Impact of engine combustion on the reactivity of diesel soot from commercial vehicle engines

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Abstract

The regeneration behavior of diesel particulate filters is significantly influenced by the reactivity of the stored soot. However, there is still a lack of analyses which describe the effects that various engine operating parameters have on soot reactivity. A medium duty single-cylinder engine with common rail injection system was used to analyze the correlations between engine speed, load, combustion air fuel ratio and soot reactivity. Diesel particulate samples were directly collected from the exhaust stream. The temperature programmed oxidation (TPO) was used to reveal the reactivity to oxygen of the soot samples. Regeneration experiments were additionally carried out on a medium duty engine test bench to analyze the influence of soot reactivity on the regeneration efficiency in particulate filters.

The results give new insights into the relation between the diesel engine combustion process and soot reactivity.

1 Introduction

In the light of new legislative requirements and due to the environmental impact of pollutant emissions it has become necessary to introduce exhaust aftertreatment systems with particulate filters for diesel commercial vehicles to reduce particulate emissions. Firstly, the use of particulate filters has a detrimental effect on the fuel consumption of the engine due to the collected soot in the filter creating a higher backpressure. This soot has to be burned off in regular intervals at high temperatures of about 600 °C. Secondly, it is necessary to ensure a safe combustion of the soot without damaging the ceramic particulate filter in real driving conditions. The reactivity and composition of the filtered soot represents an important factor on the regeneration behavior.

The in-cylinder soot formation is influenced by various parameters such as the engine speed, the fuel injection timing or the fuel mixture and its dispersion [2]. During the combustion process, depending on the operating point, the formed carbon black may be exposed to high temperatures and pressures up to 200 bars. As shown in Fig. 1, more than 95% of the soot is already oxidized in the cylinder [2].