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"Emergency Regeneration" of DPF

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Abstract

Diesel particulate filters (DPF), such as "Continuously Regenerating Technology" systems (CRT®), must be regenerated by burning off the accumulated soot particles. This requires a minimum threshold temperature around 250°C. At UMTEC a system for the "emergency regeneration" of CRT® at temperatures below 200°C has been developed, whereby the exhaust gases are artificially heated through the catalytic combustion of glycol. Glycol is oxidized on conventional Pt-oxidation-catalysts at temperatures approximately 50°C below those necessary for burning diesel. While regular regeneration takes place on a CRT®-system with NO_2, catalytic combustion of glycol ensures "emergency regeneration" at low exhaust gas temperatures resulting from abnormal operating conditions.

Problem

Diesel particulate filters (DPF), such as "Continuously Regenerating Technology" systems (CRT®), retain even the smallest of particles. To avoid clogging, they must be regenerated by burning off the accumulated soot particles. In CRT® this mechanism only works above a threshold temperature, which is usually around 250°C. Although the temperatures of exhaust gases generally exceed 250°C, particularly in the case of commercial vehicles, there are occasions when the operating conditions are such that exhaust gas temperatures are simply too low to regenerate the filters continuously. For such cases GLYCOKAT has been developed.

Solution

GLYCOKAT is a system for injecting glycol into exhaust gases that pass over an oxidizing catalyst, such as the ones used in CRT®-systems (Fig. 1). The glycol is oxidized in an exothermal reaction thereby heating up the exhaust gas. Compared to diesel fuel, glycol has the advantage of being combustible on oxidation catalysts at temperatures well below 200°C.

While regular regeneration takes place with NO_2, glycol injection ensures "emergency regeneration" at abnormally low exhaust gas temperatures, which can occur, for example, as a result of extended idling periods of the engine.

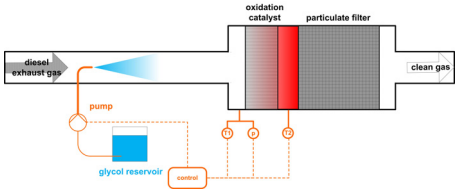

Fig. 1: Active regeneration of a CRT® filter with glycol injection

Former Trials

In initial trials on an engine test rig, the light-off temperatures of various oxidation catalysts were determined for various combustible liquids. This trial showed that glycol oxidizes on a conventional CRT® at temperatures approximately 50°C below those necessary for diesel, e.g. at 180°C instead of 230°C.

Fig. 2 shows the result on a conventional CRT® with glycol and diesel injections. The advantage of glycol with the lower light-off temperature compared with diesel is obvious.

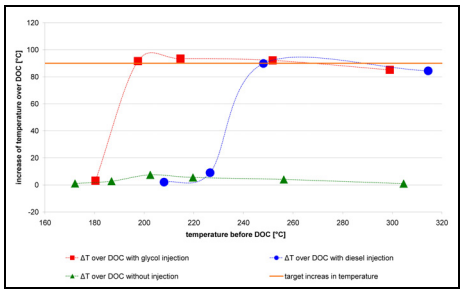

Fig. 2: Increased in temperature over DOC on a conventional CRT® using glycol and diesel.

In contrast to diesel, glycol decomposes into gaseous products at temperatures of around 170°C. This eliminates with the need for an atomizing nozzle or pre-evaporator which, in the case of diesel injection, are also prone to clogging through the formation of coking residues.

First regeneration tests under real life conditions with a basic control unit revealed, that the GLYCOKAT is a very simple and stable running system for auxiliary regenerations. The development was pushed forward with the aim to reach the maturity phase (series-production readiness).

System Description

First the components necessary to reach the state of series-production were focused. These were particularly higher demands in terms of long-life cycle and price. To cover a vast variety of applications a smart controller was developed by "CPK Automotive", a project partner of the UMTEC. The controller was programmed based on this company's data logger (AML Dyntest).

The following figure (Fig. 3) shows the main components of the GLYCOKAT-System: control box (1, data logger and controller) with two temperature sensors (2, prior an after the catalyst) and a pressure sensor (3), a display (4) and a panic button (5) for the manual activation of the regeneration (which is not started automatically). The glycol dosage is driven by the gear pump (6) and pointed directly into the exhaust gas flow. As point of injection a steel tube is used (7, there is no nozzle, contraction etc.). The amount of glycol is adjusted in order to keep a constant temperature after the catalyst.

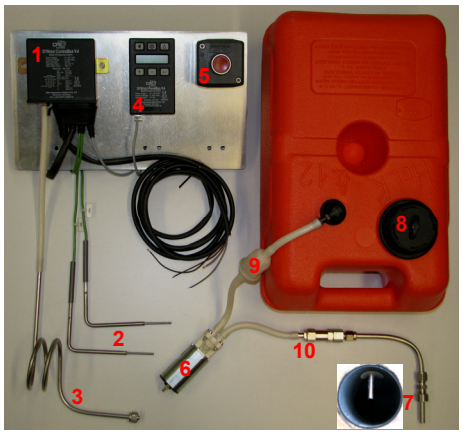

Fig. 3: System components GLYCOKAT

The glycol supply line after the glycol reservoir (8) is designed with a fuel filter (9) to avoid contamination of the pump and a non-return valve (10) prior to the injection point (7). This prevents the reservoir from uncontrolled spills through the injection point and a flow back of the exhaust fumes.

Currently Trials

The system described here is being investigated in various diesel driven motor vehicles. The regenerations are being carried out on engines while idling at elevated speed (outside of all-day use) but also dynamically under real-life conditions.

The following chart (Fig. 4) shows test's results, carried out on a light truck (IVECO Daily, Fig. 5) running under dynamic conditions on a motorway. During the injection the backpressure continuously dropped indicating the successful regeneration of the filter. The temperature of regeneration for this test was limited to 550°C.

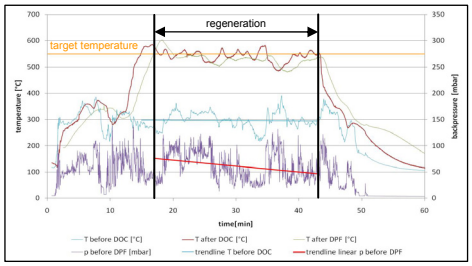

Fig 4: Temperature and backpressure during a controlled regeneration on a motorway

Fig. 5: The test vehicle, an IVECO Daily (light truck)

Next Steps

In the following months various tests are carried out on the following test vehicles:

- Light truck (IVECO Daily, 122kW), HUG Eng., CH
- Excavator (New Holland, 150kW), MBA AG, CH
- City Bus (MAN Neoplan, 228kW), VBZ, CH
- Truck (MAN TGM, 213kW), MAN Schweiz AG, CH
- Fork lift (Svetruck, 150kW), EHC Teknik, S

Focus will be on the fine tuning of the controlling algorithm.

The GLYCOKAT-System was patented by the UMTEC (worldwide). For the commercialization first license agreements have been signed.

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