IAF SPACE PROPULSION SYMPOSIUM (C4)
Solid and Hybrid Propulsion (1) (3)

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EFFECTS OF A PRE-HEATER FOR IMPROVEMENT OF COMBUSTION EFFICIENCY IN HYBRID ROCKETS USING LIQUID OXYGEN

Abstract

Chemical propulsion systems have been mostly used in space rocket launchers, and Liquid Oxygen (LOx) has been a widely used as an oxidizer not only in liquid rocket but also in hybrid rocket systems, because of its high specific impulse. While it has been widely used in hybrid rockets, the downside of using LOx is that it possesses the disadvantage of a low combustion efficiency due to the latent heat that is required for its phase change, from liquid to gas. LOx is a cryogenic liquid, and it has a very low boiling point of 90.19 K at 101.325 kPa. Preliminary studies from INNOSPACE have indicated low combustion efficiency of around 65 % for a conventional hybrid engine, using LOx. INNOSPACE, a Korean aerospace company, is a new-space venture start-up that is on the onset of entering the small satellite lunch market with its ICARUS line-up of hybrid rockets that will begin launching a small dedicated payload of 50kg, to a SSO of 500km starting in 2022, and LOx will be used as an oxidizer for the first stage of the ICARUS-N (nano-sat launcher). In this study, in order to improve the combustion efficiency for hybrid rockets with LOx, a pre-heater is installed in the pre-combustion chamber of a hybrid rocket. The pre-heater of High-Density Polyethylene (HDPE) is a disc type, with multiple small diameter holes, and the design parameters such as the hole diameter, the number of holes, and the disc thickness are calculated considering flame temperature in the pre-heater. Lab-scale hybrid propulsion system of LOx/Paraffin based fuel with a pre-heater is installed and tested at the INNOSPACE facility. The experimental setup is mainly composed of hybrid rocket engine, oxidizer feed system, ignition system and data acquisition system. The purpose of this study is to improve the combustion efficiency for a hybrid propulsion system using LOx and to determine the parameter that make for an optimum pre-heater design.