The Flexible Dual-Fuel Solution

Unveiled at a major event at MAN Diesel & Turbo's Copenhagen Diesel Research Centre in May 2011, the ME-GI engine allows the use of either oil or gas fuel while working in the highly efficient Diesel cycle. With an order book that continues to be filled up, on this page, René Sejer Laursen, from MAN Diesel & Turbo in Copenhagen, answers questions on the culmination of many years' work. On the right, we hear from Teekay, the customer.

Now that there are orders for vessels with the ME-GI engine, what makes you so confident that you have the experience for such a gas-injected model?
The ME-GI is a diesel engine, and we have been designing diesel engines for more than 100 years. The ME-GI's electronic hardware and most of the software is based on our ME-type electronics that have been in successful service for over a decade. We first installed a 40 MW stationary 12K90MC-GI in Japan in 1994. This, along with extensive testing on our in-house research engine, as well as demonstrations in front of customers at our licensees in Japan and Korea, has provided convincing evidence that we have perfected the gas components and supporting systems.

What is pilot oil and what is it needed for?
The pilot oil starts the combustion process, as the ignition of methane is slow. In a high-pressure ME-GI DF engine, gas is injected only after the combustion air is compressed, after which it is ignited by the pilot oil injection. The gas burns immediately after injection, causing a total and complete burning. Hence there is no need for derating to avoid knocking, and the large methane slip as is normal with the Otto cycle is virtually non-existent. In a low-pressure DF engine, gas and air are mixed before compression in the cylinder. Unintended ignition can take place (knocking), which is one of the primary reasons these engines are significantly derated in power.

What is the amount of the pilot oil?
We guarantee a maximum pilot fuel of 3%.

Otto-cycle engines require high quality gas – What about the ME-GI?
If we look at the quality of natural gas worldwide, less than half has a methane number higher than 80. In an Otto-cycle, low-pressure engine, power will be reduced quickly with a lower methane number. By working in the Diesel cycle, where knocking is not an issue, high gas quality is not required.

How much methane slip will there be on an ME-GI engine, and what’s the effect?
The methane slip on the ME-GI is virtually undetectable due to its operation in the Diesel cycle. When measurable, it is some 0.2 g/kWh. The methane slip from an Otto-cycle engine during routine operation can be up to 5% of the gas and, during manoeuvring, can be 10%. This represents a direct efficiency loss since methane is, in fact, the fuel and this is an unburnt or wasted portion that needs to be added to the gas consumption number. Note that methane is over 36 times worse than CO₂ as a greenhouse gas. Additionally, since it reflects unburned gas that performed no useful purpose in the engine, it is an important factor in the specific gas consumption.

Is the high-pressure system safe? What safety systems are on the engine that will detect gas leakage?
The system is extremely safe, and has multiple interlocks to ensure safe operation. The gas is in the inner pipe of the double-walled piping, and the external pipe is ventilated a minimum of 30 times per hour. The inner pipe is tested to 1.5 times the operation pressure of 300 bar, and the thickness of the outer pipe is sized to take 1.5 times max. rupture pressure coming from the inner pipe. In the event of leakage, hydrocarbon detectors will change the engine over to fuel operation while purging the system of gas. Such a change-over will take place without the engine stopping and is hardly noticeable. In a high-pressure system there is no need for explosion devices on the engine or bursting discs in the exhaust stack as would be required in a low-pressure system.

At what loads is the ME-GI capable of operating on gas?
At 10% load, the engine will switch from gas burning to purely fuel oil operation. It will then switch back to gas operation automatically when the load goes above 10%. The process is completely transparent and the operator does not have to do anything, as it is all controlled by the ME-GI control system.

Can the ME-GI burn ONLY fuel or gas, or...?
The ME-GI can burn whatever portion of gas or fuel desired, subject to the 10% low-load switchover to gas.

Regarding emissions, it has been indicated that the MAN B&W two stroke ME-GI engine will require an EGR or SCR when Tier III emissions rules come into effect in 2016. Is that the case?
When Tier III comes into effect, the ME-GI will utilise either EGR or SCR to achieve appropriate NOₓ levels. This is a consequence of the high efficiency of the Diesel cycle because NOₓ is formed when burning gas at high temperatures. With a lower combustion temperature, less NOₓ is formed. However, that also means a much lower efficiency. Otto-cycle engines that run only on gas will not require EGR or SCR due to the lower temperature/efficiency but, if they are to run on fuel oil, will require SCR. In effect, they would not be dual-fuel engines, they would be gas engines as they cannot burn fuel without after-treatment. Note that there is no need for scrubbers with an ME-GI system.

What power ratings are the ME-GI engines available in?
The entire MAN B&W product line of two-stroke engines from the 5-cylinder S30 at 3,200 kW, to the 14-cylinder K98 at 87,220 kW are available as ME-GI. In addition, all stroke lengths (L, S and G) are available as ME-GI. Because the necessary hardware changes from ME to ME-GI are not major, it is not a significant issue to make as a gas-injected engine. Lead time is essentially the same as for a standard ME engine, which can vary from yard to yard and depends on the current order backlog.

