Effects of Varying Ammonia Concentrations on Dual-Fuel Combustion Characteristics in a Heavy-Duty Diesel Engine

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Ammonia has gained increasing attention as a carbon-free energy carrier, offering potential as a supporting fuel for reducing greenhouse gas emissions in internal combustion engines. This study explores an experimental dual-fuel strategy using ammonia and diesel in a heavy-duty compression ignition engine, aiming to evaluate combustion behavior and emission characteristics. In the proposed setup, ammonia is supplied through the intake manifold alongside intake air, while diesel is injected directly into the combustion chamber to initiate ignition. The tests were conducted by varying diesel injection timing and the ammonia energy substitution ratio to observe their influence on engine performance. Findings reveal that higher ammonia substitution leads to reductions in peak cylinder pressure, combustion temperature, heat release rate, and indicated thermal efficiency. However, ammonia-rich mixtures also contribute to significant reductions in soot, carbon monoxide (CO), carbon dioxide (CO_2), and unburned hydrocarbons (UHC). A modest increase in nitrogen oxide (NO_x) emissions was noted with higher ammonia levels. These results suggest that ammonia-diesel dual fueling is a promising pathway for cleaner operation in heavy-duty diesel engines, offering a balance between emission control and combustion stability.

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