25AKSAE_B031

Analysis of Spray Behavior for Diesel Blends with High-Ethanol Concentrations in a Constant Volume

Sewon Jeong [1)] · Ocktaeck Lim[*2)]

Graduate School of Mechanical Engineering, University of Ulsan, 93 Daehak-ro, Nam-gu, Ulsan 44610, South Korea[1)],

School of Mechanical Engineering, University of Ulsan, San 29, Mugeo2-dong, Nam-gu, Ulsan 44610, South Korea[2)]

Key words: Spray Characteristics, Atomization Characteristics, CVCC, Ethanol-Diesel blends

* Corresponding author, E-mail: otlim@ulsan.ac.kr

The objective of this study is to examine the spray characteristics of diesel blended with high concentrations of ethanol under different injection and ambient pressure conditions. While diesel engines are valued for their high efficiency, they face increasing challenges regarding emissions and stringent environmental regulations. Ethanol, characterized by its relatively low density, viscosity, and surface tension, offers potential as a blending fuel to improve atomization and mitigate pollutant formation. To evaluate this potential, optical spray experiments were performed in a constant volume chamber, supported by CFD simulations. A phase stability assessment confirmed that blends containing up to 99.9% anhydrous ethanol remained stable for at least 30 days at room temperature. The experimental findings revealed that increasing ethanol content reduced spray penetration length from 50.8 mm for D100 to 46.2 mm for E100, while the spray cone angle widened from 28.5° to 45.3°, accompanied by a substantial increase in spray perimeter. Velocity analysis indicated that D100 maintained a more gradual decay due to higher inertia, whereas E100 experienced rapid attenuation, with DE50 showing intermediate behavior. CFD simulations further demonstrated a continuous reduction in SMD as ethanol concentration increased, confirming enhanced atomization. Results obtained with the KH-RT breakup model and LES turbulence approach exhibited strong consistency with the measured SPL data. In summary, high-ethanol diesel blends promoted improved spray dispersion and mixture uniformity, offering potential advantages in terms of combustion efficiency and emission reduction. These results provide important insights for optimizing injection strategies and developing advanced injector technologies for next-generation diesel engine applications.

Acknowledgement: This result was supported by the "Regional Innovation System & Education (RISE)" through the Ulsan RISE Center, funded by the Ministry of Education (MOE) and the Ulsan Metropolitan City, Republic of Korea.(2025-RISE-07-001). This work was supported by the National Research Foundation Korea(NRF) grant funded by the Korea government(MSIT) (No. RS-2023-00281590).