Low-Temperature Shock Tube Ignition Studies in Hydrogen

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Motivation

Recent studies have highlighted the failure of current hydrogen combustion kinetic models to predict experimental shock tube ignition delay times at low-temperature conditions (less than 1000 K). The failure cast doubts on the ability to simulate ignition delay times at these conditions in synthesis gas (syngas), a mixture of hydrogen and carbon monoxide in various compositions. Syngas is being considered as an alternative fuel for combustion applications, such as power-generation gas turbines. A well-developed chemical model for hydrogen at low temperatures is crucial for the proper design of such applications.

Overview

Our research aims to resolve the discrepancy between experimental low-temperature shock tube hydrogen ignition data with that predicted by current models, by moving away from conventional reflected shock modeling. Our efforts have led us to develop a new thermodynamic-gasdynamic model called CHEMSHOCK to account for the non-ideal effects of facility-dependent effects and localized energy release that are especially prominent at long test time which occur at low temperatures.
With a new gasdynamic model for low-temperature shock tube modeling, we are then able to design experiments to make more accurate measurements of the reaction rates for key reactions in the hydrogen/oxygen kinetic mechanism using the shock tube facilities available in our lab. By making improvements to the kinetic mechanism, we see a better correlation between modeling and experimental shock tube ignition data at low temperatures.
Figure 4: New models better predict experimental ignition delay time data for hydrogen

References