Numerical Analysis of Charge Exchange in an Opposed-Piston Engine

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Abstract : The paper presents a description of geometric models, computational algorithms, and results of numerical analyses of charge exchange in a two-stroke opposed-piston engine. The research engine was a newly designed internal Diesel engine. The unit is characterized by three cylinders in which three pairs of opposed-pistons operate. The engine will generate a power output equal to 100 kW at a crankshaft rotation speed of 3800-4000 rpm. The numerical investigations were carried out using ANSYS FLUENT solver. Numerical research, in contrast to experimental research, allows us to validate project assumptions and avoid costly prototype preparation for experimental tests. This makes it possible to optimize the geometrical model in countless variants with no production costs. The geometrical model includes an intake manifold, a cylinder, and an outlet manifold. The study was conducted for a series of modifications of manifolds and intake and exhaust ports to optimize the charge exchange process in the engine. The calculations specified a swirl coefficient obtained under stationary conditions for a full opening of intake and exhaust ports as well as a CA value of 280° for all cylinders. In addition, mass flow rates were identified separately in all of the intake and exhaust ports to achieve the best possible uniformity of flow in the individual cylinders. For the models under consideration, velocity, pressure and streamline contours were generated in important cross sections. The developed models are designed primarily to minimize the flow drag through the intake and exhaust ports while the mass flow rate increases. Firstly, in order to calculate the swirl ratio [-], tangential velocity v [m/s] and then angular velocity ω [rad / s] with respect to the charge as the mean of each element were calculated. The paper contains comparative analyses of all the intake and exhaust manifolds of the designed engine. Acknowledgement: This work has been realized in the cooperation with The Construction Office of WSK "PZL-KALISZ" S.A." and is part of Grant Agreement No. POIR.01.02.00-00-0002/15 financed by the Polish National Centre for Research and Development.

Keywords : computational fluid dynamics, engine swirl, fluid mechanics, mass flow rates, numerical analysis, opposed-piston engine

Conference Title : ICAMAME 2018 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering

Conference Location : Kyoto, Japan

Conference Dates : April 26-27, 2018