June 20th, 2023

Technology Collaboration Programme on Advanced Motor Fuels

Task 60 Marine Fuels

Presentation for Clean Marine Conference in Taastrup, Denmark.

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Strategy & Technology Chair

Technology Collaboration Programme
by iea

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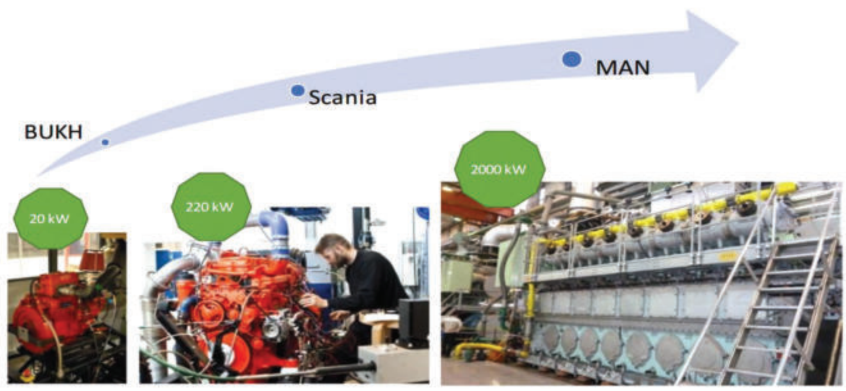
- Key messages of Task 60



IEA-AMF

Who we are and what we do?

- IEA was founded by OECD during the oil crisis in 1973-74.
- AMF belongs to IEA's Technology Collaboration Program (TCP)
- TCP has 8 thematic groups, 39 committees, 6000 experts representing 55 countries
- AMF started in 1984 with alcohol fuels in focus
- 16 contracting parties from 14 countries
- 59 completed tasks
- 7 ongoing tasks
- Chairman is a Dane

Denmark	Mr. Jesper Schramm	Delegate Chair
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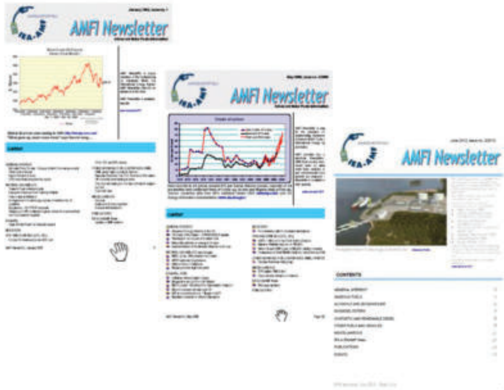


TEKNOLOGISK INSTITUT

Global transport energy demand surpasses 100 EJ

- Rising demand for transportation worldwide
- Transport energy demand >2800 Mtoe and growing
- 96 % of which is fossil
- 10-15% is used for shipping
- Combustion engine will prevail for a long time

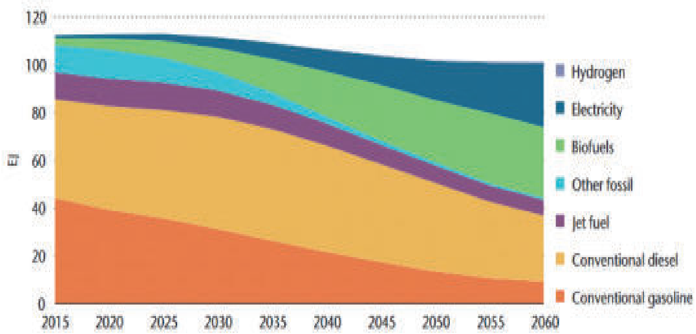
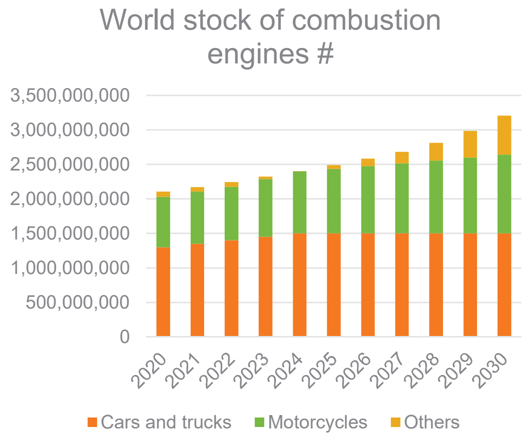


Figure 2: Role of biofuels in transport – IEA 2DS Scenario

The case for combustion engines

Why we need advanced motor fuels?

