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Reduction of NO_2-Emissions from Continuously Regenerating Particulate Filters by NOxOPT-Technology

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Abstract

Conventional continuously regenerating particulate filters produce an excess of NO_2, thus aggravating the well known problems with ground level ozone formation ("summer smog"). UMTEC has developed an exhaust gas treatment system that employs a backpressure-controlled partial bypass for the oxidation catalyst (NOxOPT). The additional NO_2-emissions produced by continuously regenerating particulate filters were decreased by 70-90%.

Problem

Conventional continuously regenerating particulate filters convert NO to NO_2 in an oxidation catalyst which is positioned upstream of the filter. This NO_2 is used for continuously oxidizing the soot accumulated in the filter. Typically, a considerable excess of NO_2 is supplied in order to guarantee the complete regeneration of the filter even under the most detrimental conditions. However, NO_2 is much more poisonous than NO and a direct precursor of ozone. Thus, the conventional continuously regenerating particle filter promotes the development of ground level ozone. Also, NO_2 causes malodours which leads to complaints for example by the passengers of city buses.

Solution

A controlled oxidation catalytic converter system called NOxOPT was developed. The oxidation catalyst is supplied with a bypass that includes a flap. During default operation, the flap is open and the exhaust-gas flows through the bypass. As the NO_2 concentration is not sufficient to regenerate the filter, the soot accumulates and the backpressure rises. As soon as the backpressure exceeds a given limit, the control system closes the flap. Now all exhaust-gas flows through the catalyst and sufficient NO_2 for regenerating the filter is produced. Consequently, the backpressure decreases again. Once the filter is completely regenerated, the flap opens and the system is run in bypass mode again. With this modification, continuously regenerating particulate filters can be run without excessive NO_2-emissions.

Experimental

Prototypes of NOxOPT were manufactured and tested. First experiments were carried out on an engine test rig. Then, the conventional continuously regenerating particulate filter system of a NEOPLAN-Centroliner-bus was adapted to a NOxOPT-System. Experiments were carried out during regular line-service at the public transport system of Verkehrsbetriebe Zürich VBZ. Backpressure, Temperatures and pollutants were all measured and registered.

Results

The additional NO_2-emission produced by continuously regenerating particulate filters was decreased by 90% on the test rig and by 75% in practice on the bus. After regeneration, the backpressure fell back completely to the baseline. With most tests, the ratio between loading period and regeneration period was 2:1.

Prospects

NOxOPT has been shown to minimize the NO_2-emissions of diesel engines successfully. Thus, ground level ozone formation and malodours caused by NO_2 are minimized. The system has great potential in niche applications, e.g. for inner-city bus traffic or for operation in enclosed spaces. For developing the prototype to a serial model, we are currently looking for industrial partners.

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Solution

A controlled oxidation catalytic converter system called NOxOPT was developed. The principle is shown in *fig.1*:

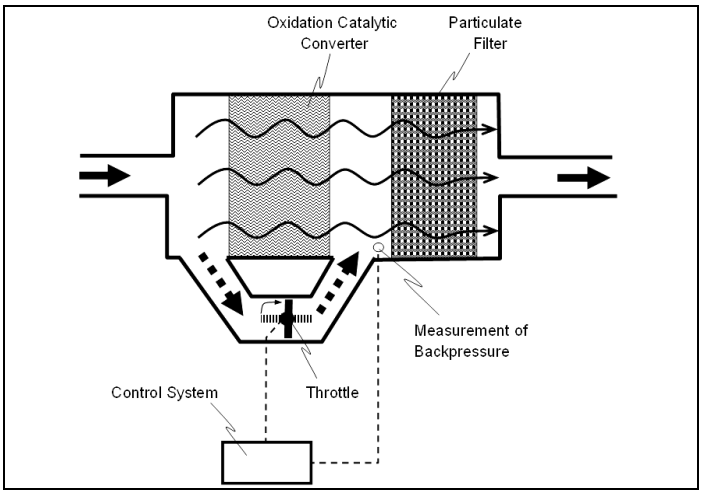

Fig 1: Principle of NOxOPT

The oxidation catalyst is supplied with a bypass that includes a flap. During default operation, the flap is open and the exhaust-gas flows through the bypass. As the NO_2 concentration is not sufficient to regenerate the filter, the soot accumulates and the backpressure rises. As soon as the backpressure exceeds a given limit, the control system closes the flap. Now all exhaust-gas flows through the catalyst and sufficient NO_2 for regenerating the filter is produced. Consequently, the backpressure decreases again. Once the filter is completely regenerated, the flap opens and the system is run in bypass mode again. With this modification, continuously regenerating particulate filters can be run without excessive NO_2-emissions.

Experimental

Prototypes of NOxOPT were manufactured and tested. First experiments were carried out on an engine test rig *(fig.2)*. Then, the conventional continuously regenerating particulate filter system of a NEOPLAN-Centroliner-bus was adapted to a NOxOPT-System. Experiments were carried out during regular line-service at the public transport system of Verkehrsbetriebe Zürich VBZ *(fig.3)*. Backpressure, Temperatures and pollutants were all measured and registered.

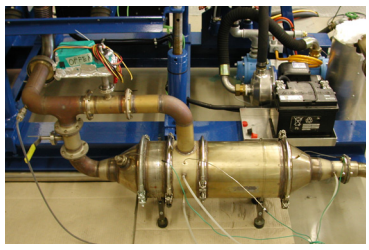

Fig 2: Prototype on an engine test rig

Fig 3: Experimental vehicle

Results

The additional NO_2-emission produced by continuously regenerating particulate filters was decreased by 90% on the test rig and by 75% in practice on the bus *(fig.4)*. After regeneration, the backpressure fell back completely to the baseline. With most tests, the ratio between loading period and regeneration period was 2:1.

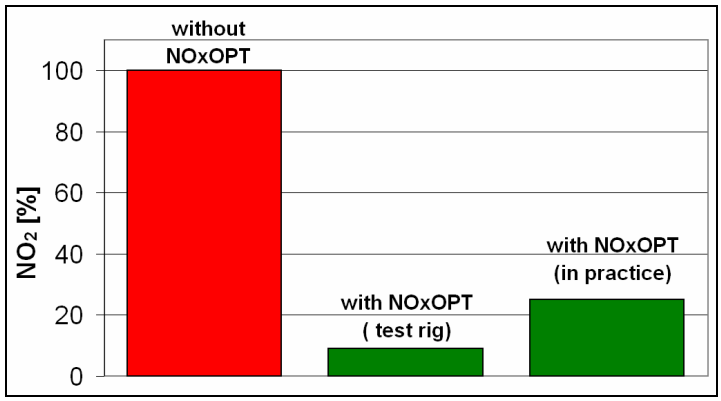

Fig 4: Additional NO_2 emission caused by continuously regenerating particulate filters

Prospects

NOxOPT has been shown to minimize the NO_2-emissions of diesel engines successfully. Thus, ground level ozone formation and malodours caused by NO_2 are minimized. The system has great potential in niche applications, e.g. for inner-city bus traffic or for operation in enclosed spaces.

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