A numerical study of emission characteristics of ammonia-diesel direct injection strategy under ammonia compression ignition engine

Ardhika Setiawan [1)] · Ocktaeck Lim[*2)]

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: ammonia engine, dual fuel engine, emission, direct injection

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

The use of ammonia-diesel dual fuel can greatly reduce greenhouse gas emissions, with the ammonia supply mechanism and ammonia energy ratio playing vital roles in determining the features of ammonia-diesel dual fuel engines. The ammonia energy ratio and supply manner have a significant influence on the performance of ammonia-diesel dual-fuel engines. This study numerically models an ammonia-diesel dual-fuel engine with coupled chemical reaction kinetics using 3D CFD. The ammonia energy ratio is then evaluated in relation to the emissions of an ammonia-diesel dual-fuel engine that operates in both direct injection and ammonia premix modes. The study was carried out on a single-cylinder compression ignition research engine that had been transformed into a diesel-ammonia dual fuel engine. The experiment employed a compression ratio (CR) of 16.25 with a maximum ammonia energy fraction of 100%. The comprehensive emission propagation during the combustion process was created using computational fluid dynamic (CFD) modeling. Ammonia undergoes a second stage of combustion during the expansion step, showing that the fuel cannot be completely burnt during the original auto-ignition process. The use of up to 50% ammonia in direct injection CI engines indicates an increase in CO2, HC, and NOx emissions. Applying SOI to diesel at 0 and 40 BTDC with a propane energy percentage of greater than 50% results in a significant variance in emissions, indicating poor combustion quality that promotes emission generation.