- >>2,000,000,000 combustion engines in use today
- 168,000,000 units produced every year (expected to reach 370,693,000 by 2030)
- Basically, made from steel and aluminium
- Cost from 30-600 EUR/kW, (avg. ~4000 EUR/unit)
- Efficiency from 30-55%
- Applicable to any form of transportation, machinery, power generation, …
- Burns practically any fuel; liquid, gaseous, slurry
- Most feasible solution for 100 years



Background

Why talk about marine fuels?

- Subject introduced to AMF by Denmark
- First report finished in 2014
- Outlook was rather unsettling then…
- About 400,000,000 tons of fuel per year
- New developments are starting to deliver
- Still a long way to go
- Time for a new assesment

	IFO	LSFO	MGO/GTL/ BTL	HVO/SVO/ FAME	MeOH	DME/LPG	LNG/LBG
Engine and fuel system cost	Drop-in	Drop-in	Drop-in	Drop-in	Dual fuel	Gas tank	Dual fuel Cryo tanks
Projected fuel cost		Refining	Refining	Land use		Infra-structure	Infra-structure
Emission abatement cost	SOx, NOx, PM, CO_2	NOx, PM, CO_2					
Safety related cost					Flash point	Ventilation	Press/temp
Indirect cost				Ethics	Cargo space	Cargo space	Cargo space

- Serious impediment
- Signifficant cost
- Feasible solution available

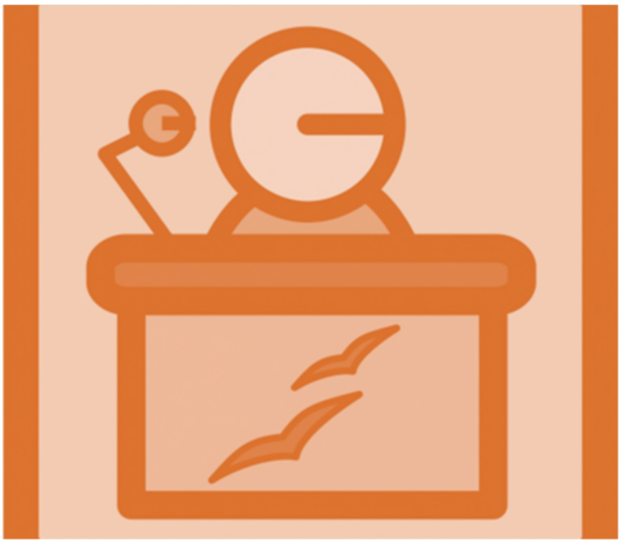
Main Info

Annex 60 The Progress of Advanced Marine Fuels	
Operating Agent (institution)	Danish Technological Institute www.dti.dk
Start and End Date	November 7th, 2019 – November 7th, 2022
Participants	Canada, China, Denmark, Finland, Korea, Sweden, Switzerland, US, Austria
Task Sharing	EUR 1 750 000
Cost Sharing	EUR 45 000 (Methanol Institute)
Total Budget	EUR 1 795 000
Project Leader (name and email)	Kim Winther, kwi@dti.dk

AMF Task 60

Specific tasks by country

- Austria: Methanol with Carbon Capture
- Canada: Black Carbon emisions
- China: Fishing boats and small vessels
- Denmark: 4-stroke methanol engine
- Finland: LBG and more
- Korea: Multifuel engine
- Sweden: Inland waterways
- Switzerland: Large DF engine
- USA: Biofuels and LCA



