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## EcoEGR coming to your Tier III engine soon

MAN B&W two-stroke diesel engines use selective catalytic reduction (SCR) or exhaust gas recirculation (EGR) to comply with IMO Tier III requirements. The choice between the two depends on engine SMCR, ship type, fuel type, CAPEX and OPEX and other conditions related to the standards and preferences of the engine builders and yards.

One of the advantages of EGR is the compact integration of most of the equipment on the engine body itself, providing minimum extra work on the test bed and during sea trials for installation, commissioning and NO<sub>x</sub> certification, as shown in Fig. 1.

For Tier III engines with EGR, we will introduce an SFOC optimised version of the EGR. This is a new tuning method of the

engine in Tier II mode and Tier III mode which will lower the SFOC without increasing the NO<sub>x</sub> emission. This is obtained by using a fuel optimised engine tuning simultaneously with operating the EGR with 10–15% recirculation in Tier II mode and with slightly increased recirculation in Tier III mode compared to the standard EGR control. The new tuning method is designated EcoEGR.

Compared to today's standard EGR, the EcoEGR will result in a 1.5–6 g/kWh reduction of SFOC for engines operated in Tier II mode. When operated in Tier III mode, the reduction in SFOC will be 0–2 g/kWh. If the recirculation system fails, the engine can still operate in Tier II mode and comply with IMO NO<sub>x</sub> requirements.

The EcoEGR tuning has been shoptested on the engine types 6G70ME-C9.5 and 7G80ME-C9.5. Besides the gains in SFOC, EcoEGR also gives lower temperatures of the components in the combustion chamber.

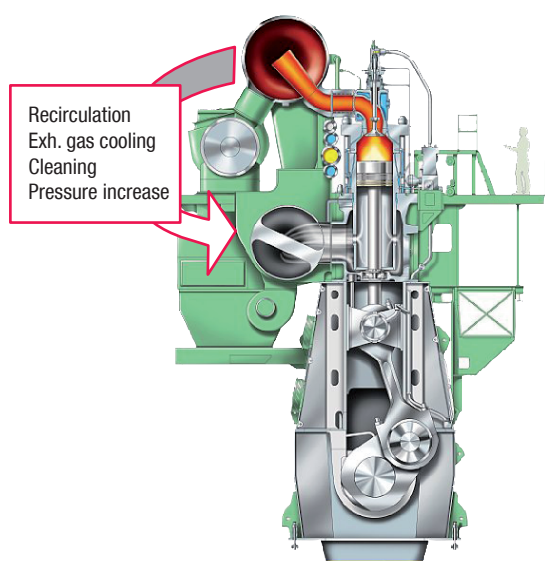
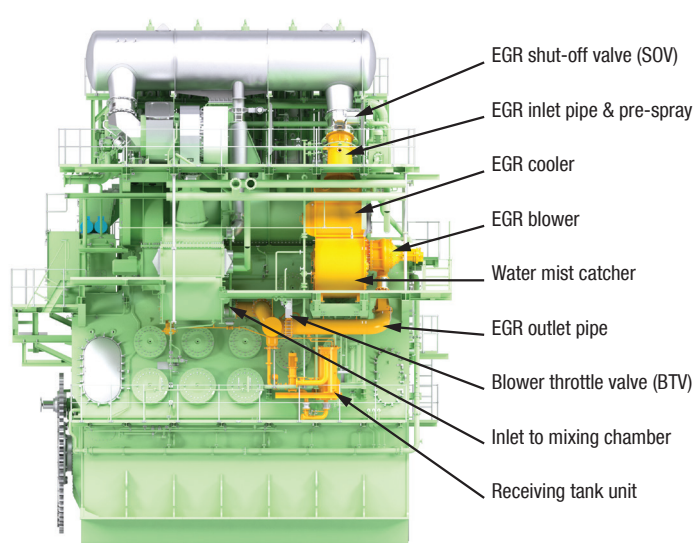


Fig. 1: EGR principle



# Market Update Note



A comparison of the test results is shown in Fig. 2.

