Investigation on Spray Characteristics of Water Emulsified Diesel with Different Injection Pressure and Ambient Temperature

Ming Huo1, Shenlun Lin2, Haifeng Liu3, Chia-fon F. Lee1.4*
1 Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, IL, 61801, USA
2 Department of Environmental Engineering, National Cheng Kung University, Tainan 70101, Taiwan
3 State Key Laboratory of Engines, Tianjin University, Tianjin, 300072, China
4 Center for Combustion Energy and State Key Laboratory of Automotive Safety and Energy, Tsinghua University, Beijing 100084, China
minghuo2@illinois.edu and cflee@illinois.edu

Abstract

The application of emulsified fuel in diesel engines has been proved to be beneficial as it reduced the exhaust emission of both nitrogen oxides and particulate matter. The enhanced atomization, often associated with the "micro explosion" phenomena, will lead to better fuel air mixing. In this study, the spray characteristics of water emulsified diesel fuel with different water content were experimentally investigated in a constant volume combustion chamber with different injection pressures and various ambient temperatures. The bubbles' size of the water phase in the fuel was first measured using microscope for all the prepared fuels and stability tests have been conducted to ensure no phase separation before measurement. The fuels were later injected and combusted in a constant volume chamber with optical access. The evolution of the entire injection was record by a high speed camera using Mie scattering. The images were processed to acquire the spray characteristics such as liquid penetration and cone angle, as such, the impacts of the ambient temperature and injection pressure on the spray performance were evaluated. It is shown that both W10 (10% water by volume) and W20 were featured with longer liquid penetration, especially under low ambient temperatures, which was attributed by the low volatility of the water. Notable increased cone angles and "fattened" main jet body were observed for emulsified fuel at the beginning stage of injection indicating the possible occurrence of micro-explosion.

* Corresponding author: cflee@illinois.edu