

The Charge Exchange and Mixture Formation Model in the ASz-62IR Radial Aircraft Engine

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Abstract : The ASz62IR engine is a radial aircraft engine with 9 cylinders. This object is produced by the Polish company WSK "PZL-KALISZ" S.A. This engine is currently being developed by the above company and Lublin University of Technology. In order to provide an effective work of the technological development of this unit it was decided to make the simulation model. The model of ASz-62IR was developed with AVL BOOST software which is a tool dedicated to the one-dimensional modeling of internal combustion engines. This model can be used to calculate parameters of an air and fuel flow in an intake system including charging devices as well as combustion and exhaust flow to the environment. The main purpose of this model is the analysis of the charge exchange and mixture formation in this engine. For this purpose, the model consists of elements such: as air inlet, throttle system, compressor connector, charging compressor, inlet pipes and injectors, outlet pipes, fuel injection and model of fuel mixing and evaporation. The model of charge exchange and mixture formation was based on the model of mass flow rate in intake and exhaust pipes, and also on the calculation of gas properties values like gas constant or thermal capacity. This model was based on the equations to describe isentropic flow. The energy equation to describe flow under steady conditions was transformed into the mass flow equation. In the model the flow coefficient $\mu\sigma$ was used, that varies with the stroke/valve opening and was determined in a steady flow state. The geometry of the inlet channels and other key components was mapped with reference to the technical documentation of the engine and empirical measurements of the structure elements. The volume of elements on the charge flow path between the air inlet and the exhaust outlet was measured by the CAD mapping of the structure. Taken from the technical documentation, the original characteristics of the compressor engine was entered into the model. Additionally, the model uses a general model for the transport of chemical compounds of the mixture. There are 7 compounds used, i.e. fuel, O₂, N₂, CO₂, H₂O, CO, H₂. A gasoline fuel of a calorific value of 43.5 MJ/kg and an air mass fraction for stoichiometric mixture of 14.5 were used. Indirect injection into the intake manifold is used in this model. The model assumes the following simplifications: the mixture is homogenous at the beginning of combustion, accordingly, mixture stoichiometric coefficient A/F remains constant during combustion, combusted and non-combusted charges show identical pressures and temperatures although their compositions change. As a result of the simulation studies based on the model described above, the basic parameters of combustion process, charge exchange, mixture formation in cylinders were obtained. The AVL Boost software is very useful for the piston engine performance simulations. This work has been financed by the Polish National Centre for Research and Development, INNOLOT, under Grant Agreement No. INNOLOT/I/1/NCBR/2013.

Keywords : aviation propulsion, AVL Boost, engine model, charge exchange, mixture formation

Conference Title : ICAMAME 2016 : International Conference on Aerospace, Mechanical, Automotive and Materials Engineering

Conference Location : San Francisco, United States

Conference Dates : September 26-27, 2016