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TRANSIENT SIMULATION OF OPERATION PROCESS IN A THROTTLEABLE HYBRID ROCKET MOTOR

Abstract

Throttleable rocket motor can be used for planetary entry and descent, space rendezvous, orbital maneuvering including orientation and stabilization in space, and hovering and hazard avoidance during planetary landing. It can also continuously follow the most economical thrust curve in a given situation as opposed to making discrete throttling changes over a few select operating points. The hybrid rocket motor could be throttled by simply changing the oxidizer flow rate. Further, The hybrid rocket motor provide several distinct advantages such as simplicity, safety, low cost, and restart capability over both solid-propellant and liquid-propellant rocket motors, which make it suitable for a broad range of applications including sounding rocket, tactical missile, and launch vehicle propulsion as well as space engines. A throttleable hybrid rocket motor was developed at Beihang University to assess the throttling capability of hybrid rocket motor. The motor used hydroxyl terminated polybutadiene (HTPB) as the solid fuel and hydrogen peroxide as the oxidizer. The oxidizer flow rate is from 0.1kg/s to 0.5kg/s, and the maximum thrust is 1250N with a 5:1 throttling ratio. An unsteady simulation model was developed in this paper to investigate the combustion process in the throttleable hybrid rocket when the solid fuel surface regressed or the oxidizer flow rate changed. The realizable κ-ε turbulence model combined with the Eddy-Dissipation combustion model were adopted in the present study, and dynamics mesh techniques were used to simulate the regression process of the solid fuel surface. The distributions of temperature, velocity, species concentration was obtained, as well as solid fuel regression rate. The simulation results indicate that the regression rate is exponentially depended on the oxidizer flux and the reciprocal of fuel port diameter. The regression rate decreases with the working time when the oxidizer flow rate keeps constant. The dynamic response of pressure and regression rate when the oxidizer flow was throttled was also obtained. The results show that there is a lag between the regression rate and oxidizer flow rate.