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"Emergency Regeneration" of DPF with Catalytic Combustion of Glycol

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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 only works above a threshold temperature, which is usually around 220°C. A system for "emergency regeneration" of CRT at temperatures below 220°C has been developed, wherein the exhaust gases are artificially heated through the catalytic combustion of glycol. Glycol is used instead of diesel because it is oxidized on conventional Pt oxidation catalysts (which are used in CRT systems) at temperatures approximately 50°C below those necessary for burning diesel. While the regular regeneration takes place on a CRT system with NO_2, catalytic combustion of glycol ensures "emergency regeneration" at low temperatures resulting from abnormal operating conditions.

Problem

Diesel particulate filters (DPF), such as "Continuously Regenerating Technology" (CRT) systems, 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 220°C. Although the temperatures of the exhaust gases generally exceed 220°C, particularly in the case of commercial vehicles, there are occasions when the operating conditions are such that the exhaust gas temperatures are simply too low to regenerate the filters. For such cases GLYCOCAT has been developed.

Solution

GLYCOCAT concerns an injection system for injecting fuel into the exhaust gases that pass over an oxidizing catalyst such as the ones that are used in CRT systems. The glycol is oxidized in an exothermal reaction thereby heating up the exhaust gas. Compared to diesel fuel, glycol has the big advantage of being combustible on oxidation catalysts even at temperatures markedly below 200°C.

While the regular regeneration takes place with NO_2, glycol injection ensures "emergency regeneration" at abnormally low exhaust gas temperatures resulting e.g. from extended idling periods of the engine.

While the simultaneous oxidation of fuel (such as glycol) and the oxidation of NO => NO_2 compete on a given catalyst, we have found ways to ensure that both processes do not interfere with each other. However, for proprietary reasons we cannot publish the details at this occasion.

Experimental

On a block heat and power plant, as well as on an engine test rig, the light-off temperatures of various oxidation catalysts have been determined for various combustible liquids. In Fig. 2 it is shown, that glycol oxidizes on a conventional CRT at temperatures approximately 60°C below those necessary for diesel.

In contrast to diesel, glycol decomposes into gaseous products at temperatures around 170°C. This does away 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.

For emergency regeneration, the engine cooling water may be tapped and the additional glycol tank may be completely dispensed with. Cooling water for diesel engines contains 30%-50% glycol, which has such a high calorific value that it vaporizes the water injected together with the glycol and yet has enough excess heat to heat the exhaust gases. This has been confirmed by the trials we conducted using various aqueous glycol solutions (Fig. 3).

Our GLYCOCAT system is entirely autonomous, encompassing a temperature sensor, a backpressure sensor and a small glycol tank plus a pump. It can therefore be used for retrofitting CRT-equipped engines that occasionally run into regeneration problems due to low exhaust gas temperatures.

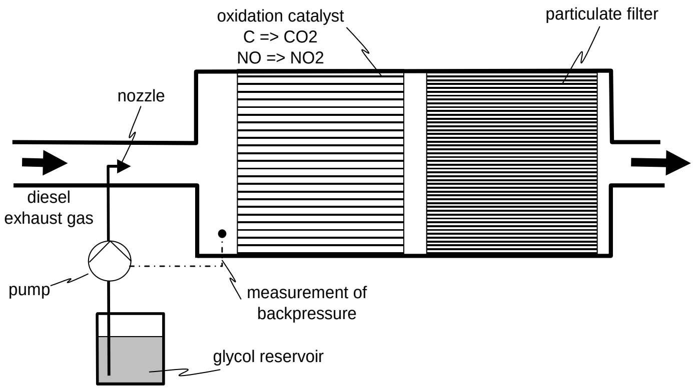

Fig. 1: Active regeneration of a CRT filter with glycol injection

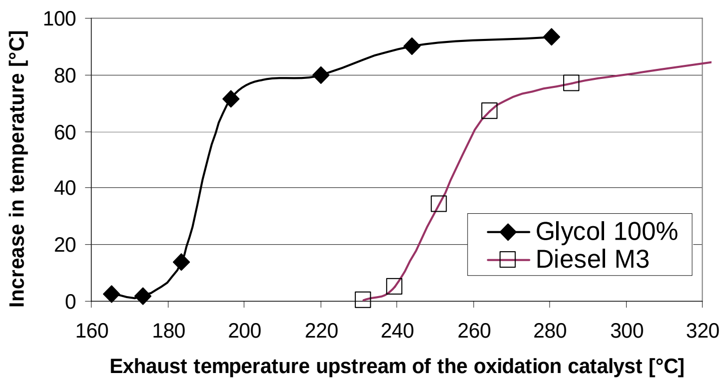

Fig. 2: On a conventional Pt-catalyst, glycol is oxidized at exhaust gas temperatures below 200°C, thus heating up the exhaust gas by approximately 80°C.

