Paper ID: 31758
student

SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations (IP)

Author: Mr. xingliang sun
BUAA, China, lzxx0717@buaa.edu.cn

Dr. Hui Tian
Beijing University of Aeronautics and Astronautics (BUAA), China, tianhui@buaa.edu.cn
Dr. Nanjia Yu
School of Astronautics, Beihang University, China, ynj@buaa.edu.cn
Prof. Guobiao Cai
Beijing University of Aeronautics and Astronautics (BUAA), China, cgb@buaa.edu.cn

SIZE EFFECT STUDY OF GRAIN PORT ON A LONG-TIME WORKING HYBRID ROCKET MOTOR

Abstract

This study is driven by the promise to offer a cheap and reliable long-time working sounding rocket powered by hybrid rocket motor, which uses 98 hydrogen peroxide as the oxidizer and HTPB-based grain as the fuel. The top priority of rocket design is to master the relation between regression rate and grain port diameter at certain oxidizer mass flow rate. Numerical simulations and firing tests are combined to investigate the characteristic of combustion flow field, the regression rate distribution along with axis, and the motor performance. In the simulation part, numerical simulation model is established on the convective heat transfer between the diffusion combustion flame and the grain surface. The initial grain port diameter of the three size motor are 50 mm, 109 mm, and 183 mm. The oxidizer mass flow rate are 0.35 kg/s, 1.0 kg/s, and 1.0 kg/s, respectively. The numerical regression rate of the three size motor at initial condition are 0.88 mm/s, 0.64 mm/s, and 0.34 mm/s. The averaged regression rate gained by firing test on the three size motor with a 5s working time are 1.037 mm/s, 0.78 mm/s, and 0.54 mm/s. The regression rate difference of the same size motor is because that numerical model is established on convective heat transfer. By comparing and analysis numerical and experimental regression rate, the radiation heat transfer can be determined and the size effect of grain port can be studied, this are discussed in details in the following paper. One long-time working firing test has been successfully conducted on the motor with an initial grain port of 109 mm, the working time reaches 50s. The experimental chamber pressure and motor thrust are obtained. The chamber pressure drops from 2.0 MPa to 1.5 MPa, and the motor thrust drops from 3058 N to 2841 N, this is mainly caused by the fatal erosion of nozzle throat. Based on the results of firing test, the thermal protection design, especially the nozzle thermal protection, has been improved, so that the working time of next firing test can extend to 120s with a good performance. A data reduction program of the long-time working motor test data is developed to calculate the motor transient parameters. The detailed introduction and results of the reduction method are presented and discussed.