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Institute for Environmental and Process Engineering

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NOxOPT: NO_2-optmised oxidation catalyst

Exhaust Gas Treatment

A discontinuously regenerating particulate filter without excessive NO_2-emission

Fig. 1: NO_2-optmised particulate filter system NOxOPT

Subject: Exhaust Gas Aftertreatment

Background / Problem

The use of a closed particle filter reduces a diesel engine's soot particle output by 97% (mostly over 99.9%). Continuously regenerating particle filters (CRT) are very common in heavy diesel vehicles like buses, trucks or construction vehicles, due to its relative low acquisition cost and its little maintenance for such systems.

CRT's consist of a particle filter for recovering the soot particles, and an oxidation catalyst which is positioned upstream of the filter. The raw exhaust gas first flows over the oxidation catalyst, where the NO (nitrogen monoxide) contained in the raw exhaust gas is oxidised with excess oxygen into NO_2 (nitrogen dioxide). In the downstream particle filter, this NO_2 serves as an oxidation agent for the combustion of the accumulated soot particles ("regeneration"). Thus, the NO_2 is again reduced to NO.

With this method, such a large NO_2 excess must be produced, that the regeneration of the particle filter functions perfectly even under the most unfavourable conditions.

Unfortunately, NO_2 is significantly more harmful than NO, as NO_2 is a strong irritant to the human respiratory system. Furthermore, it participates directly in the formation of ground level ozone. NO_2 emissions are particularly undesirable in confined spaces, e.g. in tunnels, but also in inner city areas. Although the soot particles are effectively removed from the exhaust gas by conventional CRT technology, the emission of harmful NO_2 is dramatically increased. Such a situation is obviously very unsatisfactory, since the already precarious problems with regard to the ozone are made worse.

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Solution

UMTEC has developed the NOxOPT, a regulated oxidation catalyst. Compared to a CRT, the oxidation catalytic converter in the NOxOPT has a flap-controlled bypass through the oxidation catalyst. The flap is open during load operations (Fig. 2). In this case, the main part of the exhaust gas flows through the bypass, creating very little NO_2. The balance flows through the oxidation catalyst. If the gas stream flowing through the oxidation catalyst is insufficient to regenerate the particle filter, the exhaust gas back-pressure increases due to the accumulation of soot in the particle filter. When a preset pressure limit is exceeded, the closure of the flap is activated by a pressure probe and the electronic data processing unit (Fig. 3). Now, the entire exhaust gas flows over the catalyst, by which means sufficient NO_2 is produced for the regeneration of the particle filter. If the filter is burnt free, the exhaust gas back-pressure decreases, and the bypass is opened again. In this manner, the CRT is being operated without a continuous NO_2-excess.

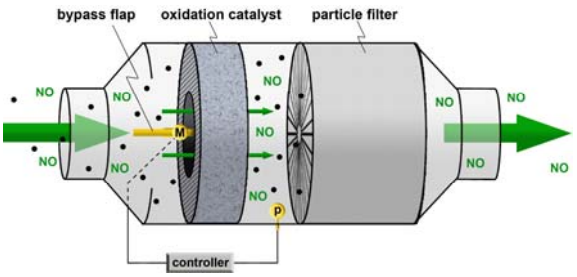

Fig. 2: load operations (flap opened)

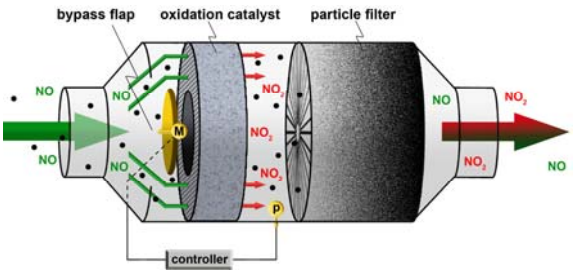

Fig. 3: regeneration operations (flap closed)

Results field test

Already in 2006 a NO_XOPT-prototype has been proven successful on a city bus of VBZ (Verkehrsbetriebe Zürich). In this mode, the emission of NO_2 was reduced by 70% compared with the original CRT. Middle of April 2008, on the same test vehicle, the original CRT was replaced by a commercial NOxOPT-Systeme (Fig. 1). Till end of August 2008 the NO_XOPT-System had completed more than 900 operating hours.

It was observed, that the particle filter was loaded during ¾ of the operating time, ¼ of the operating time was needed to regenerate the particle filter (Fig. 4).

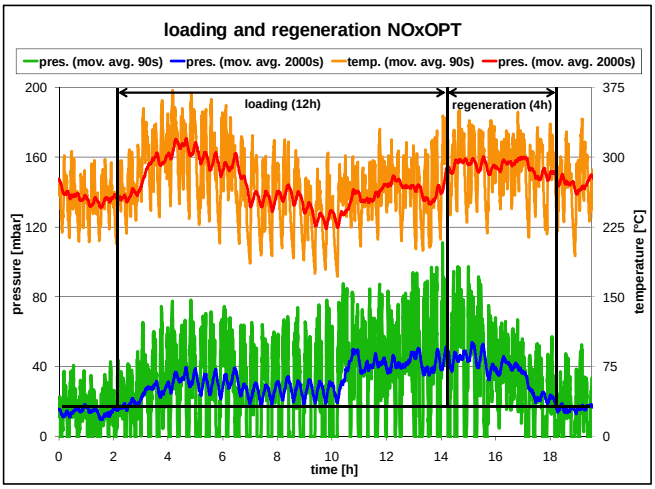

Fig. 4: loading and regeneration

The NO_XOPT emitted 76% less NO_2 during the whole operating time compared with the CRT (Fig. 5, loading mode -90% NO_2, regeneration mode -33% NO_2). On average the NO_2 emissions from NOxOPT are approximately equal to the NO_2 emissions from the raw exhaust gas and thus below the benchmark of 30% NO_2/NO_x.

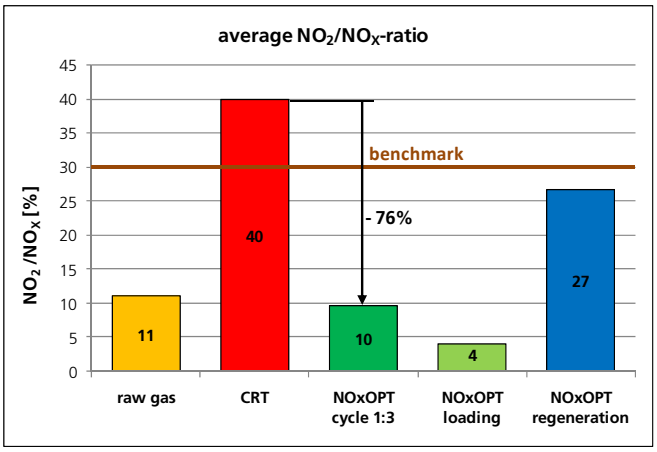

Fig. 5: average NO_2/NO_X-ratio under field conditions

The NO_XOPT is marketed via FILTECTA a Spin-off of UMTEC (www.filtecta.ch). Currently at UMTEC further improvements of the NO_XOPT principle are under development („retrofitting of a retrofit-system"). In 2006 UMTEC has been granted the patent for NO_XOPT.