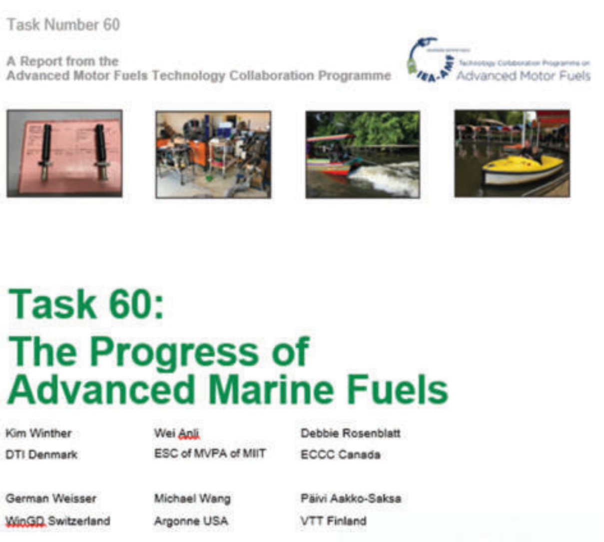
Key messages

- Ultralow Sulphur marine fuel has become available in adequate quantities around the globe, contribution greatly to a reduction in marine sulfur emissions.
- LNG as a fuel has seen a big surge in both number ships and total amount of LNG used for shipping. This reduces both sulfur and Black Carbon emissions.
- Scrubber installations have also surged since the introduction of the IMO 2020 sulfur cap. Scrubbers effectively capture sulfur but are ineffective towards Black Carbon. Open loop scrubbers are not allowed in China.
- Emissions of Black Carbon can be met effectively with advanced fuels such as methane, ammonia, hydrogen, or methanol.
- The global NO_X regulation applies only to new ships and has no effect on existing ships. To reduce NO_X pollution from older ships, local enforcement, differentiated harbor taxes, and incentivized retrofit programs are needed.
- Biofuels produced with fast catalytic pyrolysis or hydrothermal liquefaction are potentially promising drop-in fuels.
- Methanol dual-fuel engines are becoming an accepted option for new ships.
- Hydrogen engines are still new to the market.
- Ammonia engines are still in the research and development phase.
- The many different fuel production pathways are to be considered in the well-to-wake perspective when assessing climate impact.
- Carbon capture technology is important for the decarbonization of the shipping industry.
- Electrification may be the best option for short sea shipping.

Full report

Free download of all AMF reports

- Available at www.iea-amf.org
- Soon...

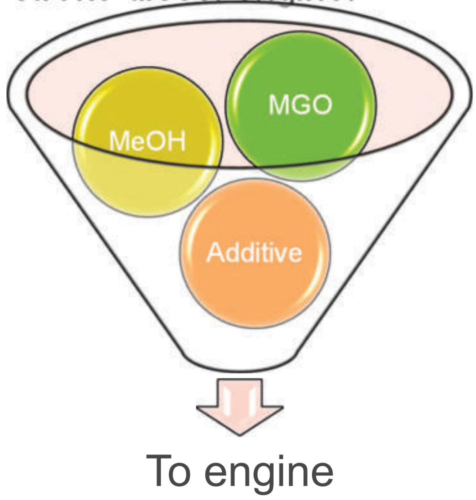

Task Number 60

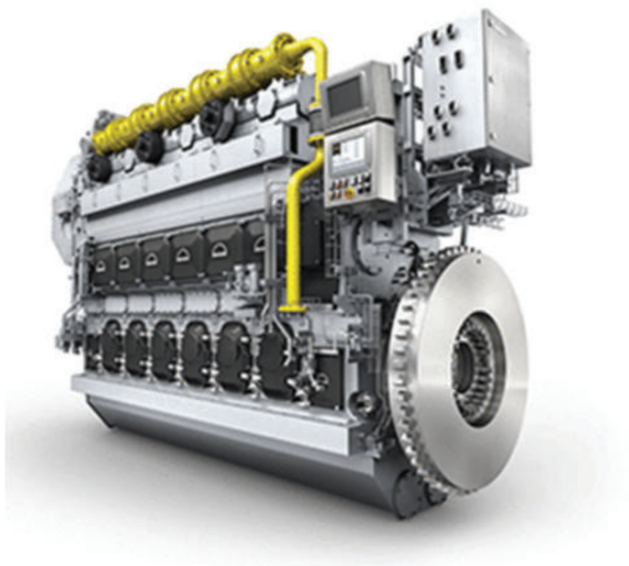
A Report from the
Advanced Motor Fuels Technology Collaboration Programme

