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Individual Cylinder Ultra-fast NO Measurement for Marine Diesel Engines

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Abstract: Detailed measurement of engine exhaust emissions is most important for the introduction of appropriate emission reduction methods. Up to now the NOx optimization on full sized marine diesel engines has been very time consuming and cost-intensive.

Individual Cylinder NO measurement allows to evaluate an engine component (e.g. injection nozzle) by installing it only in one cylinder. This provides a very high potential for cost saving during the development especially for large marine diesel engines.

A Fast Response Chemiluminescense Detector has been used in conjunction with a customised sampling probe, to evaluate the NO concentration in the gas stream of one individual exhaust port of a multi cylinder marine diesel engine. The measurements were done with crank angle resolution, under steady state as well as transient engine load conditions. The design characteristics of the NO probe and measurement system were optimized on a special made test bench. It was shown that it is possible to measure the temporal variations in the NO concentration within one cycle of one individual cylinder. The advanced system for individual cylinder NO measurements is linked to a measurement system for engine operational and performance parameters.

For marine diesel engines using heavy fuel and with large exhaust receiver diameters, the mechanical reliability and measurement availability of the sampling probe becomes important. Frequent blocking rendering the probe inoperable should be avoided and the breaking of sample probe in the exhaust receiver can lead to severe damage of the downstream turbocharger turbine.

The development of individual cylinder NO measurement was focused on:

- Design of an advanced fast sampling system for marine diesel engines
- Adaptation of the system to avoid blocking at high particulate emission levels
- Adaptation to highly pulsating flow in the exhaust port stream
- Sampling probe and equipment reliability

The activity resulted in an NO emission measuring technique of very high accuracy for individual cylinder investigations. Individual cylinder NO emission measurements on multi cylinder engines can be highly cost effective, since each cylinder can be adapted and monitored separately. Engine designers can evaluate engine settings in shorter time and the development of exhaust gas aftertreatment and other advanced combustion concepts (e.g. injection timing) can be done on basis of real time behaviour or even cyclic variation. Moreover the modelling of the combustion can be better validated experimentally and very expensive test bed running time can be reduced.

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