Numerical Investigation of GDI Spray Morphology at Different Injection Pressures Using DPM Simulation

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Abstract

Gasoline remains a widely used fuel in engine applications, but its combustion contributes significantly to carbon dioxide emissions and particulate matter, exacerbating greenhouse gas effects. To mitigate these environmental impacts, researchers have explored various strategies to enhance fuel injection processes, including adjustments to injection timing, optimization of the fuel-air mixture, and the development of advanced technologies such as direct and multi-point injection systems. This study employs a Computational Fluid Dynamics (CFD) approach using ANSYS Fluent to investigate the spray behavior and characteristics of gasoline direct injection at varying pressures. The simulation utilizes the Discrete Phase Model (DPM) alongside a realizable k-epsilon turbulence model, with injection pressures set at 40 bar, 120 bar, 200 bar, and 300 bar. Results indicate that higher injection pressures, particularly at 300 bar, lead to deeper spray penetration and finer droplet atomization. These findings demonstrate that high-pressure direct injection enhances fuel-air mixing efficiency and has the potential to reduce carbon emissions in engine operations.

Keywords

Gasoline Fuels, Computational Fluid Dynamics, Discrete Phase Model (DPM), High Injection Pressure.

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