Engine bench tests over a Ag/Al_2O_3 converter for continuous HC-SCR under lean conditions using a 6.4 liter common rail turbo diesel *off road* engine

Kalle Arve[1], Kari Eränen[1], Jani Hoikkala[2], Krister Ekman[2],Seppo Niemi[2] and Dmitry Yu. Murzin[1]*
[1]*Åbo Akademi University,20500 Turku, Finland*
[2]*Turku University of Applied Sciences, 20700 Turku, Finland,*
*dmurzin@abo.fi

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 NO_x 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 NO_x reduction by HC-SCR in engine bench tests using a 6.4 liter common rail turbo charged *off road* diesel engine.

Materials and Methods

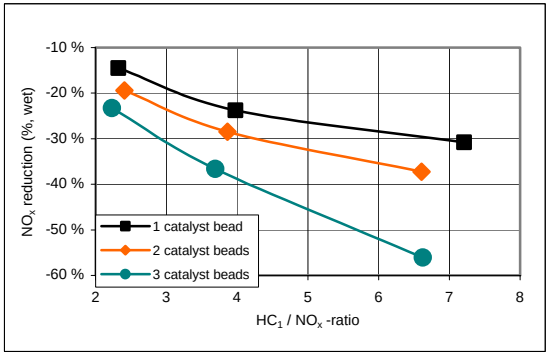
A 2 wt.% Ag/alumina catalyst, described in [5], was wash coated on a cordierite monolith bricks (400 cpi). A 6.4 liter common rail turbo diesel engine manufactured by Sisu Diesel Oy was used in the engine bench tests and a commercial standard diesel fuel available in Finland (less than 10 ppm sulfur, 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 NO_x, 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 NO_x 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 HC_1/NO_x-ratio, over one, two and three Ag/Al_2O_3 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 NO_x level was achieved when three Ag/alumina bricks were used and at an amount of post injected diesel corresponding to a HC_1/NO_x-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. NO_x reduction activity over one, two and three Ag/alumina bricks as a function of the amount of diesel fuel injected, expressed as HC_1/NO_x-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

1. Held, W., Koenig, A., Richter, T., and Puppe, L., *SAE Paper* 900496 (1990).
2. Iwamoto, M., Yahiro, H., Shundo, S., Yu-u, Y., and Mizuno, N., *Appl. Catal*. 69 (1991).
3. Klingstedt, F., Arve, K., Eränen, K. And Murzin, D. Yu., *Acc. Chem. Rev.*, 39 (2006).
4. www.DieselNet.com.
5. Arve, K., Klingstedt, F., Eränen, K., Lindfors, L.-E., Murzin, D. Yu., Čapek, L., Dědeček, J., Sobalik, Z., Wichterlová, B., *Top. Cat.*, 30-31 (2004).