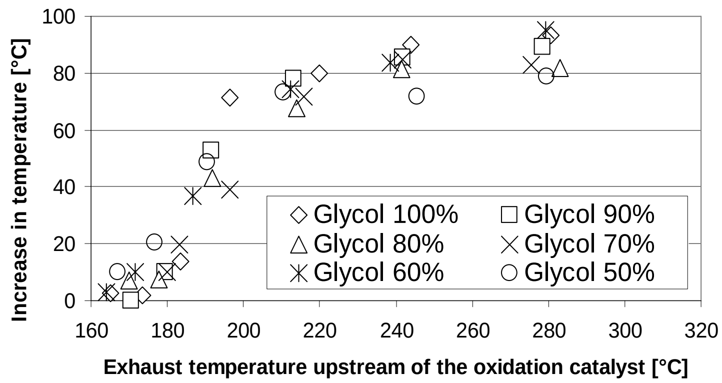

Fig. 3: Aqueous solutions can also be used in place of pure glycol.

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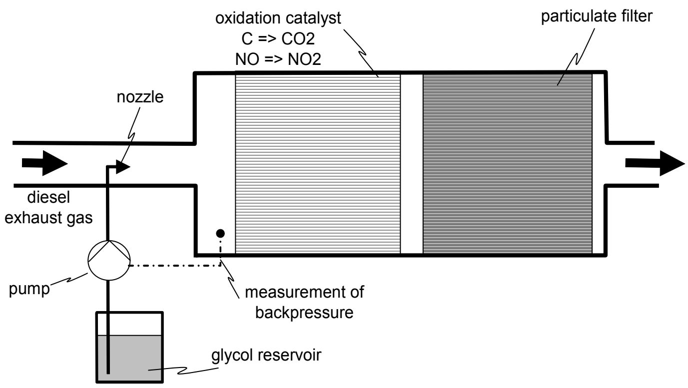

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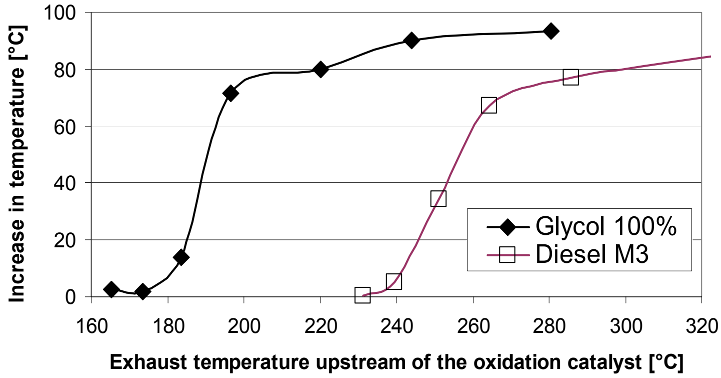

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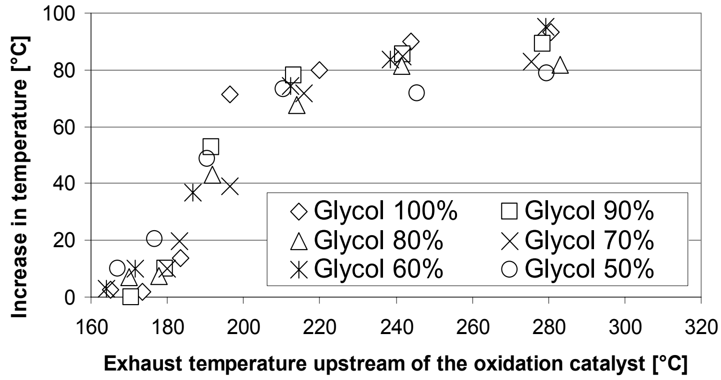

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