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Author: Mr. Junyeong Jeong
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, junyj@kaist.ac.kr

Mr. Gyu Wan Choi
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, solro010@kaist.ac.kr
Prof. Sejin Kwon
Korea Advanced Institute of Science and Technology (KAIST), Korea, Republic of, trumpet@kaist.ac.kr

STATIC AND RE-IGNITION TEST OF HYPERGOLIC HYBRID ROCKET USING HYDROGEN PEROXIDE OXIDIZER

Abstract

In the recent decade, the hypergolic hybrid rocket (HHR) has been considered as an attractive propulsion system for space missions. It has the advantages such as a simpler system and long-term storability of solid fuel in the low-temperature environment than hypergolic bi-propellant. However, HHR has not been able to be applied in space due to its low technical readiness level (TRL). Therefore, various research groups have been conducting basic experimental study on HHR using toxic hypergolic oxidizers, such as NTO or nitric acid oxidizers. Meanwhile, in the case of hydrogen peroxide, which is the only eco-friendly, storable, and hypergolic oxidizer, the study on HHR has been studied only in the form of a consumable ignitor. However, the consumable ignitor cannot be re-ignited, so its utility is low compared to other toxic hypergolic oxidizers in space propulsion where re-ignition possibility is required.

This study contains the verification through the static and re-ignition test of HHR with hydroxyl-terminated polybutadiene (HTPB)-based hypergolic solid fuel and 95 wt% hydrogen peroxide oxidizer which show an average reaction delay time of about 4 ms. HHR was designed with a combustion chamber pressure of 20 bar and a ground thrust of 120 N. Four static hot-fire tests and two re-ignition tests were successfully performed. For the static hot-fire test, the average specific impulse efficiency and c* efficiency were measured to be 90.8% and 99.3%, respectively. Meanwhile, in the case of the re-ignition test, they were measured to be 90.0%, and 99.0%, respectively. Interestingly, although the storage period of the six fuel grains and their density were varied, there was no difference in the rocket performance. In addition, although the ratio of the real density to the theoretical maximum density ranged from 77.8% to 84.3%, there was no significant difference in the fuel regression rate from 2.2mm/s to 2.5mm/s. The porous structure of the solid fuel could increase the reactive surface area and thus increase its regression rate. Despite the porous structure, no fuel grain loss or unbalanced regression occurred in all fuel grains after the hot-fire tests. As a result, it was confirmed that hydrogen peroxide/HTPB-based hypergolic solid fuel successfully performed high efficiency and reliable ignition through this study. Consequently, this study informs that HHR using hydrogen peroxide and HTPB-based hypergolic solid fuel can be a promising candidate for the future space propulsion system.