁾⁽⁵⁴⁾⁽⁵⁹⁾	Inner Mongolia Langfang, Bengbu, Yantai, Luoyang (four different plant locations)	400,000mt (four plants with 100,000 DME output in each)	Construction started summer 2006 and estimated onstream in 2009. Approved by NDRC in April 2006.	Domestic Fuel	
Shangdong Jiutai Chemical Group ⁽²⁰⁾⁽⁵³⁾	Inner Mongolia	1,000,000 mt	2009 estimated onstream	Domestic Fuel	GE gasification technology
Yankuang Group ⁽³³⁾		200,000 mt	2009 Estimated onstream	Domestic Fuel	
Sichuan LuTianHua ⁽⁶⁾	Luzhou	110,000 mt	2006 (March) expected to come onstream in 2010.	Domestic Fuel	Toyo Engineering to design plant and supply catalyst.



PRC Downstream Confirmed Expansion Projects...



Company	Location	Capacity	Start up date	Use	Engineering
Shenergy Group Ltd, Inner Mongolia Manshi Coal Group, China National Coal Group, Sinopec ⁽²²⁾⁽⁵⁰⁾⁽⁵¹⁾	Inner Mongolia	3,000,000 mt	2010 estimated onstream	Domestic Fuel	
Yuanxing Alkali ⁽²³⁾	Inner Mongolia Autonomous Region	3,000,000 mt	Planning (08-11-2006) estimated onstream 2011	Coal being used as feedstock. A successful trial 20,000 tpa DME project was completed the first week of 08-2006 at Yangxing.	Sasol Technology



PRC Announced Unconfirmed Projects...

Company	Location	Capacity	Start up date	Use	Engineering
Shangdong Jiutai Chemical Group (19)(53)	Tianjin, Northern China	3,000,000 mt	Agreement Signed With Local Government in August 2006. Announcement with further details anticipated in November 2006 and no announcement as of 02-26-07 has been made.	Domestic Fuel	Company has own technology that cuts costs RMB 3,000 (USD \$375) per ton
Synthesis Energy Systems and Golden Concord Holdings (62)(63)	Inner Mongolia	150,000 mt	Planning 2007 (Coal-to-DME)	Domestic Fuel	
Sinkiang ⁽¹³⁾			2006 Feasibility Study	Domestic Fuel	



PRC Announced Projects...

Company	Location	Capacity	Start up date	Use	Engineering
Shanxi Sanquan (11)		100,000 mt	2006 Planning	Domestic Fuel	
Tiacheng Technology (21)		200,000 mt	Planning 2007	Domestic Fuel	
Lanhua Group (30)	Shangdong	1,000,000 mt	Unconfirmed	Domestic Fuel	
Mengda Group (31)	Inner Mongolia	1,000,000 mt	Unconfirmed	Domestic Fuel	



International DME Projects...

Company	Location	Capacity	Start Up Date	Use	Engineering
Zagros Petrochemical ⁽²⁹⁾	Assaluyeh	800,000 mt	Will become onstream in 2007.	Domestic Fuel	Petrochemical Research & Technology under contract for detailed engineering and Haldor Topsoe for technology license.
Mitsubishi Gas Chemical, ITOCHU, Japan Petroleum Exploration, Taiyo Oil Company, Total, Toyota Tsusho, JGC Corporation, Mitsubishi Heavy Industries, Mitsubishi Chemical ⁽²⁷⁾	Niigata	80,000 mt (with max capacity of 100,000)	2007 feasibility planning and estimated onstream June 2008	Aerosol Domestic Fuel	JGC Corporation



International DME Projects...

Company	Location	Capacity	Start Up Date	Use	Engineering
Japan DME (Mitsubishi Gas Chemical, ITOCHU, Mitsubishi Heavy Industries) ⁽²⁸⁾	Papua New Guinea	1,000,000 mt	Feasibility Study announced March 1, 2007 and if commercialized projected onstream in 2011.	Domestic Fuel	JGC Corporation



International DME Projects...

