

DIESEL ENGINE IN-CYLINDER CALCULATIONS WITH OPENFOAM

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ABSTRACT - The reduction of diesel engines emissions is a challenging task. Reducing both soot and NOx at the same time is quite difficult, especially with no fuel consumption penalty. Reducing them both is possible by enhancing the air-fuel mixing process in order to improve combustion. Experimental research still does not give us enough information about the very complex thermo-and fluid dynamic processes that are occurring in a diesel engine. In addition, experimental research is still quite expensive and time consuming.

The objective of this work is to give support to experimental research by providing some insight into the complex phenomena that occur in the cylinder and the combustion chamber of diesel engines, using Computational Fluid Dynamics (CFD) modeling. The first task was to calculate the air flow through the inlet ports and cylinder of a diesel engine and the second one was to calculate combustion in a diesel engine.

A steady flow test rig setup for diesel engine ports development has been successfully simulated with OpenFOAM (a free CFD software). The flow through the inlet ports was simulated at different valve lifts. The CFD calculated values of flow coefficients and swirl ratios agree fairly well with the experimental results. By sectioning the domain, a detailed description of the flow field can be obtained. A step forward was the simulation of combustion in a direct injection diesel engine. This is a much more complex task, but the calculated in-cylinder pressure corresponds to the measured pressure.

INTRODUCTION

Combustion in diesel engines is influenced by the injection process and fuel jet interaction with the air inside the cylinder. Knowledge of the air movement inside the cylinder is of great importance for the improvement of the combustion process and it helps reduce the pollutants emissions of diesel engines.

There are many methods of studying the in-cylinder air movement, but they can be classified in two groups: experimental research and mathematical calculus models. Experimental research reproduces more or less the real operating conditions of the engine and usually it has high costs. Nevertheless, experimental validation is always necessary in the development of an engine. Amongst the mostly used experimental methods for in-cylinder flow study are the AVL – Thienor and Toppelmann method of steady flow test rig, which outputs two coefficients which characterize the in-cylinder flow, and LDA (Laser-Doppler Anemometry), which can measure the velocity in some limited measuring points in the volume.

In the last few years the computing power of workstations and personal computers grew exponentially, and it continues to grow. Computational Fluid Dynamics (CFD) programs have also evolved. They became more robust, precise, and they can even calculate the combustion process in engines. The results obtained by CFD calculations agree well with experimental

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