Fast Evaluation Method of the Ash Aging Effect on Catalyzed Diesel Particulate Filters

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The employment of Diesel Particulates Filters (DPFs) has increased in the automotive industry in the recent years. Every year innovative catalyzed DPFs appear in the market. Establishing a certain maintenance-free time period regarding the DPF is of major importance. One of the most serious problems the filter manufacturers face concerning system's durability is the performance deterioration due to the filter aging because of the accumulation of the ash particles. The evaluation of the effect of the ash aging on the filter performance is a time and cost consuming task that slows down the process of manufacturing innovative filter structures and designs. Thus, a methodology for the fast evaluation of the effect of ash aging on the DPF performance would easily be appreciated.

The origins of ash are the lubricating oil additives, the engine wear as well as the fuel, especially if it contains additives for regeneration purposes. As fuel additives are decreasingly favoured into the emission control area, the most significant source of ash particles becomes the lube oil. Attempts for the development of rapid ash aging techniques have been reported in the literature. Most of them were based on oil-doping of fuel to decrease the necessary testing time. Methods of artificially increased oil consumption move away from the "natural" engine oil consumption and this movement may lead to unrepresentative results e.g. results concerning the filter backpressure increase due to accumulation of the ash (Sutton *et al*., 2004).

In the present work the effort was placed in developing a very rapid ash aging technique (ash-aging duration of 1 day) which resembles the real life conditions of ash accumulation. The method can be applied to small-scale filter samples. Small-scale filter sample testing is of particular importance during substrate material or catalyst material developments. The main lube ash formation and deposition pathways are considered to be the following:

- Ash forms as particles and transports/deposits on to the filter.
- Ash forms on the filter by pyrolysis of deposited oil droplets.
- Combination of the above.

In this method the ash particles are formed and deposited on filter samples enclosed into a high-temperature Aerosol-based Synthesis and Deposition (ASD) reactor (Konstandopoulos *et al*., 2005). Solutions of diesel fuel and engine oil are sprayed into the reactor. Tuning the operating conditions of the ASD unit allows to efficiently control the parameters that primarily affect the oil-derived ash formation and deposition.

The produced ash particles exhibited many morphological and compositional similarities to engine produced ash particles, but more importantly they exhibited the same ash layer flow resistance properties. The latter determine the pressure drop behaviour of the ash-loaded filter. This method was applied for the fast aging of sintered metal filter materials.

Ash-aged filter samples have been evaluated with respect to their soot loading behaviour, regeneration and filtration efficiency. For the uncoated filters, the results showed that an ash mass load up to a certain level leads to decreased overall pressure drop during soot loading. For coated filters the ash deposit may lead to either increased or decreased overall pressure drop depending on the type of the catalytic coating. The ash particle layer caused a significant increase in the filtration efficiency of the samples.

The kind of effect of the ash particles on the soot oxidation rate depends also on the catalyst type. Figure 1 presents the effect of the ash particles on the soot conversion rate for a coated and an uncoated filter sample.

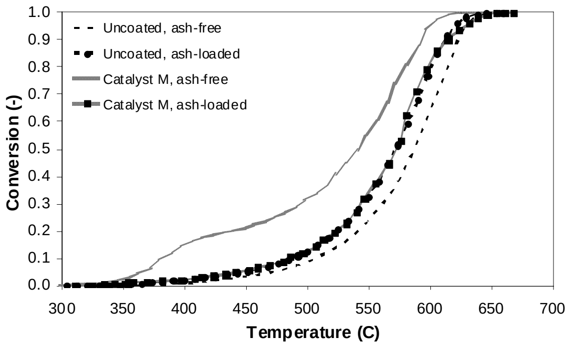

Figure 1. Effect of the ash particle layer on the soot oxidation for coated and uncoated filters.

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