

DME: Global Developments – Opportunities and Challenges

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On behalf of
International DME Association
(www.aboutdme.org)

2005 World Methanol Conference

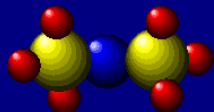
Miami Beach, FL

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Outline

- About DME
- Why DME Now
- DME Markets
- Latest DME Developments
- Economics
- Global Challenges
- Conclusions



About DME

Overview

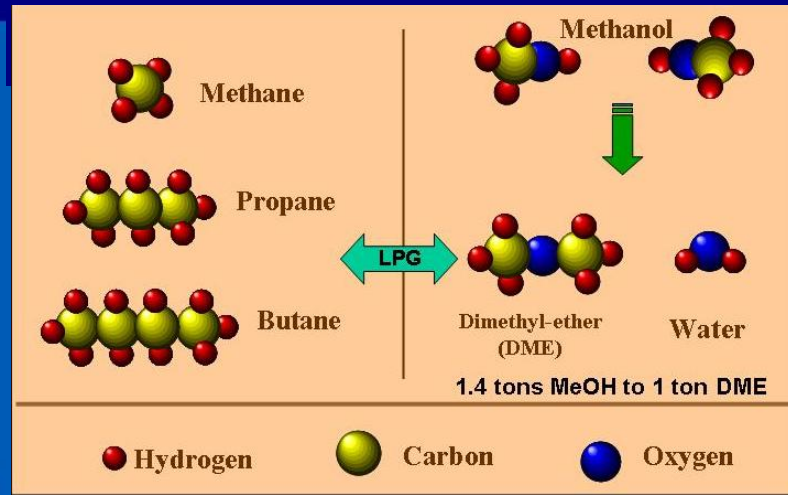
- Burns like natural gas
- Handles like LPG
- Similar to methanol with respect to:
 - Manufacturing technology
 - Costs
 - Petrochemical feedstock
- Environmentally friendly with significant global consumer history as propellant.
 - Clean burning
- Outstanding diesel alternative fuel
- Very large market potential as synthetic LPG, diesel alternative and fuel for power generation



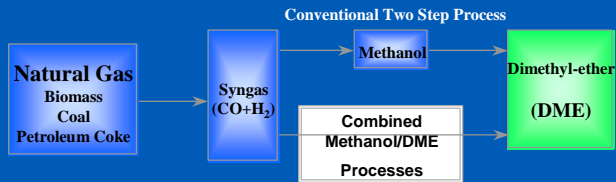
DME: made from methanol; "Synthetic LPG"

- DME Today: 150,000 T/y primarily as aerosol propellant plus about 50,000 T/y for emerging fuels market
- Manufacturing plants similar to methanol
 - Capital cost differential small
 - Co-production DME and methanol feasible

International DME Association



DME can be manufactured from multi-feedstocks similar to methanol production ...



- Today: Current suppliers for propellant market include Akzo Nobel, DuPont, and Mitsubishi Gas Chemicals.
- Tomorrow: Future mega-plant technology providers include Haldor Topsoe, Lurgi, Toyo Engineering, Mitsubishi Gas Chemicals and JFE Holdings.

Property	DME	Propane (Butane)	Methanol
Boiling Point (deg C)	-25	-42 (-0.5)	65
Vapor Pressure @ 20 deg C (bar)	5.1	8.4 (2.1)	0.3
Liquid Density (kg/m ³)	670	500 (610)	790
Lower Heating Value (MJ/kg)	28	46 (46)	20
Auto Ignition Temp @ 1 atm (deg C)	235-350	470 (365)	465
Explosion/Flammability Limit in air (vol %)	3.4-17	2.1- 9.4 (1.9-8.4)	7.3-36
Octane, (R+M)/2	low	104	100
Cetane	55-60	5	5

A brief history of DME

	Major Activity/Event	Companies
1963	First use as aerosol	Akzo Nobel
1992-95	Diesel fuel demonstration	AVL, BP, DTU, HTAS, Navistar
Jan 1995	DME multi-purpose fuel strategy	BP visit with NEDO, TEPCO, EPDC and others
Feb. 1995	BP press conference and first papers in Detroit	AVL, BP, DTU, HTAS, Navistar
1996-2001	IEA DME Annex XIV and XX (workshops and studies)	TNO and 16 companies
1996-now	Multiple commercial projects pursued	Japan DME Ltd, DME International, India DME, Chinese ventures
2000/01	Formation of IDA and JDF	160+ members
2004/5	Iran DME project; DME 1 Conference; China DME projects 2 nd Asian DME Conference	

Why DME now?

