The Diesel Cycle Verified for Methanol Operation
Abstract
In 2012 MAN Diesel & Turbo decided to expand the engine portfolio with engine designs that allow operation on fuels with low flashpoints.

Since then, nine engines of the 50-bore MAN B&W engine design intended for operation on methanol have been ordered. The orders placed are based on MAN Diesel & Turbo’s proven ME-LGI design concept and the engines will be delivered in 2015 from various licensees.

On 17 March 2015, the first test on methanol was completed at MAN Diesel & Turbo’s Diesel Research Centre in Copenhagen, Denmark, in the presence of classification societies, ship-owners, licensees and fuel gas system makers. This technical paper focuses on the technical data obtained from this test and the subsequent test made on a 4-cylinder engine in Japan.

General facts
Why is methanol interesting? Methanol can be stored in conventional non-pressurised tanks and is easy to transport – even to remote areas. Methanol contains no sulphur, and its combustion therefore leads to zero emission of sulphur. Methanol can be made from a vast variety of biomasses. The use of methanol as fuel for marine transportation or stationary power generation, underlines the fuel flexibility of the diesel engine. From being a by-product, methanol has now become a real fuel. New methanol production technologies for collecting flare gas and turn it into methanol are also becoming available. The introduction of this technology is driven by the new emissions regulations in the US, where flaring of gas from oil and gas fields is prohibited in some states.

Methanol is for a large part produced from methane i.e. CH4 as it can be more attractive seen from the logistic point of view even though energy is consumed in the production of methanol. This is particularly relevant to take into account when remote areas are in focus.

The injection of the low flashpoint methanol is done by a booster fuel injection valve (FBIV), which facilitates a supply pressure of only 8 bar of the methanol at engine inlet.

The FBIV system is cooled and lubricated by an engine integrated system. Fig. 1

Results from verification
The successful operation on one cylinder at the MAN Diesel & Turbo Diesel Research Centre in Copenhagen verified the ME-LGI design concept. The heat release measurements taken during the test showed that the combustion of methanol is similar to, or even better than, the combustion of diesel.

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Fig. 1: Cross section of fuel booster injection valve (FBIV)
As illustrated in Fig. 2, the heat release is higher at 0 to 20 degrees CA, and lower at 20 degrees CA or higher. It shows that more energy is released in the period where most of the energy can be transferred into movement of the piston, and it indicates that the engine efficiency is better when running on methanol than when running on diesel. In Fig. 3 it can actually be seen that the engine efficiency when burning methanol at 100% engine load is approx. 1% better than when burning fuel.

The power remains unchanged with operation on methanol and, most importantly, the consumption of methanol seems to be slightly lower than the consumption of diesel.

The engine performance is measured during operation in high-load tuning, and the SFOC values are shown in fuel equivalent figures.

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**Fig. 2: Heat release curves at 100% load**

**Fig. 3: Specific fuel consumption curve for diesel and methanol**
As regards emissions, the NO\textsubscript{x} value from operation on methanol is lower compared to diesel. Methanol burns colder and thus, for the same engine settings, produce lower amounts of NO\textsubscript{x} emissions. Fig. 4.

The fuel is supplied to the engine as shown in Fig. 5. The double-walled piping, both in the engine hall and on the engines, means that the level of safety during operation is very high. With adequate purging of the double-walled pipes - whenever operation on 100% pilot oil is required - the continuous power supply is ensured.

![Fig. 4: NO\textsubscript{x} emission for diesel and methanol](image1)

![Fig. 5: Fuel gas supply system for methanol](image2)
The components were dismantled for inspection and showed no signs of cavitation or wear, Fig. 6.

**Design focus in the future**

The future design focus will be on evaluating the long-term operation on methanol for items not yet seen during the short-term tests.

Even though the ME-LGI concept has only recently been successfully verified, the basics of the concept have been known for many years.

The ME-LGI design is available for the full engine programme both for marine and stationary applications, Fig. 7.

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*Fig. 6: Parts dismantled after test on methanol*

*Fig. 6: The MAN B&W two-stroke low speed engine programme*
Reference:

Paper: Fuel Flexibility Done Right -
MAN B&W ME-GI-S and
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