IEA-Advanced Motor Fuels
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Annex/Task 60

Technology Collaboration Programme
by iea

Annex 60: The Progress of Advanced Marine Fuels

Project Duration	November 7, 2019 – November 7, 2022
Participants **Task sharing** **Cost sharing**	 Canada, China, Denmark, Finland, Korea, Sweden, Switzerland, USA Methanol Institute, USA | Belgium
Total Budget	€ 1,795,000 ($2,161,000 US)
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Purpose, Objectives and Key Question

In 2013, AMF released its first annex report on marine fuels (Annex 41). This report highlighted the fact that no alternative fuel option existed without significant added cost or other serious impediments. The preferred fuel, HFO, was soon to be banned or restricted due to the high Sulphur and fossil carbon content. Recent developments, however, have highlighted several new fuel options which should be assessed.

Key Question: How can the new forms of advanced marine fuels contribute to carbon neutral shipping in the future?

Activities

The activities are distributed per country to reflect a broad range of technologies.

- Canada: Low Sulphur marine diesel fuel, engines and scrubber technology
- China: Methanol for fishing vessels and watercraft
- Denmark: Methanol flex-fuel, Ammonia for CI, DPF and SCR for coastal shipping
- Finland: Methanol and LBG
- Korea: LNG/LPG mixture technology, ammonia for small SI-engines
- Switzerland: Dual fuel for 2-stroke, methane-mixtures (e.g., with H_2)
- Sweden: Fuels for smaller marine engines on inland waterways
- USA: LNG and other alternative fuels

Two virtual meetings were held during 2020.

Key Findings

Some results are summarized below.

Finland

Finland performed fuel efficiency modelling in the advance fuel project (EU) http://advancefuel.aalto.fi/. Finland also studied HP direct injection of methanol in dual fuel (DF) engine, ethane and hydrogen enrichment of methane and straight methanol with ignition improver. Finland applied internal EGR for ignition improvement in methanol diesel engine with good results.

Canada

Canada is currently conducting a literature search focusing on black carbon and particulate matter emission factors used in marine emission inventories. Additional aspects that will be investigated include: different types of marine fuels (heavy fuel oil, marine diesel oil and very low-sulfur fuel oil), operating conditions, type of marine engine used (2-stroke, 4-stroke) and emission control technologies (i.e. scrubbers).

Denmark
Denmark ran a unit injector flex fuel concept with diesel and methanol mix at standard compression ratio 1:16.

China
China is focused on work on several levels: commercial vessel; barges handled by ministry of transportation; fishing boats handled by ministry of agriculture; methanol bunkering special issue due to low FP; looking into different vessels sizes; harbor crafts; pilot trials commencing in 2021, and transportation of methanol from the northwest to coastal regions versus importing methanol. China also has two marine engines type: high speed 200-400 kW for 1,000 tDW, and medium speed up to 1 MW for 10,000 tDW. China has no low-speed engine, no 2-strokes, and no solid work on glow plugs. China uses DMCC concept (port injected methanol) for smaller marine vessels. The first fishing vessel was put in service in December 2018. The first container barge went in service May 2019. Diesel replacement is 30-40%. Geely has methanol engines for cars and trucks, with 20,000 vehicles running. DMCC runs in 160 heavy vehicles, mine trucks, loaders, and locomotives. NO_x-soot tradeoff is significantly improved. No SCR is needed. Material compatibility is ensured by anti-corrosion treatment of components.