EcoEGR is expected to be fully developed in the second half of 2018, and it will initially be available for ME-C engine types. EcoEGR can also be applied to ME-C-GI/LGI engines, but the saving in SFOC is less compared to ME-C. EcoEGR is not considered for ME-B engines.

For engines running on low-sulphur fuels (<0.5 %S), considerable overall savings are obtained with EcoEGR tuning, even when counting in the consumption of NaOH and power, and possible sludge disposal.

When operating in Tier II mode on high-sulphur fuels (2-3.5% S) and with a SO<sub>x</sub> scrubber solution to comply with the IMO 2020 sulphur cap, our present estimate shows the additional costs for NaOH, power, and the sludge disposal required to operate the EcoEGR system will counterbalance the savings in SFOC.

The design differences between EcoEGR and standard EGR for new orders will be:

- For single turbocharger (TC) applications it will still be an EGR bypass (EGRBP) concept with only a few differences. See Table 1 in the attachment for further details.
- For multiple TC applications the present TC cut-out (EGRTC) concept is replaced by a bypass solution and the TCs will be of equal size. See Table 2 in the attachment for further details.

We expect to introduce EcoEGR in our engine programme in the second half of 2018. Until the design is ready for release, we expect that some owners would like to know if their Tier III engines on order or to be ordered can be prepared for a later modification from standard EGR to EcoEGR.

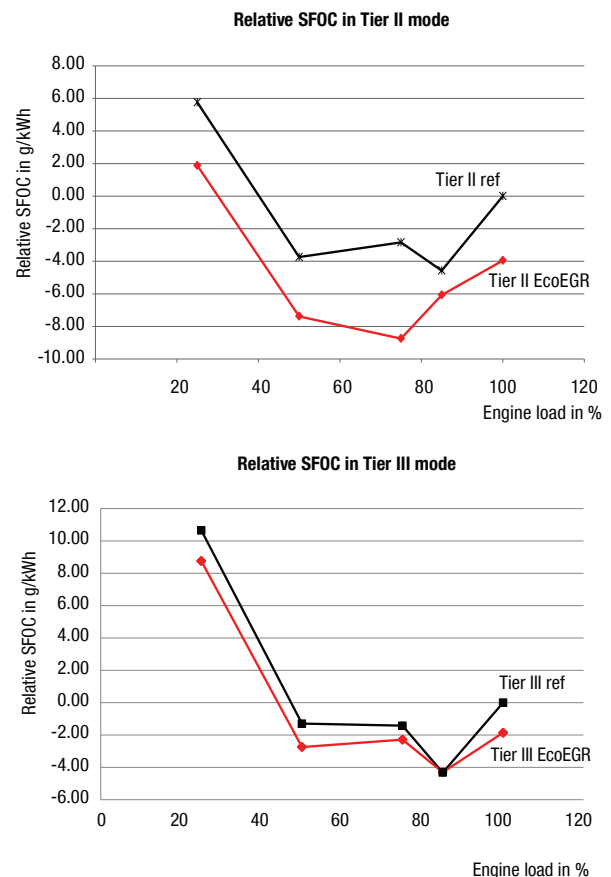


Fig. 2: Comparison of recirculation rate and SFOC for standard EGR and EcoEGR in Tier II mode and Tier III mode



# Market Update Note

Such possible preparations are briefly outlined below and more detailed in attached tables for different TC configurations:

- For engines with one TC and EGRBP, there will only be a few design changes, thus little preparation is needed.
- For engines with two TCs and standard EGRTC, the large TC will need an upgrade in capacity, which sometimes means installing a bigger TC frame size.
- For engines with more than two TCs, the necessary changes are engine specific due to limited space, and cannot be outlined beforehand, but must be investigated case by case.
- The time with active EcoEGR in Tier II mode will require larger tanks for NaOH and sludge storage, furthermore the increased recirculation in Tier III mode will require an increased capacity of the water treatment system. The yards must pay attention to both issues.
- For all engines, a retrofit solution requires a dual IMO certificate either obtained at the shop test or later in service after the retrofit. The torsional vibration conditions have to be investigated for both solutions as well.