Task 60:
The Progress of
Advanced Marine Fuels

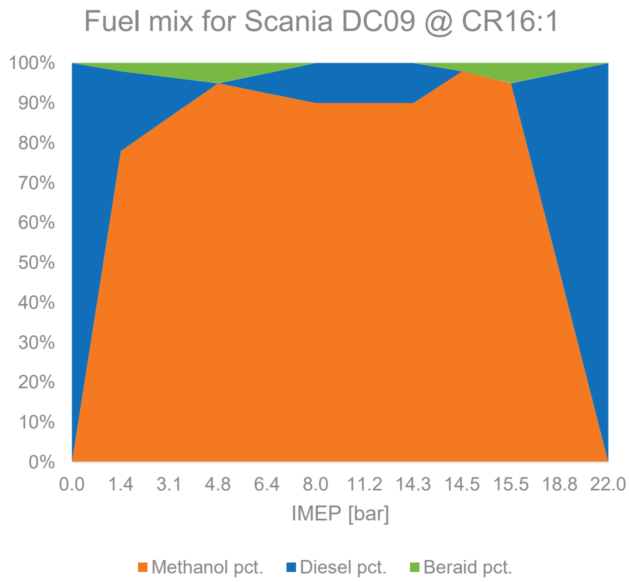
Kim Winther DTI Denmark	Wei Anli ESC of MVPA of MIIT	Debbie Rosenblatt ECCC Canada
German Weisser WinGD Switzerland	Michael Wang Argonne USA	Päivi Aakko-Saksa VTT Finland

- Mission: A low cost solution to methanol combustion in a standard four stroke diesel engine.

