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

Author: Prof. Shigeru Aso
Kyushu University, Japan

Dr. Yasuhiro Tani
Kyushu University, Japan
Mr. Masato Mizuchi
Kyushu University, Japan
Mr. Masato Yamashita
Kyushu University, Japan
Mr. Yudai Maji
Kyushu University, Japan
Mr. Koki Katakami
Kyushu University, Japan
Dr. Toru Shimada
Institute of Space and Astronautical Science (ISAS), Japan Aerospace Exploration Agency, Japan

DEVELOPMENT OF MODULE-TYPE HYBRID ROCKET ENGINE WITH MULTI-SECTION SWIRL INJECTION METHOD FOR FLIGHT EXPERIMENTS

Abstract

Hybrid rocket is one of the promising space propulsion systems with a lot of advantages such as safety, low cost, throttling of thrust, re-ignition, and nontoxic and nonhazardous propellant. However it also has disadvantages of low fuel regression rate and low combustion efficiency. The authors have proposed a new combustion method which can increase fuel regression rate by 3 to 8 times compared with that of conventional method. The new method is named as Multi-Section Swirl Injection Method, which generates swirling flows at some cross-sections in combustion chamber. In the present study, various improvements have been conducted in order to increase performance of the flight engine. Paraffin fuel with lower melting point and oxygen gas are selected as propellant. Oxygen gas will be replaced by liquid oxygen for real flight. To realize Multi-Section Swirl Injection Method for real flight, module-type engine structure, in which swirl oxygen injection is attached at upstream end to introduce swirl flow in combustion chamber, has been proposed. By combining those module-type engine we could keep swirl injection throughout combustion chamber. In the present study two engine modules are combined together and swirl oxygen injectors are attached at each engine modules. In the combustion experiments the present authors tuned mass flow rates of oxygen injections of two module-type engines to keep each O/F at optimum value of 2.1 for paraffin fuel and O/F values at each module-type engine are 2.07 (upstream model) and 2.2 (downstream module) respectively. This module-type engine can change mass flow rate during flight and could keep optimum O/F during flight. Also throttling the total thrust of module-type engine could be easy by changing mass flow rates of each model-type engine. Also flight experiments have been conducted with new module-type engine. By the limitation of launch site of University filed, the length and diameter of test rocket is 2 m and 0.166m respectively with 13 kg. CFRP oxygen tank with 10 MPa oxygen is used and two module-type engine with paraffin fuel is mounted. The flight experiments are successfully conducted. Those results shows that module-type hybrid rocket engine with Multi-Section Swirl Injection Method is quite promising.