For already signed orders of ships with Tier III engines, the shipowners are recommended to contact the engine builder through the shipyard to learn about the possibilities for applying EcoEGR, either installed from the beginning or as a retrofit. The possibilities will depend on engine type and delivery time. The decision to install EcoEGR must be based on a detailed analysis of the net savings from reduced fuel costs versus additional costs for continuous operation of the EGR. The selected fuel type and the engine operational load profile will have a significant influence on the savings.

# 1. From Standard EGRBP to EcoEGR

## Table of Differences: One TC Application



Item	EcoEGR	Preparation of EcoEGR Retrofit	Retrofit of EcoEGR
<b>Nozzle</b>	Spray pattern changed		New nozzle
<b>Compression volume</b>	Increased		Thinner shims
<b>Turbocharger</b>			
<b>Fuel injection</b>	Timing changed		New control parameter
<b>Fuel injection</b>	Rate shaping changed		New control parameter
<b>Exhaust valve timing</b>	Timing changed		New control parameter
<b>Exhaust gas bypass (EGB)</b>			
<b>Cylinder bypass (CBV)</b>			
<b>Water treatment system (WTS)</b>	Higher capacity	Capacity to be adjusted due to the increased recirculation in Tier III mode	
<b>Central cooling water system: LT and SW pump capacities and cooler size</b>	Higher capacity	Capacity to be adjusted due to the increased recirculation in Tier III mode	
<b>Freshwater generator</b>	Higher capacity (*Only for operation on fuels with S>0.5%)	Capacity to be adjusted due to the increased water amount needed in EcoEGR mode.	
<b>Sludge tank at hull side</b>	Increased volume	Volume to be increased	
<b>NaOH tank at hull side</b>	Increased volume	Volume to be increased	
<b>NO<sub>x</sub> technical file</b>	Technical file for Tier II and III modes	Must be made for Tier II and III modes at the shop test for both Standard and EcoEGR	Submit for approval
<b>Torsional vibration calculation</b>	Different for EcoEGR	Must be made for both Tier II and III modes for EcoEGR	Submit for approval

## 2. From Standard EGRTC to EcoEGR

Table of Differences: Two, Three or Four TC Application



Item	EcoEGR	Preparation of EcoEGR Retrofit	Retrofit of EcoEGR
<b>Nozzle</b>	Spray pattern changed		New nozzle
<b>Compression volume</b>	Increased		Thinner shims
<b>Turbochargers</b>	Changed from a concept with large and small TCs and cut out of the smaller TCs to a concept with bypass and several TCs of the same size	Depending on the TC layout, the large TCs need a frame size one size larger to ensure sufficient TC capacity at retrofit	Capacity upgrade of large TCs Small TCs removed or cut out permanently
<b>Scavenge air cooler</b>	Higher capacity	Capacity to be adjusted	
<b>Fuel injection</b>	Timing changed		New control parameter
<b>Fuel injection</b>	Rate shaping changed		New control parameter
<b>Exhaust valve timing</b>	Timing changed		New control parameter
<b>Exhaust gas bypass (EGB)</b>	EGB functionality needed	Flange on exhaust receiver and ships exhaust pipe	Pipe piece and valve fitted New control parameter
<b>Cylinder bypass valve (CBV)</b>	Opens at different engine loads		New control parameter
<b>Water treatment system (WTS)</b>	Higher capacity	Capacity to be adjusted due to the increased recirculation in Tier III mode	
<b>Central cooling water system: LT and SW pump capacities and cooler size</b>	Higher capacity	Capacity to be adjusted due to the increased recirculation in Tier III mode	
<b>Freshwater generator</b>	Higher capacity (Only for operation on fuels with S>0.5%)	Capacity to be adjusted due to the increased water amount needed in EcoEGR mode.	
<b>Sludge tank at hull side</b>	Increased volume		
<b>NaOH tank at hull side</b>	Increased volume		
<b>NO<sub>x</sub> technical file</b>	Technical file for Tier II and III modes	Must be made for Tier II and III modes at the shop test for both Standard and EcoEGR	Submit for approval
<b>Torsional vibration calculation</b>	Different for EcoEGR	Must be made for both Tier II and III modes for EcoEGR	Submit for approval