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The Verification Study of Computational Fluid Dynamics Model of the Aircraft Piston Engine

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Abstract : This paper presents the results of the research to verify the combustion in aircraft piston engine Asz62-IR. This engine was modernized and a type of ignition system was developed. Due to the high costs of experiments of a nine-cylinder 1,000 hp aircraft engine, a simulation technique should be applied. Therefore, computational fluid dynamics to simulate the combustion process is a reasonable solution. Accordingly, the tests for varied ignition advance angles were carried out and the optimal value to be tested on a real engine was specified. The CFD model was created with the AVL Fire software. The engine in the research had two spark plugs for each cylinder and ignition advance angles had to be set up separately for each spark. The results of the simulation were verified by comparing the pressure in the cylinder. The courses of the indicated pressure of the engine mounted on a test stand were compared. The real course of pressure was measured with an optical sensor, mounted in a specially drilled hole between the valves. It was the OPTRAND pressure sensor, which was designed especially to engine combustion process research. The indicated pressure was measured in cylinder no 3. The engine was running at take-off power. The engine was loaded by a propeller at a special test bench. The verification of the CFD simulation results was based on the results of the test bench studies. The course of the simulated pressure obtained is within the measurement error of the optical sensor. This error is 1% and reflects the hysteresis and nonlinearity of the sensor. The real indicated pressure measured in the cylinder and the pressure taken from the simulation were compared. It can be claimed that the verification of CFD simulations based on the pressure is a success. The next step was to research on the impact of changing the ignition advance timing of spark plugs 1 and 2 on a combustion process. Moving ignition timing between 1 and 2 spark plug results in a longer and uneven firing of a mixture. The most optimal point in terms of indicated power occurs when ignition is simultaneous for both spark plugs, but so severely separated ignitions are assured that ignition will occur at all speeds and loads of engine. It should be confirmed by a bench experiment of the engine. However, this simulation research enabled us to determine the optimal ignition advance angle to be implemented into the ignition control system. This knowledge allows us to set up the ignition point with two spark plugs to achieve as large power as possible.

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