Promising Fuel in Advanced Engines: Ignition Delay Measurements and Modeling of Straight Run Naphtha

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Petroleum-based fuels supply almost 95% of the energy used in the transportation sector. Due to their high boiling points, refineries must perform elaborate processing of the crude oil to obtain such fuels. Improving fuel efficiency can therefore help reduce global energy usage and minimize greenhouse gas emissions. This research introduces a novel fundamental autoignition study on the reactivity of Haltermann Straight Run Naphtha (HSRN) through ignition delay measurements and modeling with chemical kinetic models. HSRN is a low-octane fuel and one of the first distillates of crude oil refining process. Such fuel is an attractive low-cost candidate for advanced low-temperature compression ignition engines. Experimentations were conducted using a high-pressure shock tube and a rapid compression machine (RCM) over a temperature range of 700-1250 K, pressures of 20 and 60 bars, and equivalence ratios of 0.5, 1 and 2. Experimental ignition delay data were modeled and compared with simulated data from a two-component Primary Reference Fuel (PRF60) surrogate and a six-component surrogate. Under shock tube, both surrogates adequately captured the measured ignition delay times at high and intermediate temperatures. However, the PRF60 surrogate failed to reproduce the fuel reactivity at low temperatures. For the RCM, the six-component surrogate showed better agreement with experimental data than PRF60. Therefore, a six-component surrogate has been found suitable to model HSRN reactivity over the entire range of engine operating conditions. This novel study will pave the way for future studies to utilize the use of HSRN as a low-emission, high-efficiency fuel in advanced engines.