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IAF SPACE PROPULSION SYMPOSIUM (C4)
New Missions Enabled by New Propulsion Technology and Systems (6)

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AIR, CARBON DIOXIDE AND WATER AS OXIDIZERS FOR METAL-BASED FUELS FOR AEROSPACE PROPULSION AND FUTURE SPACE MISSIONS

Abstract

The performance of a propellant depends critically on its combustion characteristics which have a direct impact on the system performance, reliability, long-term stability and environmental footprint. Also, cost, operability and material availability must be considered. Metal combustion has been studied since the 1960s as a viable solution for propulsion, power and storage systems. Metals can react with air, carbon dioxide or water to generate thermal and chemical energy for various applications. These reactions generate metal-oxides when metals are reacting with air, hydrogen when reacting with water and carbon monoxide as well as a small amount of carbon when reacting with carbon dioxide. The objective of this work is to explore and investigate relevant, recent alternatives for developing clean energy with high performances based on metal-air reactions, metal-water reactions that can generate hydrogen as a secondary fuel; or even metal-carbon dioxide reactions that can be conducted on-site in Mars for exploration missions. The main combustion and propulsion characteristics of these metal fuels are numerically investigated through the Rocket Propulsion Analysis software and compared. When metals are reacting with air or iced water, metal-oxides can be captured and recycled to achieve low-net-carbon emissions while hydrogen can act as a secondary fuel to enhance combustion. Such fuels can be applied for Earth to Orbit missions and Moon missions. Metal fuels can also react with carbon dioxide which is the main component of the atmosphere of Mars (95.9