High-speed imaging of reflected shockwave-initiated combustion

Shock tubes are considered ideal reactors and are used extensively to provide valuable chemical kinetic measurements, such as ignition delay times and in-situ species time-histories. However, due to nonideal affects the combustion of fuel inside shock tubes can become inhomogeneous, particularly at low temperatures, which complicates the acquired data. In this work, the combustion of practical fuels used by society are investigated with high-speed imaging. First, high-speed images were captured through the end wall of the shock tube for two hydrogen-oxygen systems. The combustion process was found to initiate in two modes, one that is homogeneous across the fluid medium and one that proceeds through a deflagration-to-detonation channel. In the second part of this work, the shock tube test section was redesigned to promote optical access from the end and side walls of the shock tube test section. Two high-speed cameras were used to capture perpendicular views of the combustion of iso-octane and n-heptane, two primary reference fuels. A homogeneous and nonhomogeneous combustion process were seen for these fuels as well. Using the side view images, the impact of the sporadic ignition process was evaluated on commonly used diagnostics in shock tubes. Based on these results, it is recommended that shock tube diagnostics be confined to the homogeneous ignition modes of fuels. This is found to strongly correlate with the temperature of the combustion process, where high temperatures promote a homogeneous ignition event.

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The public is welcome to attend.