

9TH RUSSIA & CIS OIL & GAS EXECUTIVE SUMMIT

MONETIZING GAS THROUGH METHANOL

Chris Chatterton

JUNE 19TH – 21st, 2019 GORKY GOROD, SOCHI, RUSSIA



- *MI*

- Methanol Supply & Demand
- Methanol as a Clean Fuel
- Methanol Economics
- Summary





WWW.METHANOL.ORG





METHANOL PRODUCTION



2018 ~ 122mn t nameplate capacity

Rest of World – ex China





GLOBAL METHANOL PRODUCTION VS CAPACITY



- Rest of world methanol production (excluding China) operates to best of abilities. Excess production from the rest of the world is exported to China
- China "generally" represents the high-cost methanol production bloc in the world and operates to meet China demand, less imports received from the rest of the world
- Industrial scale since 1923 (BASF)
 Source: Argus



GLOBAL METHANOL DEMAND BY COUNTRY/REGION

- China dominates global methanol industry demand – 54% in 2018
- W Europe and N America compete for the 2nd and 3rd spots – top three accounting for 75% of total
- Concentrated consumer base, ~30% of demand from top 25 consumers
 - Main consumers are large, global chemical companies and China MTO producers: BASF, Momentive, Celanese, BP, Dow/Dow Corning, Lucite, Evonik, LyondellBasell, SABIC, Sinopec, Ningbo Fund, Jiangsu Sailboat, etc
- Industry growth expected at 4.5% per year. The equivalent of 2 world scale methanol units



Source: Argus



METHANOL INDUSTRY PRODUCTION CASH COST CURVES



Source: Argus



٠

٠

٠

RENEWABLE PATHWAYS ARE RAPIDLY DEVELOPING





WWW.METHANOL.ORG

E-METHANOL: AN EFFICIENT ENERGY CARRIER



-253°C, and 140% more H₂ than compressed hydrogen at 700 bars.

Source: Prof. SHIH Choon Fong, NTU, MI



BASF: CO₂ EMISSION FREE METHANOL PRODUCTION



Methanol Synthesis and Distillation Process practically unchanged

Source: BASF



BASF We create chemistry

11





BROADLY, METHANOL IS...

- A cost effective and "future proof" fuel which can be produced from a variety of feedstocks – to include renewables
- One of the top 5 seaborne chemical commodities safely handled for over 50 years
- A lower cost alternative for converting vessels to methanol – minimal and economically viable without
 subsidies
- Widely available and alleviates many infrastructure and safety limitations both on land and at sea, trading
 within a narrower price range than competing fuels
- Not as well understood as a fuel, even though it has similar handling characteristics as distillate fuel



METHANOL CHARACTERISTICS

Parameters		Petrol C ₅ -C ₁₂ Hydrocarbon	Diesel C ₁₀ -C ₂₁ Hydrocarbon	Natural Gas CH₄	Methanol CH₃OH	Ethanol C₂H₅OH
Mass Fraction	С	85	86	75	37.5	52.2
	н	15	14	25	12.5	13.0
	Ο	0	0	0	50	34.8
Density (liquid)(kg/L)		0.72-0.78	0.82-0.86 0.42-0.46		0.79	0.81
Boiling point (°C)		30-190	180-360	-162	65	78
Flash point (⁰ C)		-50 ~-20	>55	-188	11	9
Auto-ignition point (°C)		420	250	650	465	426
Lower heating value (MJ/kg)		44.0	42.5	50	19.5	25
Octane number		70-97	20-30	130	111	108
Cetane number		-15	40-55	Low	3-5	8
Flammability limits (%)		1.1-5.9	1.58-8.2	5-15	6-36.5	4-19
Vapour pressure at 37ºC/kPa		55-103	<1.37		31.6	15.8



METHANOL FUEL POWER SYSTEM

Methanol carriers – use cargo as fuel



Methanol engine Methanol cargo pump

Source: CCS, Waterfront Shipping



PRACTICAL SOLUTION

- Multi fuel engines and applications will be the norm going forward
- Methanol can be readily and safely applied in both new build and conversion
- Low Carbon Methanol or Renewable Methanol can be a practical solution for dual fuel applications, to include other alternative fuels such as LPG and LNG



Source: Westfal-Larsen



CONVENTIONAL MeOH EMISSIONS SCORECARD



Methanol (MeOH) achieves low emissions & acts as a bridge in lowering CO₂ now and in the future (blending renewable or bio methanol)

Source: Waterfront Shipping



METHANOL / WATER BLENDING (EMULSIFICATION)



- Approximately 25-40% water is added to the methanol to achieve a Tier III compliant solution
- NOx decreases almost linearly with water content, to approximately 2 g/kWh at 50% and 75% load
- Similar system is being planned for fuel oil
- R&D testing completed service test is under preparation likely on one of the WFS vessels