DME projects are being planned in Japan, New Guinea, and Iran. The Zagros plant in Iran is scheduled to come onstream in 2007 and has a annual capacity of 800,000 mt. The plants in Japan and New Guinea are newly proposed and still in undergoing feasibility studies.

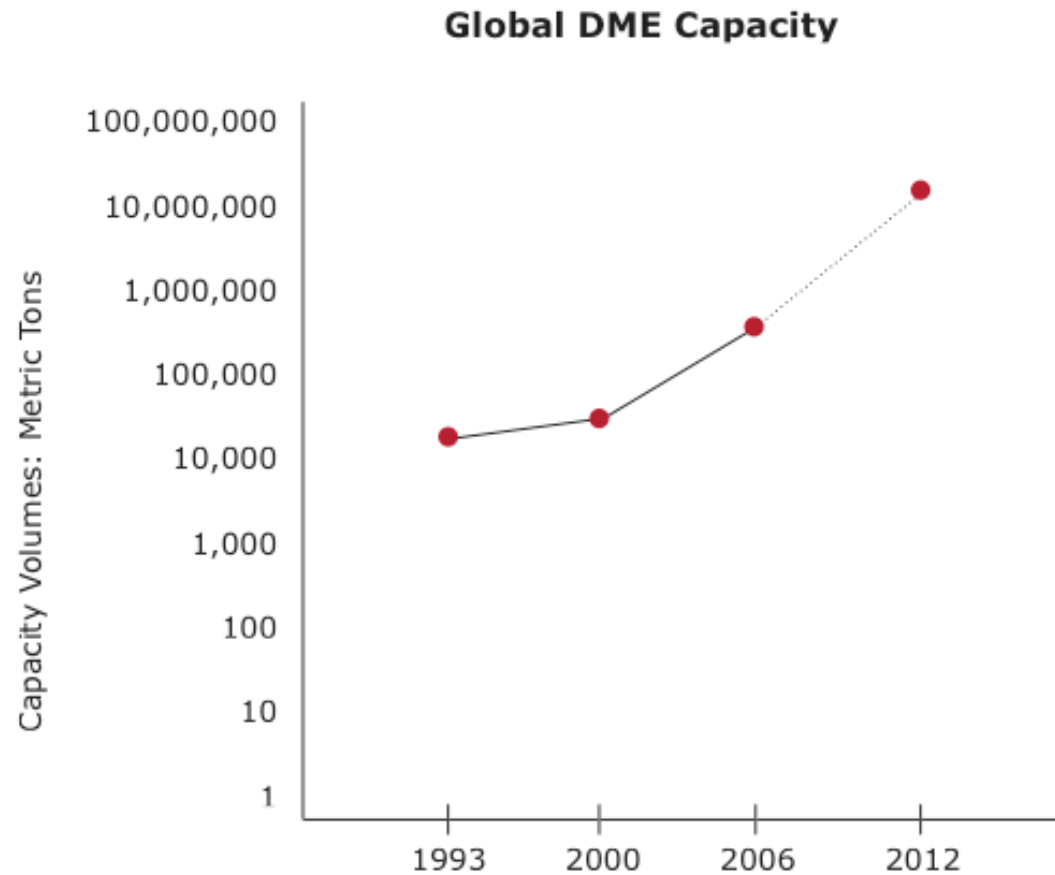
Forecasted 2012 Global Capacity

- China Capacity = 9,437,000 mt
- Other Capacity = 1,880,000 mt

- Total Global Capacity = 11,317,000 mt



Global DME Capacity...



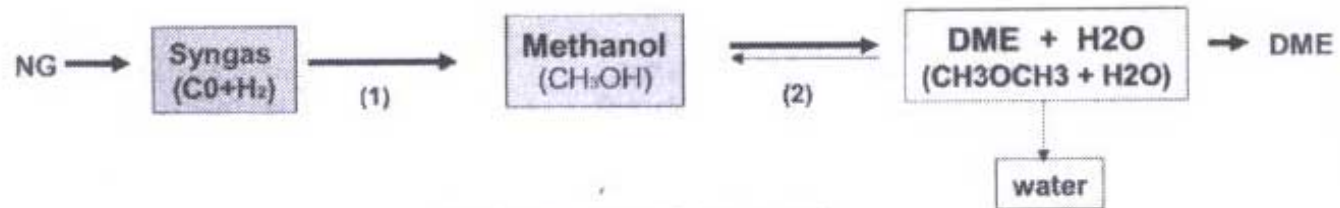
1993 Capacity = 20,000 mt
2000 Capacity = 30,000 mt
2006 Capacity = 545,000 mt
2012 Capacity = 11,317,000 mt



