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Combustion System Development for IMO Tier 2

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Abstract: As already decided by an IMO MARPOL Conference Resolution in 1997, the Marine Environment Protection Committee has now, after the coming into force of Annex VI to the MARPOL Convention in 2005, been invited to review the NO_x emission limits. An IMO Working Group (WG) agreed in April 2006 that a two-step approach should be implemented with Tier 2 limits, achievable preferably by in-engine measures from 2010 and a further tightening of the limits from 2015 (Tier 3). The WG considers the NO_x reducing potential of in-engine measures to be up to 20% for medium-speed HFO four-stroke diesel engines.

This article describes investigations carried out at MAN Diesel SE to reduce emissions of medium-speed diesel engines. The aim of the experiments was to show which technology is required for engines with a mean effective pressure of mep $\approx$ 26 bar in order to fulfil future emission limits without affecting fuel consumption.

It is well known that, with a combination of increased compression ratio and modified valve timing (Miller cycle), it is possible to reduce the NO_x emissions significantly. Experimental studies on the research engine 1L 32/44 showed, that increasing smoke values at low load can be counteracted with variable valve trains and electronically controlled injection systems.

The flexibility of common rail injection systems is particularly advantageous. Different CR systems and strategies with pre-, post- and boot-injections have been analysed and tested to find out their potential to lower smoke emissions and improve the $NO_x - sfoc$ trade-off.

The experimental results presented show that, for medium-speed engines with a mean effective pressure of mep $\approx$ 26 bar, a 20% NO_x reduction can be achieved with in-engine measures and with no change in fuel consumption in the 70-85% load range.

However, should the required NO_x reduction be approximately 30%, an increased fuel consumption has to be accepted and the engines rated power has to be reduced. Alternatively, a 30% NO_x reduction with no change in fuel consumption and rated power could be achieved with additional external measures, such as fuel-water emulsion or with more extreme Miller valve timings and a two-stage turbocharging system.