Abstract

Currently, internal combustion engine developments are mainly driven by energetic efficiency increases and the emissions reduction. In order to reach the last objective set by emission regulations, manufacturers are forced to install progressively aftertreatment systems in the exhaust lines. With regard to the particle emission, the diesel particulate filter has become an essential and standard technology in Diesel engine exhaust lines.

Traditionally, aftertreatment systems are placed downstream of the turbine. This position limits the thermal level in the aftertreatment elements, which affects the diesel oxidation catalyst conversion efficiency during the cold start or at low engine load, as well as the conditions for passive regeneration in the DPF. In addition, as the DPF becomes loaded, the engine performance is affected. With the aim of contributing to minimize this effect, the pre-turbo configuration of the aftertreatment systems is proposed, in particular the DOC and DPF. Therefore, the main objective of the proposed doctoral thesis has been the evaluation of the interaction between the pre-turbo aftertreatment arquitecture and the Diesel engine.

Achieving this objective requires the use of modelling and experimental tools. Regarding the first one, a 1D model which allows calculating the engine response as function of the aftertreatment system configuration has been used. To carry out a reliable modelling of the pre-turbo configuration, it is necessary a precise prediction of the temperature distribution along the DPF at steady-state and transient conditions. Also, taking into account different soot loading levels turn out essential. For that purpose, an important part of the work has been driven to perform improvements in the wall-flow diesel particulate model previously developed in basic aspects, such as the thermal behaviour and the pressure drop prediction under soot loading conditions.

In order to confirm the results provided by the model, an experimental evaluation has been performed in a turbocharged Diesel engine with a pre-turbo aftertreatment configuration. This work has allowed assessing the engine performance at both steady-state and transient operating conditions, as well as the study of the effect on the engine emissions, filtration efficiency, passive regeneration ocurrences in the DPF or the DOC conversion efficiency.

This work provides a rigorous study of the pre-turbo aftertreatment arquitecture effect on the engine, confirming the advantages and proposing solutions to overcome the drawbacks that may present.