SPACE PROPULSION SYMPOSIUM (C4)
Propulsion System (2) (2)

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INVESTIGATION OF FUEL REGRESSION RATE IN A LAB-SCALE N2O/HTPB HYBRID ROCKET MOTOR

Abstract

The investigation aimed to acquire fuel regression rate and evaluate the affecting factors, both of which were approached through theoretical analysis and motor firing. The tests were conducted on lab-scale hybrid rocket motors with propellant combinations of liquid N2O and HTPB based fuels. Two types of metalized fuel, distinguished by the weight percentage of Al and Mg powders and existence of certain amount of AP, were casted into tubes of 25mm in port diameter, 10mm of wall thickness and 600mm in length. They were burnt under chamber pressures around 4MPa, in a typical configuration hybrid motor with multi-orifice axial injection. According to theoretical calculating, these metalized fuels present almost the same top specific impulse as pure HTPB fuel. However, the fuels borrowed from ramjet promote density impulse. Also they provide higher adiabatic flame temperature and enormous radiant products which are believed to be two factors affecting regression rate positively. Besides, mechanical performance of the two fuels is approved. The fuel regression rates were carefully calculated from test data and thoroughly examined. A method was applied to reasonably eliminate the fuel consumed during startup and burnout periods. Based on former researchers' techniques, the average regression rates were obtained with corresponding oxidizer mass flux, chamber pressure and characteristic velocity with its efficiency. The classical power law relationship between regression rate and oxidizer flux was obtained. A more complex relation including pressure and port diameter was introduced to be responsible for the effect of radiant heat flux. These relations were compared with theoretical ones deduced by former researchers and author. The primary results of the experiments showed that the power exponent value was obviously lower than the theoretical 0.8 or the ones from pure HTPB firings reported in literature. Another investigation was about the axial variation of fuel regression rate which was observed through splitting the grains after burning. The port profile showed apparently nonlinear descending from the inlet to the middle location and the trend became indistinctively till to the outlet. It was believed that the vaporizing behavior of oxidizer and the growth and merge of flow boundary layer were two main factors. At the end, one of the two types of fuel was selected to apply in large scale motors based on the investigations.