Engine bench tests over a Ag/Al₂O₃ converter for continuous HC-SCR under lean conditions using a 6.4 liter common rail turbo diesel off road engine

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Introduction
Selective catalytic reduction of NO with hydrocarbons (HC-SCR) has received much attention as one of the most promising and straightforward methods for reducing NOₓ emissions under conditions of excess oxygen. Since the early work of Held et al. [1] and Iwamoto et al. [2] a large number of different materials have been proposed and tested for HC-SCR. Among these, Ag/alumina has shown high activity both in laboratory and full-scale tests when applied in a passenger vehicle [3]. In practice, all engines for heavy duty and off road purposes are diesel engines. Therefore, the emission regulations for these engines have also continuously become more stringent [4]. In this study we have investigated the activity of a Ag/alumina converter for NOₓ reduction by HC-SCR in engine bench tests using a 6.4 liter common rail turbo charged off road diesel engine.

Materials and Methods
A 2 wt.% Ag/alumina catalyst, described in [5], was wash coated on a cordierite monolith bricks (400 cpi). A 6.4 liter common rail turbo diesel engine manufactured by Sisu Diesel Oy was used in the engine bench tests and a commercial standard diesel fuel available in Finland (less than 10 ppm sulfur, 25-30 % aromatics) was used to run the engine. The converter consisted of five independent modules, all containing one catalytic brick (Figure 1). By removing some of the modules it was possible to alter the catalyst volume. Post injection was used to inject diesel fuel as reducing agent for the HC-SCR. The levels of NOₓ, CO and THC emissions were continuously determined both up streams and down streams of the converter with two Horiba Mexa analyzers. Moreover, the temperature could be monitored and exhaust gas composition could be analyzed after each brick separately due to the flexibility of the system (Figure 1). The performance of the catalyst was studied by systematically varying the catalyst volume, engine load and amount of post injected diesel.

Results and Discussion
The activity of the Ag/alumina catalyst for NOₓ reduction was studied by systematically varying the catalyst volume and running the engine at different loads. The results as a function of injected diesel fuel, expressed as the HC₁/NOₓ-ratio, over one, two and three Ag/Al₂O₃ bricks are shown in Figure 2. In these tests the engine was run at a load of 50 %, giving a converter temperature of about 380 °C. As shown, a reduction of approximately 55% in NOₓ level was achieved when three Ag/alumina bricks were used and at an amount of post injected diesel corresponding to a HC₁/NOₓ-ratio of 6.6. Such a result is very promising keeping in mind that there is a large potential to further optimize the system which is the scope of future work.

Figure 1. The converter system containing five Ag/alumina bricks and the Horiba analyzers used in the study.

Figure 2. NOₓ reduction activity over one, two and three Ag/alumina bricks as a function of the amount of diesel fuel injected, expressed as HC₁/NOₓ-ratio.

Significance
The results from this study are of highest industrial importance as they show that the HC-SCR technique in combination with a Ag/alumina catalyst has the potential for reducing NO from an off road engine to meet the coming legislation for these applications.

References