Paper ID: 41940
oral

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

Author: Dr. Yen-Sen Chen
American Institute of Aeronautics and Astronautics (AIAA), Taiwan, China, ychen_esi@yahoo.com

ASSESSMENT OF THE FLIGHT EXPERIMENTS OF A MULTIFUNCTION HYBRID SOUNDING ROCKET

Abstract

Hybrid rocket propulsion has been incorporated in the development of a multifunction sounding rocket for space flight experiment applications of Taiwan. With the proposed multifunction hybrid sounding rocket design in this research using an enhanced-mixing combustion method, hybrid rocket engines can also deliver vacuum thrust performance close to that of kerosene liquid engines but with much reduced development and production costs.

High fidelity numerical modeling design approach and hot-fire experiments are employed to assess the overall performance of the enhanced-mixing hybrid rocket engines. Flight tests using hybrid sounding rockets have been conducted to validate the performance of the propulsion system.

In the hybrid rocket propulsion literature, the engine performance is usually discussed with a fixed geometry at ignition or assumed geometry at certain point into the burn. Detailed discussions on the history of the solid grain burning surface variations are still lacking which can impact the internal flow pattern and the overall performance of the hybrid rocket engine.

To further assess the thrust performance of the present enhanced-mixing hybrid rocket design, a comprehensive computational approach is proposed to analyze the internal ballistics of the hybrid rocket engine throughout its entire burn time such that the issues of O/F ratio variations, fuel grain regression history and overall Isp performance associated with the variations in the internal flow dynamics can be revealed in a single analysis. The baseline design of the present enhanced-mixing hybrid rocket engine incorporates hydrogen peroxide and SBR (Styrene-Butadiene Rubber) high-density propellants system for combustion.

Based on the optimized design using the present computational method, a multifunction hybrid sound rocket is designed and integrated for flight tests. The present rocket system is a two-stage design with thrust level of 8,000 kgf and 1,000 kgf for the first- and second-stage, respectively. A thrust vectoring control system and a reaction control system are employed and integrated with the guidance, navigation and control system of the sounding rocket such that more versatile flight trajectories can be performed to maximize the overall outcome of the flight experiments.

Numerical simulations of the hybrid rocket engine internal ballistics, ground hot-fire tests and flight tests of the present multifunction hybrid sounding rocket will be presented in this paper. The overall rocket performance will be presented in terms of Isp and O/F ratio variations throughout the propulsion phases of the launch operations.