Multiple Markets

Multiple Sources

Ready technologies

Green

Economic viability

DME

DME: clean and green

- HEALTH:
 - Approved as consumer product propellant
 - No human hazard relative to toxicity or carcinogenicity within exposure limits
- SAFETY
 - Flammable liquid like LPG
 - Thermally stable
 - No tendency to peroxide formation found
 - Similar safety guidelines and codes as LPG
- ENVIRONMENT
 - Low emission fuel (LPG, Power, Diesel)
 - Does not deplete ozone
 - Minimal impact on land/water due to volatility



Visit www.aboutdme.org

Extensive HSE file

Photos Courtesy of Akzo Nobel and DuPont

DME as LPG blendstock

- DME/LPG blending work (BP, ENI)
- Completely miscible
- Below 20 %v DME, existing LPG infrastructure can be used
- **THIS IS THE PRIMARY MARKET**
 - Existing/growing market
 - High value market
 - Relatively easy blending
- Challenges:
 - Regulatory permits
 - Validation of blending on large scale



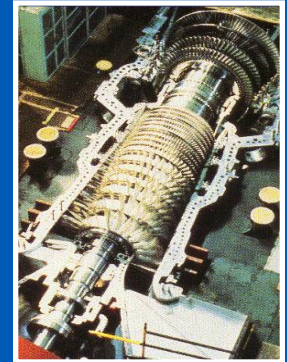
DME for Power Generation

MHI Testing – Reported at 2004 DME 1 Conference

- Confirmation and verification of gas-fired and liquid-fired stable combustion aimed at low NO_x.
- Following decisions by the customer who would introduce the technology, performance verification is to be carried out based on the environmental standards, etc. in place at the installation locations.



- 1995-2000: BP partnership with GE and EPDC(Japan); Studies with Siemens Westinghouse (SW)
- Multiple, detailed combustor tests
- DME is excellent gas turbine fuel
- GE and SW provide commercial offerings of DME-fired E class and F class gas turbines
- GE and SW guarantee power output, heat rate and performance
- DME exhibit record efficiencies and low emissions



Picture Courtesy of GE

Latest DME Developments

DME - Global Activities

Over the past several years, global recognition of DME's potential manifested by the formation of four associations representing about 160 companies, technical institutes, universities and individuals



Korea DME Forum

China DME Association

DME in Japan

Japan DME Forum coordinates multiple programs (\$200 million over 2002-2005)

•Utilization

- Power generation systems
- Household/industry fuel
- Diesel related technologies
- Emission tests from diesel engine
- Marketing study
- Road test of DME vehicles

•Production

- Production technologies
- Ocean transportation

•Codes & Standards

- Studies for standardization of DME fuel

Numerous Fleet Tests



Direct process (JFE) 100t/d demonstration plant

DME Commercial Projects - Studies

- Japan DME Ltd: 5,000 t/d, Western Australia, Middle East, Indonesia, Papua New Guinea
- DME International Inc, 2,500-4,000 t/d, Middle East/Indonesia/Australia
- Mitsui & Co, TEC: 7,000 t/d, Iran, Indonesia

DME in China

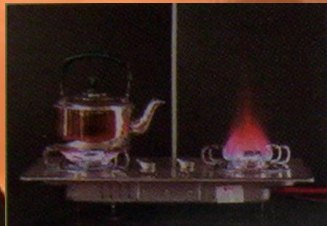
Shandong Jiutai Chemical Industry, Linyi, Shandong

- 100,000 T/yr DME capacity. 50,000 customers using bottled DME.
- Established Jiutai Energy Mongolia Ltd. Planning 1 million T/yr.

"Now, energy is in short supply. DME can not only ensure energy security of our country, but also reduce environmental pollution." Shandong Jiutai Chem. Ind.

Luthianhua Group Inc, Luzhou, Sichuan

- 10,000 T/y – Commercial DME plant for fuel use - August 2003 start-up. Toyo Engineering methanol dehydration technology.
- 110,000 T/y – with 2005 start-up



DME in Iran

World's First Large-Scale DME Plant

- Production capacity: 800,000 T/yr
- Owner: Zagros Petrochemical Co.
- Location: Bandar Assalouyeh/ Pars Special Economic/Energy Zone
- Licensor: NPC-RT and Haldor Topsoe AS
- Feed: ASTM Grade AA Methanol
- Technology: methanol dehydration, fixed-bed reactor
- Product purity (wt%) – above 99%
- Primary market: LPG substitute in Iran and Region
- Current Project Status:
 - EPC company selected
 - First production in 2008

Other DME Activities Around the World *

Sweden

- Volvo 2nd generation heavy duty vehicle – 3 more in '06
- Volvo DME fleet tests in Växjö



Russia

- Moscow program: "Alternative fuels use in city's motor transport for 2002-2004" ..
- VNIIGAZ (GAZPROM Research Institute) developing technology to manufacture DME

USA

- DME-Fueled Shuttle Bus Demonstration, Penn State University,



Italy

- Snamprogetti Program : DME as LPG substitute, and LPG/DME interchangeability in diesel engines (with SwRI)

Brazil

A network, headed by the Petrobras Research Centre, was established including one Research Institute and three University Laboratories.

