66th International Astronautical Congress 2015

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

Author: Mr. Dongeun Lee
Konkuk University, Korea, Republic of, del891213@naver.com

Prof. Changjin Lee
Konkuk University, Korea, Republic of, cjlee@konkuk.ac.kr
Prof. Yung-Hwan Byun
Korea, Republic of, yhbyun@konkuk.ac.kr

PRELIMINARY DESIGN OF HYBRID GAS GENERATOR IN STAGED HYBRID ROCKET ENGINE

Abstract

Due to many advantages over solid and liquid rocket including its high safety level as well as low environmental impacts, hybrid rocket has brought broad research interests for launch vehicle applications. However, major drawbacks such as low regression rate and O/F shifting during combustion have limited their application to practical propulsive systems.

A staged hybrid rocket is a new concept, which has combined characteristics of both gas generator and afterburner type hybrid rockets. Unlike gas generator type, staged hybrid rocket shows an improved safety, better/easier controllability of the fuel flow rate, and low development cost. Moreover, the combustion in staged hybrid rocket produces higher level of fuel-rich exhaust comparing to first combustor of afterburner type, maintaining optimal O/F ratio would be easier and enhancement of aft-end mixing would be greater without sacrificing stop-restart capability. Therefore better performance could be realized over afterburner type.

Since a staged hybrid rocket concept has not been fully reviewed, evaluated and refined yet, this study is the first effort to study the new hybrid rocket system with respect to reliability and performance criteria. To do this, the analysis of fuel-rich combustion characteristics in the primary chamber was set to be the research goal.

Primary requirement of fuel-rich gas generator is to produce low temperature combustion gas below a certain design value, say 1300K in this study. Since combustion gas temperature is closely related to equivalence ratio, combustion tests were carried out with various equivalence ratios by controlling geometrical parameters such as fuel length, oxidizer flow rate, port diameter and fuel type. GOx(gaseous oxygen) was used as the base oxidizer. The sensitivity of each parameter was evaluated through the series of test. It was found that the each parameter showed very limited effect on the change of equivalence ratio, due to hybrid rocket combustion characteristics. Therefore with mixture of O_2 and N_2, new types of oxidizer were additionally introduced. Fuel regression rate decreased whereas equivalence ratio increased as the oxygen content decreases in the mixture.

As a result, with use of HTPB and mixed oxidizer, equivalence ratio had increased significantly resulting in the substantial decrease of combustion gas temperature. Averaged combustion gas temperature as low as 1460K was successfully produced from the primary combustor. Nevertheless, study will continue to attain fuel-rich combustion gas below 1300K. To do this, the addition of AP(Ammonium Perchlorate) to HTPB will be newly used to decrease combustion gas temperature further.