Kinetic Simulation of Ammonia/Hydrogen Combustion Under Gas Turbine Conditions for CO2 Reduction

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Fossil fuels are the main source of energy, but they release CO_2, which is the leading cause of global warming. Ammonia (NH_3) and hydrogen (H_2) are two of the best candidates to replace fossil fuels and help the transition to net-zero CO_2 emissions. Previous studies show that NH_3 is an efficient energy carrier and can be produced from many renewable resources, but it has a long ignition delay time (IDT), low laminar flame speed (LFS), and high nitrogen oxide (NO_x) emissions. On the other hand, H_2 has short IDT, high LFS, and low NO_x emissions. In this study, chemical kinetic simulations were conducted using Ansys Chemkin Pro software under gas turbine conditions to find the optimal mixture by matching the IDT, LFS, and NO_x emissions of NH_3/H_2 mixtures with methane (CH_4). The result of this study suggested that the IDT of 100% CH_4 is similar to an 80% NH_3/ 20% H_2 mixture at low temperatures and 100% NH_3 at high temperatures. Additionally, the NO_x emissions of NH_3/ H_2 mixtures at low temperatures are minimal at equivalence ratios equal to or less than 1.1. Moreover, the simulation results suggest that under lean conditions, LFS of 80% H_2/ 20% NH_3 has a similar trend as 100% CH_4. In conclusion, the ratio of NH_3/H_2 mixtures can be varied to have similar thermodynamic and combustion characteristics as 100% CH_4 for specific conditions. These ratios can be tested experimentally to confirm these properties and their use at an industrial scale.