A Modeling Study of Charge Preparation and Combustion in an HCCI Engine Using a Variable Pressure Pulse (VPP) Injection System and Optimized PRF Blends

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Abstract

This study uses a multi-dimensional CFD code, the KIVA-CHEMKIN code, to investigate the use of gasoline/diesel dual fuel blends in an HCCI engine. The detailed chemistry calculations used a primary reference fuel mechanism, which has been extensively validated against experimental data at conditions similar to those of the present study. Parameter optimization was performed by coupling the Non-Dominated Sorting Genetic Algorithm (NSGAII) with the KIVA-CHEMKIN code.

The first part of the study focused on choosing an optimized fuel blend and EGR combination for HCCI operation at two engine loads (6 and 11 bar IMEP). It was found that the minimum ISFC could not be achieved with either neat diesel fuel or neat gasoline. Next, a genetic algorithm (GA) was used with CFD modeling to optimize injection parameters of a split injection event (injection pressures, timings, and fuel split) in order to achieve an adequately homogeneous fuel blend with minimum wall film using port fuel injection of gasoline and direct injection of diesel fuel. Finally, the optimized fuel, EGR, and injection parameters were evaluated with the KIVA-CHEMKIN code and controlled HCCI operation was achieved at 11 bar IMEP. The optimized fuel blend and EGR rate for 11 bar IMEP were PRF 65 and 50%, respectively. The injection optimization resulted in 64% of the diesel fuel being injected at 67° BTDC with an injection pressure of 100 bar. The remainder of the fuel was injected at 33° BTDC at 550 bar. The combination of optimized fuel, EGR, and injection parameters resulted in near zero NOx and soot and a net ISFC of only 163 g/kW-hr.

Key words:
diesel sprays, modeling, combustion, HCCI

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