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Transient analysis on ignition process of catalytic hybrid rocket motor

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Abstract

This paper is aimed to analyze the transient process and ignition delay time of catalytic hybrid rocket motor through two-dimensional axisymmetric transient simulations and lab-scale firing tests. The overall catalytic ignition process is divided into five stages by analyzing typical firing traces. The total ignition delay time includes valve response time, pipeline filling time, catalytic bed startup time, monopropellant pressure buildup time and fuel grain heating time. The numerical simulations mainly focus on the fuel grain heating stage of catalytic hybrid rocket motor. The ignition transient flow fields of the motor with 90% hydrogen peroxide (90HP) and polyethylene (PE) propellants are obtained. Simulation results also reveal that the fuel grain heating time exponentially decreases with the increase of the oxidizer mass flow flux. Several firing tests of 90HP-PE lab-scale catalytic hybrid rocket motor are conducted to analyze the delay time of different ignition stages. The fuel grain heating time trend summarized by the experimental data accords well with that by the simulation results. Besides, the experimental data also show that the pipeline filling time, the catalytic bed startup time, the monopropellant pressure buildup time and the fuel grain heating time all decrease when the oxidizer mass flow rate increases. Therefore, the total ignition delay time almost linearly decreases with the increase of the oxidizer mass flow rate.

Keywords: hybrid rocket motor, catalytic ignition, transient process, ignition delay time

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