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Ammonia measurements using FTIR in high pressure conditions

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Key Words:

Abstract

The application of two-stage turbocharging technology on Wärtsilä diesel engines (4-stroke) is focusing on developing advanced engine technology, which with the turbocharger, is able to reach the highest possible performance and become a cost-effective commercial solution for its customers. In the new engine designs, two turbochargers are arranged in series to generate increased air pressure, airflow and a superior turbocharging effect. At the same time, both fuel consumption and CO_2 emissions are reduced. Further emissions reduction can be achieved with additional engine systems or by the use of exhaust gas after-treatment like SCR. SCR reactor is located between the HP and LP turbines for ensuring suitable temperatures for SCR reactions. Due to pressurized conditions a compact SCR reactor and mixing duct can be used.

This study concentrates on measurement and determination of ammonia concentration levels after the urea injection point in a specific mixing duct to ensure the sufficient ammonia conversion levels before catalyst in an inter-turbine SCR (ITSCR) installation. Ammonia concentrations were measured in different sampling position after the injection point and analyzed using Fourier Transform Infra Red (FTIR) –technique. A specific measurement arrangement was used to conduct the measurements at high pressure side (between two turbochargers). Sample before SCR was led to the analyzer through temperature controlled sampling probe and heated metallic filter. Total sample flow was divided into two parts; by-pass flow and sample flow to analyzer. Sample flow to analyzer was about 5 litres per minute (lpm) and by-pass flow was about 10 lpm, except with engine load of 25 % there was no by-pass flow. Temperature of the sampling line was adjusted to be 180ºC. Length of the sample line was about 2 meters. Sampling arrangement before SCR is shown in Figure 1.

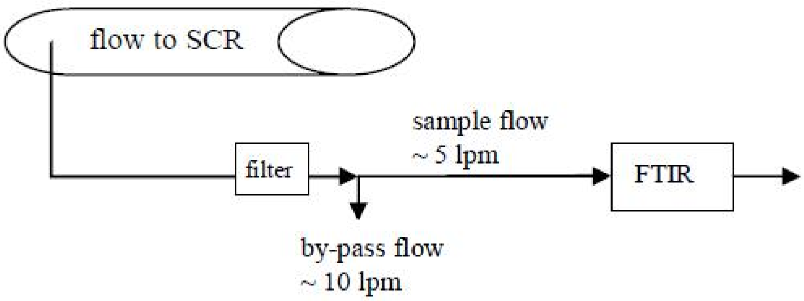

Figure 1. Ammonia sampling arrangement in inter-turbine SCR application.

The results of the measurements were compared to a 1D- model on the behaviour of single urea-water droplet in exhaust gas. The model is a time-dependent nonlinear equation for three unknowns: droplet radius, droplet velocity and droplet temperature. At certain time instant, the values of the unknowns are obtained by solving a nonlinear system of equations. The model includes several material parameters related to the exhaust gas and droplet. The obtained measurement results were in good agreement with the 1D- model results and can be further used to design more compact mixing solutions.

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