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Numerical Analysis of Engine Performance and Emission of a 2-Stroke Opposed Piston Hydrogen Engine

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Abstract : As a zero-carbon fuel, hydrogen can be used in combustion engines to avoid carbon emissions. This paper numerically investigates the engine performance of a two-stroke opposed piston hydrogen engine by using three-dimensional (3D) Computational Fluid Dynamics (CFD) simulations. The engine displacement is 12.2 cm, and the compression ratio of 39. RANS simulations with the k-ε turbulence model and coupled chemistry combustion models are performed at an engine speed of 4500 rpm and hydrogen flow rate of up to 100 gr/s. In order to model the hydrogen injection process, the hydrogen nozzle was meshed with refined mesh, and injection pressure varied between 100 and 200 bars. In order to optimize the hydrogen combustion process, the injection timing was optimized between 15 before the top dead center and 10. The results showed that the combustion efficiency was mostly influenced by the injection pressures due to its impact on the fuel/air mixing and charge inhomogeneity. Nitrogen oxide (NO_x) emissions are well correlated with engine peak temperatures, demonstrating that the thermal NO mechanism is dominant under engine conditions. Through the optimization of hydrogen injection timing and pressure, the peak thermal efficiency of 45 and NOx emission of 15 ppm/kWh can be achieved at an injection timing of 350 CA and pressure of 160 bars.

Keywords : engine, hydrogen, diesel, two-stroke, opposed-piston, decarbonisation
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