Source: MAN



METHANOL FUELLED VESSELS AND PILOTS

	DUAL FUEL			FUEL CELL		PROJECT R&D
Quantity	7 +4	1	1	2	1	+4
Vessel Type	Chemical tankers	ROPAX ferry	Pilot boat	Tourist boat	Ferry	Cruise ships, fishing boats, barges, dredges, others
Owner	MOL, WL, Marinvest, Mitsui, NYK	Stena Line	MI/SMA ScandiNaos	Innogy HTWG Konstanz	Viking Line	SUMMETH/MARTEC, Lean Ships, Methaship, Billion Miles ¹ , FiTech ² , IWAI ³ , PCG Product Vessel ⁴ , NTU ² , GMM, Fastwater, Port of Rotterdam Barge, Jupiter, Paxell, Methanex Fishing ⁵
Engine Type	2 stroke MAN	4 stroke Wärtsila	high speed Scania, Weichai	Serenergy fuel cell stacks		SI hybrid, dual fuel, etc.
Design	new build	retrofit	retrofit	retrofit	retrofit	new build & retrofit



All projects are based in the EU unless noted otherwise¹China/SG, ²EU/China/SG, ³India, ⁴Malaysia, ⁵China

METHANOL IS WIDELY AVAILABLE





HAZARD COMPARISON

	METHANOL	DIESEL	GASOLINE
Hazard pictograms (CPL)			
Signal word: (CPL)	Danger	Danger	Danger
Hazard statements (CPL)	H225 Highly flammable liqued and vapour. H201 Toxic if swellowed. H211 Toxic in contact with skin. H221 Toxic if inhaled. H227 caused demage to organic.	HERE: Flammable logical and support. HERE: More be fotal if swellowed and enters of wwws. HERE: Causes skin initiation. HERE: Reported of Causing Causes. HERE: Supported of Causing Causes. HERE: More cause domains to one on through proformed or repeated exposure. HERE: Tokic to aquate life with long being effects.	H220: Notivenely flammable liquid and vapour. H236: Movies fotal if smallowed and enters of wows H225: Causes site initiation H288: May cause genetic defects H288: May cause genetic defects H288: Supercised of domastics fertility or the unitern child H288: May cause drowstreak or duranes. H288: May cause drowstreak or duranes. H288: Cause Strowstreak or duranes.
Precautionary statements (CLP)	P220 - Yong a new from hard Me newbing P220 - Weng probables glowes, performance of the performance of the performance of the performance P220 - Weng probables of the performance of the performance of the performance of the performance P220 - Mark Lands - Cold Cold (or here) - Mercong "Wate of researching at meta-instantial statistics, Kowa size with analog/docume P221 - Mark Lands - Wate Office of the performance of the performance of the performance of the performance P221 - Mark Lands - Wate Office of the performance of the performance of the performance of the performance P221 - Mark Lands - Wate Office of the performance of the performance of the performance of the performance of the performance P221 - Mark Lands - Wate Office of the performance of the pe	P302. Dikais special indexvilues index and P303. Roma and yours indexvilues indexvirus any special P303. Roma and yours indexvirus any service tests P303. Roma and your service tests P304. Roma and your special indexvirus any service tests P304. Roma any service tests P305. Roma and your special indexvirus any service tests P305. Roma any service tests P30	P325. Didata special index/lines before set P325. Dis of heading wild all solely presentations have internet read and under dised P326. Do not heading wild all solely presentations have internet read and under dised P326. Do not heading wild special isotened P326. Do not heading wild set and P326. Do not head wild set and P326. Do not heading wild set and P

Methanol classified as "not more dangerous" than other fuels such as gasoline or diesel – fuels largely familiar to most people



METHANOL POISONING CASE STUDY

Occupational Medicine, Volume 42, Issue 1, 1 January 1992, Pages 47–49, https://doi.org /10.1093/occmed/42.1.47 A. Downie ➡, T. M. Khattab, M. I. A. Malik, I. N. Samara Published: 01 January 1992

Abstract

Methanol (CH 3 OH) is a chemical feedstock of increasing importance as well as a commonly used solvent. In the early 1980s methanol production was introduced at a new petrochemical complex in the Saudi port of Jubail. A case is presented of a consultant <u>supervising tank cleaning prior</u> to methanol loading. He wore positive pressure breathing apparatus but no protective clothing. After 2-3 hours working in the confined space of the tank, he worked on deck and continued to wear his methanol-soaked clothing which eventually dried out. Visual symptoms of acute methanol toxicity presented some 8 hours after exposure. The appropriate treatment (with ethanol provided by the ship bond) was carried out in hospital and the individual <u>recovered completely.</u> Most reported cases of methanol toxicity are social in origin, arising from ingestion. This particular case, though unusual, does present some interesting lessons.