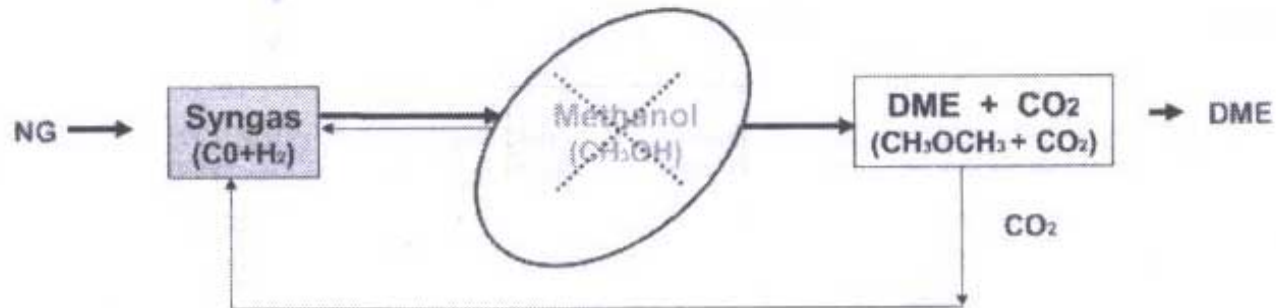
Technical Challenges ...

- Most DME plants are small and lack the capacity to be economically competitive in the fuel market for commercialization to liquid fuels.
- Large scale production of DME using a more economical process is a major technical challenge for the production of DME in the fuels market.
- JFE has developed a “direct” (vs. “indirect”) process

Topsoe, Lurgi, TEC, MGC (Conventional Indirect Process)



JFE (Direct Process)



Technical Challenges ...

MeOH/DME Plant Challenges

The direct and indirect synthesis processes have different degrees of integration. Direct synthesis of DME is the most economic.

Multiple Technology Vendors:

- Lurgi
- DPT (Davy Process Technology)
- HTAS (Haldor Topsoe)
- Toyo
- Kvaerner
- JFE & Total
 - The process of direct synthesis of (DME) “destroys” the least amount of natural gas, making it one of the most difficult processes for the chemical conversion of methane. The thermal efficiency of the process by JFE is 65% - 70% higher than conventional Fischer-Tropsch (FT) process. ⁽³⁴⁾



Conclusions...

- DME worldwide capacity is 545,000 mt onstream as of the end of 2006. The capacity is forecasted to increase to 11,317,000 mt by 2012 with construction of new plants. The average annual growth of capacity and output was 97% and 96% in China were DME is onstream as of the end of 2006.
- The use of DME as a alternative fuel will be determined in China. The cost of DME can become economically viable when “1.8 tons of dimethyl ether can replace 1 ton of diesel on average. Based on a market price of RMB3 800 per ton (at the end of 2006), the price for 1.8 tons of dimethyl ether is RMB6 840, being RMB2 040 higher than RMB4 800 for 1 ton of diesel.”
(62)



Conclusions...

- DME production capacity in China needs to exceed 11 million mt for use as a domestic fuel by 2012 to be cost effective in the domestic fuels market. The capacity is expected to reach 9,437,000 mt by 2012 in China, however that is dependant upon the building of plants that have not yet been constructed. Currently, there is a projected additional capacity of 5,300,000 mt that could potentially be added by 2012 if the announced projects not currently scheduled for construction are approved. In the event that the additional announced projects are built the capacity by 2012 in China has the potential to reach 14,737,000 mt and would be economically viable.
- The Xinao Group estimated production capacity of DME April of 2007 for China to be 8,500,000 mt by 2010 and China Chemical Reporter estimated it be 10,000,000 mt.



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