Problems of soot fouling on EGRc: technology and engine conditions dependency

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Abstract

Legislation for vehicles imposes more and more severe constraints regarding gaseous emissions to the environment. Apart from CO_2 restrictions, which are related to optimization of engine operation through increase of its efficiency, the pollutants that are limited are the following: CO, HC, NO_x and PM (particulate matter). Evolution of standards in the European Union shows the challenge that car manufactures must face for coming years, in particular for passenger cars equipped with diesel engines.

Typical after-treatment in diesel engines consists of DOC (Diesel Oxidation Catalyst) and DPF (Diesel Particle Filter) to reduce CO, HC and PM emissions (like soot). The EGR (Exhaust Gas Recirculation) system provides reduction of NO_x emissions in source. Function: it consists of introducing a part of burnt gas to the combustion chamber in order to reduce temperature in the combustion chamber and also to decrease oxygen content, thus avoiding formation of NO_x. The most usual EGR system consists of an EGR valve, that controls the quantity of mass recirculated, and an EGR cooler (EGRc) to decrease temperature of this mass.

As for the EGR system, the impact of soot is a known issue which affects its operation [1,2,3], and it is called fouling. This fouling is caused by soot deposition and hydrocarbon and acids condensation, and is critical for components exposed to raw emissions coming from the engine, like EGR coolers. Two main effects are caused by fouling and, therefore, to the unfulfillment of NO_x emissions. Firstly, the fouling layer represents isolation for thermal transfer, so the output temperature of exhaust gas is increased. Second, this layer decreases effective hydraulic diameter, consequently increasing pressure drop and influencing on both exhaust and air engine inlet mass flow management. Both effects must be taken into account in order to select proper technology and dimensions of the EGRc. Regarding this concern, it is very important the selection of EGRc technology as well as description of design parameters (like size) so that the understanding of fouling resistance and thermal efficiency may be achieved.

Moreover, depending on engine operation conditions as well as EGRc parameters, soot properties (in terms of chemical, physical and morphological structure) will be different [3,4,5], what could imply diverse degree of malfunctioning of EGRc. Therefore, in order to get a better knowledge on soot properties, the characterization of this unwelcome product in combustion processes is important to learn about the different structures and chemical and physical properties that it may acquire through the combustion process itself.

In this context, the aim of this work is the review of the different technologies available so far in the market from Valeo and the dependency of soot fouling with respect the

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technology applied, since the accumulation of undesired material on solid surfaces of a heat exchanger is a key issue for its design.

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