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mgr inż. Dariusz Kozak

Streszczenie w języku angielskim rozprawy doktorskiej nt.:

„ Numerical study on exhaust pulse separation problem for multicylinder engine"

In light of climate change and carbon neutrality topics, engine manufacturers face higher emission restrictions. Thus, the modern engine has to be efficient to meet today's environmental demands. Therefore, the key to improving the internal combustion engine's efficiency is to minimize its heat losses. It is known that the primary heat losses are generated by the exhaust gasses in the atmosphere. Therefore, the implementation of a turbocharger with the reduction of the engine displacement volume seems a reliable way to improve engine performance and, thus, emission.

Ideally, the turbocharging system should be as simple as possible, with as minimum division of the exhaust pipes as possible. However, such a situation is only possible for engines with up to four cylinders. For such engines, the interaction between the exhaust pulses is avoided by extended intervals between cylinder exhaust phases during single engine revolution. The situation gets more complicated as the number of cylinders increases, which leads to a shorter interval between exhaust phases. That is why the exhaust systems for multicylinder engines are very complex, especially with two or more turbochargers. Separating exhaust pulses is even more complicated for the two-stroke engine as the interval between exhaust phases shortens due to the exhaust phase occurring every 360 crank angle degrees (CAD).

Most of the latest research on engine pulse separation is limited to experimental and numerical investigations with pulses from cylinder numbers up to four. Therefore, this thesis aims to design and assess the novel pulse separation turbine system from a multicylinder engine. The six-cylinder, two-stroke engine was chosen as the pulse generator, representing the extreme case as the interval between the exhaust phases is significantly reduced by the number of cylinders and two-stroke configurations.

Firstly, the experimental tests were conducted for the two-cylinder, two-stroke opposed-piston engine (OPE) "Pamar 4" with a fixed vane turbocharger for different intake pressure values. The experimental tests allowed us to estimate the exhaust profile at extremely low and high engine loads. The experimental results contributed to preparing the three-dimensional (3-D) turbine model with a unique inlet, which consisted of six exhaust pipes that connected each cylinder with the turbine stage. Such an inlet configuration was desired to separate exhaust pulses properly between adjacent pipes. The exhaust pulse profile obtained from the experimental tests in the form of varying mass-flow rates was used as the inlet to each exhaust pipe. The unsteady simulations were performed for different configurations of the turbine model. The single-stage turbine model allowed us to accurately investigate the leakage between the adjacent exhaust pipes for single-engine revolutions. However, the numerical research proved that the proper separation of the exhaust pulse and the efficiency of the hole system could have been better. Therefore, the two-stage turbine system was designed and simulated with identical rotor geometries for the first and second-stage. The first-stage rotor was intended to operate as the pulse separation device, while the second-stage rotor operated as the actual expansion device. A series of numerical simulations proved that the two-stage turbine system accurately prevented the interference of the exhaust pulses and improved the waste heat recovery, which led to increased system efficiency.

Słowa kluczowe: CFD, turbocharging, pulse turbocharging, turbine

Dariusz Kozak

Podpis Doktoranta