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Modelowanie numeryczne procesu napełniania cylindra silnika ZI

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Numerical modeling of an IC engine cylinder filling process

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Abstract

Aim of the thesis was to create numerical model of an IC engine cylinder filling process, that could be used to analyze influence of such aspects like: intake manifold geometry or valve lift profile on cylinder fill rate. Model was built using commercial computational package Ansys Fluent, which is able to simulate heat and mass flows. Geometry of a model contains: intake manifold, combustion chamber with valves, and part of a exhaust manifold. Boundary conditions were set up as a temperatures on surfaces that contacts flowing fluid. Built model was used to determine:

- influence of valve lift profile on cylinder fill rate,
- influence of ram-air intake manifold inlet geometry on cylinder fill rate,
- influence of intake manifold geometry on in-cylinder swirl during filling process.

First part of the research was model validation, which was made using 170A1 engine situated in Institute of Thermal Technology engine dynamometer. Validation was performed by comparison of in-cylinder pressure data sets, obtained from numerical model and experiment on engine-dynamometer.

After validation the influence of intake manifold geometry on in-cylinder swirl during filling process was determined. Through properly structured intake manifold a variety of in-cylinder swirls can be obtained. Numerical experiment was performed on two intake manifold geometries. As a result of the experiment two different in-cylinder swirls were obtained: a tumble swirl and axial swirl.

Another part of research was examination how valve lift profile affects on cylinder fill rate. Numerical experiment was carried out using 2 valve opening profiles: one from stock camshaft, and one from camshaft intended for use in motor-sport. As a result of the calculation 10 different cylinder fill rate values were obtained, for rpm speeds from 2000 to 6000.

Last part of research was determination of how ram-air intake manifold inlet geometry influences on cylinder fill rate. For this purpose selection one of the ten inlet geometries was carried out. After selection on simplified model, inlet geometry that provides the most effective flow conditions was implemented in full cylinder filing process model. Only one simulation for the highest rpm speed were carried out to verify does ram-air intake manifold will cause a relevant difference on cylinder filling process in analyzed engine.