Korea
Korea (KSEO) built a NG/PG mixture supply equipment for engine test, and the test will be started at the end of 2020 on 1.5 MW 4-stroke medium speed engine. An investigation of NG/PG mixture combustion characteristics and performance will be conducted compared with conventional DF engine (NG). At KIER, ammonia fuel was investigated to replace gasoline through the conversion of a conventional gasoline engine with ammonia fuel system. Though the flame speed of ammonia is five times lower than gasoline, the ammonia-gasoline dual fuel shows enhanced combustion characteristics because gasoline acts as a combustion promoter and brings about faster combustion of all the cylinder charge. For this study, an ammonia-gasoline dual fuel system was constructed, and a programmable engine controller was also developed to make both ammonia and gasoline injected separately into the intake manifold in liquid phases. As a result, ammonia was used as the main fuel to replace 70% of gasoline and the same amount of carbon emission, such as CO_2, CO, and THC, reduced emissions in the engine.

Switzerland
Switzerland was initially delayed but is still on track. Two-strokes are in focus. A review will be delivered later. Switzerland is investigating the fundamentals of gas mixtures combustion. Optical and laser-optical techniques are used. There is good synergy with the work of Aalto Finland.

Sweden
Sweden used a consultant to investigate small marine engines for inland waterways and coastal shipping. Results on system review are expected by February 2021.

United States
USA will present a status update in Q3 of 2021.

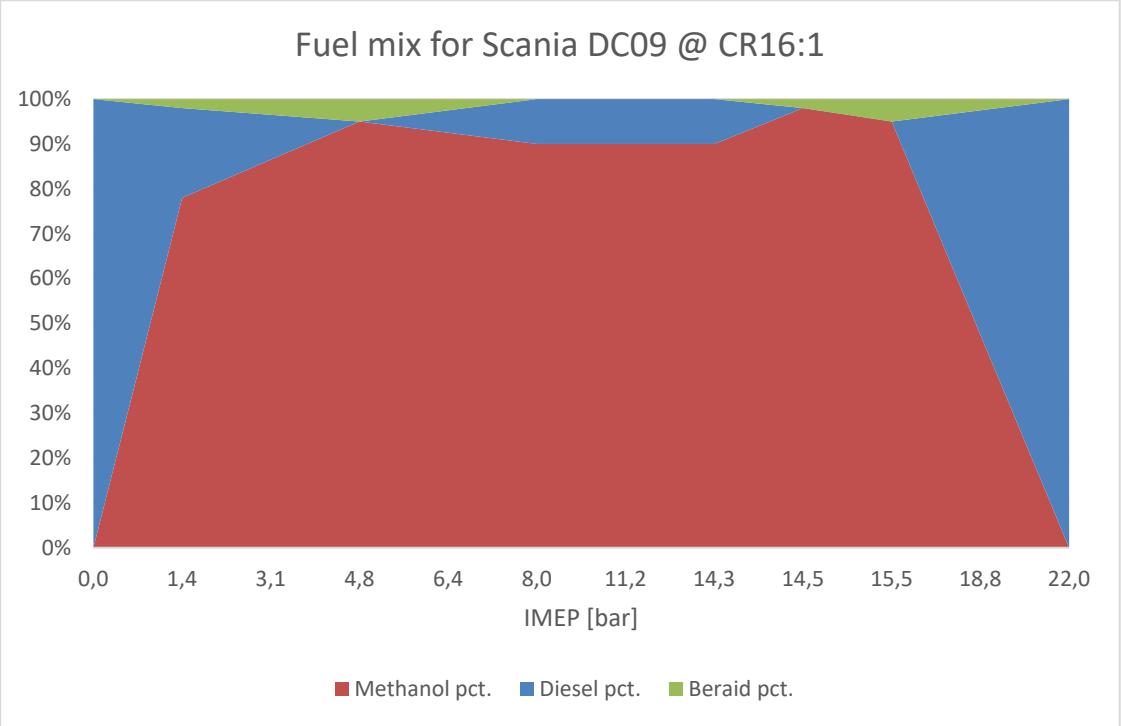

Fig. 8. Mixtures of methanol, diesel and additives are usable as fuel for standard marine engines if preheated combustion air is supplied (Result from Denmark).

Publications

A final report of the annex will be available in late 2022 and can then be downloaded on the website: https://www.iea-amf.org/content/projects/map_projects/60.