Abstract

Nowadays, engine manufacturers ought to satisfy the final user by means of fuel efficient technologies, able to meet emissions mandates, without worsening engine performance. In this sense, scientific community has carried out an important effort, researching for clean and efficient solutions. From the mentioned effort, a new combustion mode has arisen, which gathers the major combustion control strategies available for advanced compression ignition engines: *the Reactivity Controlled Compression Ignition (RCCI) combustion.*

Thus, the objective of this doctoral thesis is to analyse and to determine the potential of the RCCI combustion mode, in order to control the level of engine-out emissions and fuel consumption, using a heavy-duty compression ignition engine.

To deal with this objective, the analysis has been developed in three stages. In the first one, starting from a conventional Diesel combustion, an experimental approach has been followed to reach the RCCI combustion, whose phenomenology has been deeply studied by means of 3D-CFD modelling. This analysis has resulted in a fundamental description of the RCCI combustion process, which is the base of the research.

In the second stage, parametrical studies have been performed for the different variables that control the RCCI combustion process. There have been sequentially analysed mixing and combustion processes, performance and engine-out emissions, combining experiments with theoretical tools. By this way, it has been identified how the actuation over the variables controlling the RCCI combustion affects to its performance and emissions.

Finally, to reach the objective of this doctoral thesis, the viability of the RCCI combustion mode to operate into the whole engine load range, has been checked. According with the current context, a multiple objective optimization algorithm has been used to define the best combination of engine control strategies, for the mentioned range of operation. To conclude the research work, that RCCI operation has been critically compared with conventional Diesel combustion, at analogue operating conditions. Results have demonstrated that the RCCI combustion mode has a great technological potential to be implemented in future heavy-duty compression-ignition engines.