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

Author: Mr. Heesang Chae
Konkuk University, Korea, Republic of

Mr. Donghoon Chae
Konkuk University, Korea, Republic of
Prof. Changjin Lee
Konkuk University, Korea, Republic of

DYNAMIC RESPONSE OF THRUST MODULATION IN HYBRID ROCKET FOR VTVL PROPULSION SYSTEM

Abstract

The development of reusable launch vehicle has been attracting much research attention in order to accommodate the increasing demand for cubesat class satellite launches and to lower launch costs. Also, vertical take-off and vertical landing (VTVL) technology can be directly applied to the propulsion system of spacecraft when landing the moon or Mars. The development of controller for attitude control and thrust modulation is the major parts of the technology of vertical takeoff and landing. Hybrid rocket propulsion systems have many advantages in terms of performance, safety, development cost and operation, but the development of hybrid rocket systems capable of vertical takeoffs and landings is still in a preliminary stage. Unlike liquid rockets, hybrid rocket combustion is sensitively dependent on the change in oxidizer flow characteristics as well as oxidizer flow rate. Also, since solid fuel is used, the response time from control command to thrust adjustment is relatively longer than that of liquid rocket and is affected by various factors. Factors affecting the determination of response time include injector type, thermal inertia of solid fuel, turbulent boundary layer, and hysteresis of fuel regression rate, as well as the throttling characteristics of the oxidizer flow control valve. Especially, since the intrinsic two-phase nature of nitrous oxide (N2O) is inevitable at the injection, a proper model is required to measure accurate amount of oxidizer accounting for non-homogeneous mixture in the combustor. This study is part of the research for the development of vertical takeoff and landing demonstrator using N2O / HTPB hybrid propulsion system. And it presents experimental test results of developing control algorithm for implementing vertical takeoff and landing and the dynamic characteristics of hybrid rocket combustion. In particular, the effects of throttle valve characteristics, oxidizer injector type, hysteresis of fuel regression rate and combustion instability are accounted for to determine and to understand the dynamic characteristics of thrust modulation in hybrid rocket propulsion system.