Randi Sejer Laursen, MAN Diesel & Turbo in Copenhagen
Teekay Gives its OK to ME-GI

Tony Bingham, Director of Business Development and Technology at Teekay Shipping discusses the reasons his company chose MAN Diesel & Turbo’s dual-fuel, two-stroke ME-GI engine and their expectations for the future.

What was the background behind Teekay choosing the ME-GI engine?

At Teekay we believe that it is advancements in technology that will drive change in the shipping industry faster in the next ten years than it has over the last 20. Teekay has been watching the development of the ME-GI engine for several years and has been involved in the qualification process with other ship owners and charterers.

Teekay went through a lengthy process of investigating the possibility of re-engining some LNG steam ships and it was during this project that the ME-GI solution showed itself to be a logical choice for the future. The fuel savings it provided together with the extra gas that could be delivered to the customer by removing the steam plant resulted in an extremely attractive payback period. The steam plant replacement project was the stimulus for us to investigate the use of ME-GI in a newbuild project.

We worked very closely with DSME over a two year period on the newbuild project and after confirming the design, economics and the readiness of the charterers to accept the new engine arrangement, we placed the order in December 2012 confident that these vessels would be the next generation of LNG ships. In summary, when we set out on this project we wanted to:

- Reduce Drive Train Complexity
- Reduce Fuel Consumption
- Lower Opex Costs
- Deliver Customer Value

Teekay considered re-engining existing vessels before choosing the ME-GI engine, in great part due to its flexibility and efficiency.

What specific considerations did you take into account in making your choice of engine?

In selecting the ME-GI we recognised a number of key factors:

- The engine is based on proven technology in that the base engine is used in the majority of ships world-wide and Teekay had 96 of these engines in its own fleet at the time of ordering.
- The base engine has proven itself to be very reliable and is well known to our seagoing engineers, who are very confident in the engine. The only new part was the fuel injection system which we worked on and qualified together with the number of other ship owners and charterers.
- The fuel consumption is significantly lower than a medium-speed diesel.
- We looked at emissions and the future legislation and found the engine could be compliant.
- We considered methane slip and the growing debate around the subject and found the engine to give the lowest slip of all the propulsion plants.
- We also looked at the through life operational costs and established the engine to be the most economic of all the solutions available.

What benefits do you expect to gain from using the ME-GI?

We expect to see a reduction in OPEX from this engine but significantly the ME-GI has given us a competitive advantage with an engine that burns 26 to 30 tonnes less fuel per day on a HFO equivalent basis than the most modern SFDE installations. Whilst this is an advantage for us tendering for projects, it is really the customer who is benefiting from the fuel savings and reduction in OPEX.

Other, ME-GI-related advantages include:

- It is a well-known engine and our engineers have been very positive about the selection and look forward to the new vessels arriving into the Teekay fleet.
- There will be a reduction in high voltage components in the engine room so we see a reduction in the safety risks associated with high voltage.
- We will have vessels which meet and exceed the EEDI requirements making them the most energy efficient LNG ships available.

How positively do you expect the ME-GI to impact on your fuel budget?

The fuel savings will be seen by the customer, however it is not just the fuel savings. The design we have developed with together with DSME will result in the customer being able to deliver more cargo on an annual basis, thus improving their economics further.

Is it a challenge being an early adopter of this technology?

We have worked hard to promote the ME-GI technology through presentations to potential customers and as a result we have laid our design out for all to see. The disadvantage of our openness has been that the competitive advantage has been short-lived with a steady increase in the adoption of the technology being realised.

We have found that charterers are very interested and compliant on what we have done and our work has been validated by our own internal teams. The industry will see variations on the theme as we move forward but we believe our solution is still the optimum arrangement ordered to date. Over the last 12 months we have seen a shift in tenders being issued, with ME-GI technology now being specified as the alternative propulsion solution for a charter or an option for serious consideration.

Generally speaking, how do you see the market developing in the future in terms of fuels and engine technology?

The future is going to be increasingly focused on efficiency and the environment, therefore engines that can operate on fuels which are less onerous on the environment are going to be key. This may not be engines that just burn methane but will include other gas based fuels such as methanol, DME and LPG. We are already looking for the next solution, the next step change in technology. We cannot see it yet but as we said above technology is moving fast and we will be ready for it.

In light of this, how important will the ME-GI engine’s flexibility be?

The ME-GI has met and exceeded our requirements, it is technology that is proven, reliable and available today. It is the most efficient solution available at the moment and the whole vessel design exceeds the Energy Efficiency Design Index specified for ships to be built in 2025. We have a vessel that is going lead the next generation of LNG ship design and be competitive for many years to come.