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INVESTIGATION OF CATALYTIC RE-IGNITION PROCESS IN HYDROGEN PEROXIDE HYBRID ROCKET MOTORS

Abstract

Hydrogen Peroxide (H_2O_2) is one of the most commonly used oxidizers in hybrid rocket motors and can be catalytically decomposed to ignite solid fuels. Compared with other devices of ignition, catalytic ignition simplifies the structure and the schedule of ignition process, which further highlights the simplicity and safety of hybrid rocket motors. Moreover, multiple starts of the motor can be easily achieved by controlling the supply of H_2O_2. However, experiments indicate that the delay of catalytic ignition might vary greatly in multiple starts. The delay of first ignition from ambient temperature is often long, while the following re-ignitions could be much faster, according to the status of catalyst bed and solid fuel. This phenomenon leads to difficulties in the validation of timing sequence and total impulse of ignition. In his paper, the re-ignition process of a typical 90% H_2O_2/polyethylene (PE) hybrid rocket motor is numerically investigated. After the motor is shut down from a steady-state firing, the development of flowfield and distribution of temperature inside the solid fuel is simulated. Then decomposed H_2O_2 is injected from the head of the motor to re-ignite the fuel. Delay of re-ignitions with respect to different shut-down duration is evaluated. The start-up of catalyst bed and extent of H_2O_2 decomposition is also considered in the simulation. The results suggest that the delay of re-ignition is determined by the temperature of solid fuel and mass flux of decomposed H_2O_2. Typically, when the motor is shut down and re-ignite within 10.5 sec, the delay of ignition could be less than half of the delay of ignition from ambience. Subsequently, ignition tests are carried out on a lab-scale hybrid rocket motor platform and the simulation results are validated.