Effects of Biodiesel Addition and Exhaust Gas Recirculation on Improving Engine Performance and Emission Characteristics

Cherng-Yuan Lin *
Department of Marine Engineering, National Taiwan Ocean University, Keelung, Taiwan

Pei-Hsuan Hsiao
Department of Marine Engineering, National Taiwan Ocean University, Keelung, Taiwan

Chun-Ming Chang
Department of Marine Engineering, National Taiwan Ocean University, Keelung, Taiwan

Yuan-Liang Jeng
Department of Marine Engineering, National Taiwan Ocean University, Keelung, Taiwan

Abstract

Diesel engines are widely used as the power sources for both land and sea vehicles. The accompanying exhaust emissions pose a serious threat to the environment and living beings. Therefore, promising technologies and alternative fuels are evaluated to reduce pollution and improve diesel engine performance. Biodiesel, which has the advantages of superior biodegradability, excellent lubricity, low pollutant emissions, and environmentally friendly compounds, has high potential to replace petroleum diesel in diesel engines. In addition, exhaust gas recirculation (EGR), which recirculates a portion of exhaust gas to mix with the fresh fuel-air mixture in the engine cylinder, has been found to reduce pollutant emissions, particularly NOx. This study aims to use biodiesel, combined with EGR technology, to improve engine performance and reduce emissions. A four-cylinder, naturally aspirated direct-injection engine was used to conduct engine tests with various proportions of biodiesel in super low sulfur diesel (SLSD), while introducing various exhaust gas ratios into the engine cylinder. The experimental results showed that, compared to petro-diesel, biodiesel appeared to have a lower cetane number, heating value, and elemental carbon and sulfur content, as well as lower sulfur content, while having a higher flash point and oxygen content. Increasing biodiesel/diesel proportions caused more NOx emissions, a higher fuel consumption rate, and higher bsfc (brake specific fuel consumption). The increase in the EGR ratio in the intake air reduced NOx and CO2 emissions, while increasing black smoke opacity, SO2, and CO emissions. In addition, at high brake engine torque output, introducing high EGR ratios into the engine cylinder caused a sudden increase in CO emissions and black smoke opacity.

Keywords

Biodiesel, exhaust gas recirculation (EGR), emission reduction, engine performance, diesel engine.