Easy and reliable treatment to full recovery with either ethanol (orally) or fomepizole (injected)

Source: Malcom Pirnie Inc



SAFER FOR THE ENVIRONMENT

LC50, LC = LETHAL CONCENTRATION FISH

Concentration in water, at which half the marine population died within the specified test duration



METHANOL FUELED INDUSTRIAL BOILERS

- Industrial boilers are widely used for heating and industrial stream
- Many cities in China prohibiting use of coal and diesel
- Capacity ranges from 1 to 20 steam tons/hour
- In continuous cycle on full load, one steam ton of capacity consumes 110 kg of methanol
- Methanol fuel is used neat or emulsified (typically to 25%)
- Standards developed with MI and Methanex support
- Now more than 1000 units, consuming over 3M mtpa
- Forecasted to 5M mtpa by 2022







METHANOL FUELED CERAMIC KILNS



- ~60% of world's glass products
- ~90% of all ceramics globally





METHANOL FUELED CERAMIC KILNS





METHANOL FUELED CERAMIC KILNS – FROM THE SIMPLE





METHANOL FUELED CERAMIC KILNS – TO THE BESPOKE





METHANOL FUELED CERAMIC KILNS – TO MASS MARKETS







METHANOL FUELED CERAMIC KILNS – SMALL KILN



- 3-yr reference
- .5mt/day average consumption
- Underground storage with day tank
- 3cm kiln space
- Retrofit kit includes:
 - o **Tank**
 - Burners
 - \circ Controls
 - \circ CPU
 - Waste Heat Recovery
 - o RMB 10,000 (USD\$ 1,500)
- Methanol requires less air intake than NG or LPG
- Higher achieved temperatures with methanol to 1400°C



METHANOL FUELED CERAMIC KILNS – LARGE KILN

- 6cm kiln space
- 3-yr reference
- 3-4 mt/mo consumption
- Price similar to LPG but better quality
- Much safer than LPG, which is registering one LPG tank explosion per week often with fatalities







METHANOL FUELED COOK STOVES

- Single heating, stir fry, steaming
- Widely used in restaurants, central kitchens, mainly costdriven
- Simple storage and transportation, filling the gap of pipeline NG supply
- Fuel: 100% methanol to methanol blends usually with water (to 40%)
- AI, ML, IoT enabled







METHANOL FUELED COOK STOVES

- 24/7 on-line monitoring of all installations
- Sensors provide live data streaming of energy delivered and proactively detect technical or safety issues
- Performance and safety are continuously monitored and enhanced
- Block chain enabled
- Infrared flame and gas detection, foam fire suppression





METHANOL FUELED COOK STOVES

- Current market consuming over 5 M mtpa
- Forecast to reach 7-8 M mtpa by 2022





METHANOL FUELLED TABACCO DRIERS



STITUTE

1 out of every 3 cigarettes consumed globally is in China



- RMB1.7 trln profits + tax collected by government annually
 - Equal to military spending budget
 - More than Sinopec and CNOC combined contributions to state treasury







DISTILLATE & FUEL OIL PRICES EXPECTED TO RISE

Light-heavy product differentials,1 \$/barrel



¹Average light product (diesel, gasoline) prices minus fuel oil (3.5% sulfur, 380 centistokes).

- Higher demand for gasoil will largely have to be met by higher crude runs, putting upward price pressure on global crude prices, distillate premiums to other fuels, and refining margins in general
- This should also tighten distillate markets relative to gasoline, adding to the cost of MGO. Recently, the spread between gasoline and diesel prices has been relatively constant—about \$4–\$6 per barrel—due to the similar growth rates of the two products. However, history shows that when diesel demand accelerates relative to gasoline, diesel prices shift to premiums of \$10–\$12 per barrel over gasoline
- Timing is critical to fuel choice selection as delays could be costly, even as compliant distillate fuel becomes more widely available

Source: McKinsey



METHANEX 10-YR AVG REALIZED PRICE



- Methanex posts reference prices monthly in Asia and North America and quarterly in Europe
- Realized pricing is lower than reference prices due to discounts specified in contracts
- Higher visibility over fuel costs which lowers the risk profile

Source: Methanex Corporation



METHANOL COMPETITIVE ON ENERGY EQUIVALENT BASIS



- MGO West Coast Avg: LA, San Francisco, Seatle, Vancouver;
- MGO East Coast Avg: New York, Philadelphia, Norfolk, Montreal, Charleston
- Methanol: adjusted to energy equivalent of MGO (2.16 factor)

Source: Platts and IHS Chemical







SUMMARY

- Physics of methanol are highly competitive or surpass other alternative fuels
- Application design, whether retrofit or new build are simple, advantageous, practical and understandable – whether for ships, boilers, kilns, or cars
- Methanol should be treated as a "liquid fuel system" not to be directly compared with gas (ie; LNG, LPG, NH³ or H²)
- Compelling environmental properties
- Superior Life Cycle Analysis (LCA) advantage already with CCI technology or when renewably produced
- Infrastructure is a key enabler for methanol's uptake as a fuel due to storage being no more complicated than other liquid fuels



THANK YOU!!