Europe/USA

- AFFORHD. Alternative Fuel for Heavy Duty Engines
- Volvo, AVP/PTI, DTU, BP, TNO, Växjö
- 2002-2004, 4 million euro



Korea

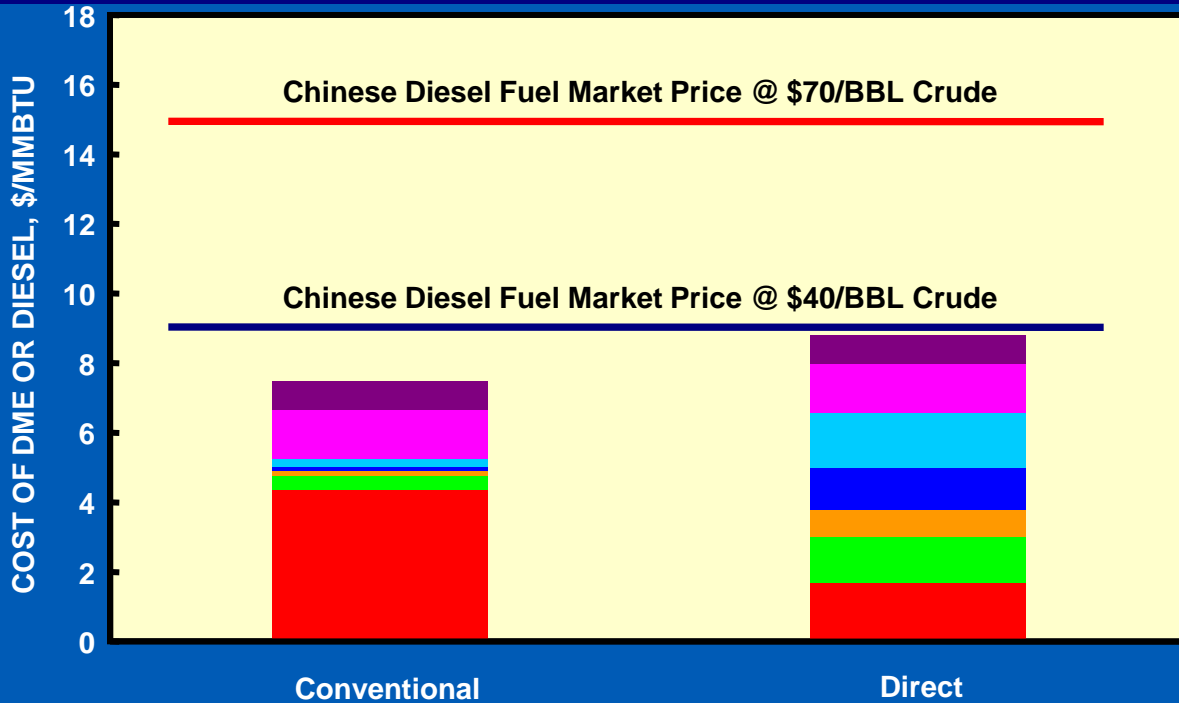
- KOGAS Demo Plant, 2004-9
- Conducting engine research
- KIER/SK/Inha Univ. Project: First prototype truck



* Only a partial list of the extensive global efforts

Economics

DME produced in the Middle East and shipped to China as a diesel substitute can achieve excellent profitability



(Natural Gas Price = \$1.00/MMBtu)

■ Natural Gas / Methanol	■ Other Variable Cost	■ Fixed Cost
■ Depreciation	■ 10% ROCE	■ Transportation
■ Tariff		

Challenges and Conclusions

Global challenges

- Raising awareness of DME
- International standards
- Strategic partnerships with other industries (methanol, LPG, clean transportation fuel)
- Competition with LNG, GTL-FT and hydrogen fuel cells
- Lack of first successful, LARGE plant

Conclusions

Dramatic progress has been made in the past 10 years in understanding and advancing the DME business

- DME is a very promising new fuel
- Many drivers and opportunities
- Significant challenges have to be overcome
- International DME Association, Japan, Korea and China DME Forums have been formed.
- A significant global DME effort has evolved - led by Asia.
- DME community must join forces for DME acceptance and growth