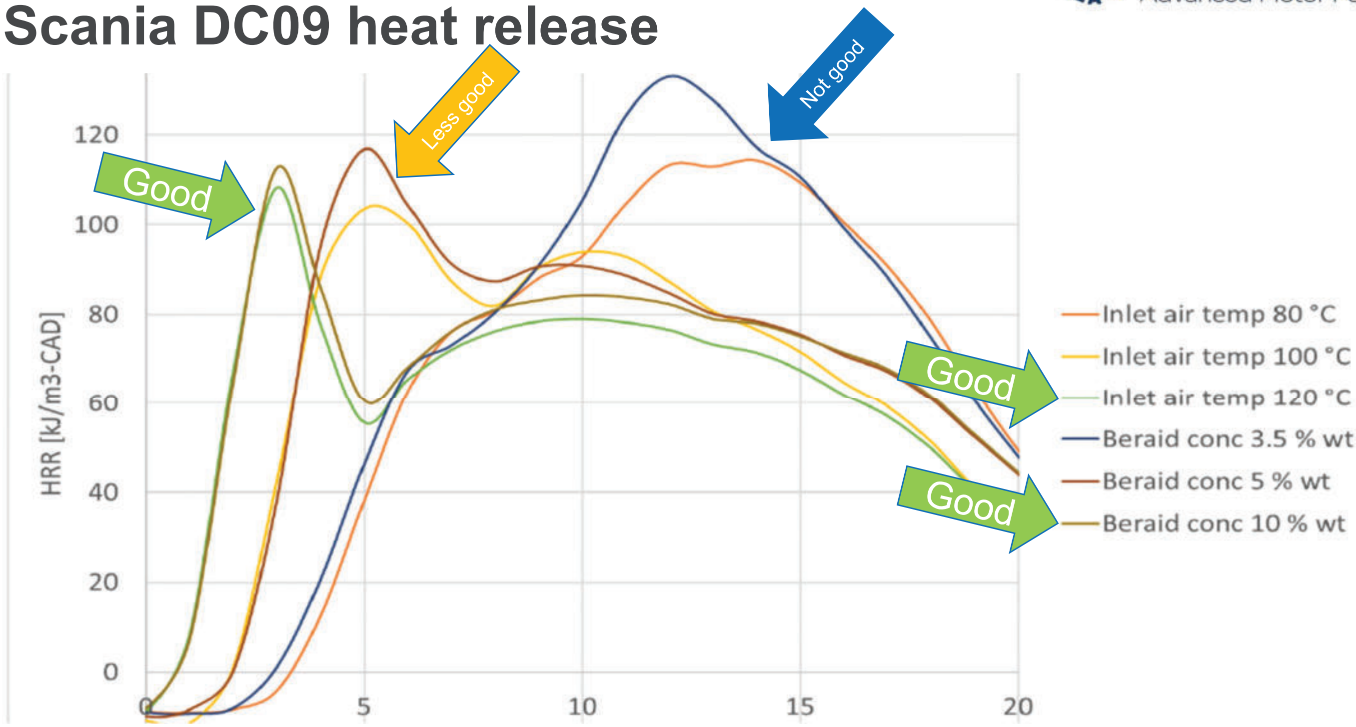




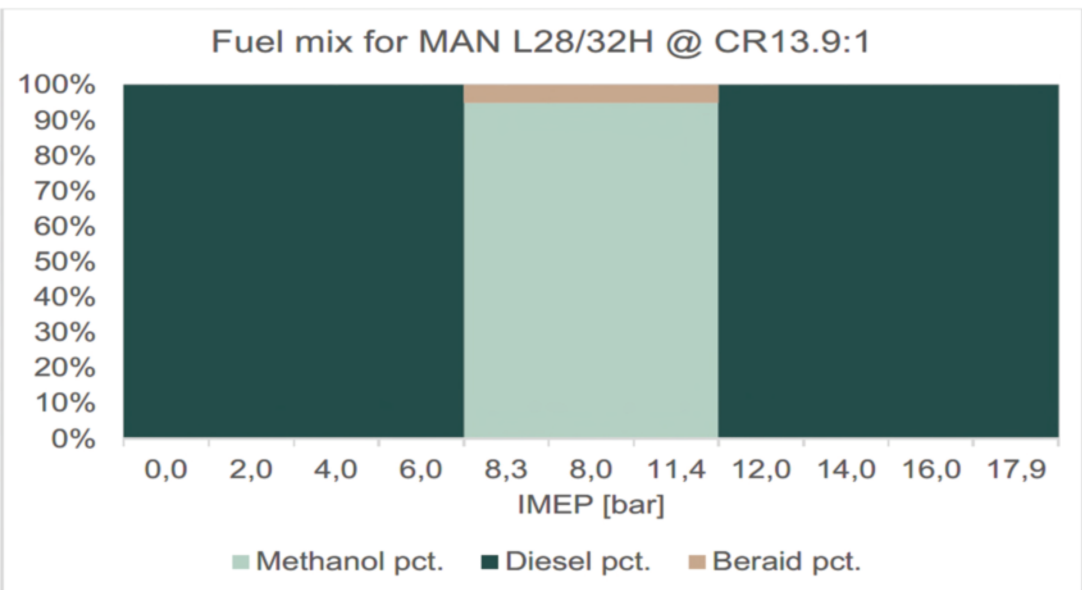
- Flex Fuel operation is possible in a wide load range
- Diesel is needed at startup and high loads
- Beraid is needed most of the time
- At medium load Beraid can be substituted with diesel
- Standard injectors, with adjustable timing were used



Scania DC09 heat release



Methanol with diesel assist <1100 kW



Diesel assist logic

Condition	Default value	Fuel selection valve
Exhaust gas temp. > Setpoint 1	320 °C	Methanol fuel
Methanol operation AND Exhaust gas temp. < Setpoint 2	300 °C	Diesel oil for (default 5 s), then return to methanol fuel
Methanol operation AND Exhaust gas temp. < Setpoint 3	380 °C	Diesel oil for (default 10 s), then return to methanol fuel
Exhaust gas temp. < Setpoint 4	260 °C	Diesel oil

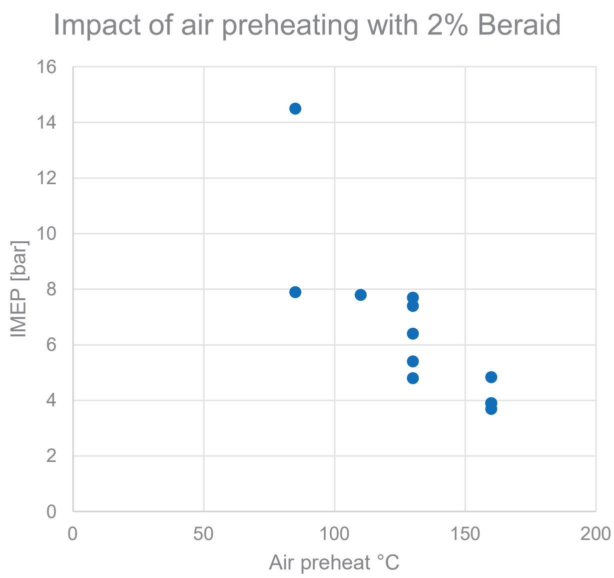
Table 1 Logic of cylinder fuel change-over during AUTO operation.

Emissions cut significantly

Table 1 Emissions measured on MAN L28/32 engine

		Diesel	Methanol	Reduction
NO	ppm	1200	600	50%
NO2	ppm	50	20	60%
NOx	ppm	1250	620	50%
THC	ppm	50	40	20%
CO	ppm	170	150	12%
PM	mg/Nm3	25	12	52%

- Air preheating helps at low load
- At medium-high load turbo generates enough heat for ignition



Thank you