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Space Vehicles for Exploration & Propulsion for Deep Space (3)
Space Vehicles for Exploration & Propulsion for Deep Space - Session 2 (2)

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BIO-BASED PROPELLANTS FOR UPPER-STAGE ROCKETS

Abstract

This study investigates the potential of bio-based propellants, particularly ethanol, for use in upper-stage rocket systems, where optimized performance and reduced emissions are essential. As the space industry pivots toward greener technologies, replacing toxic propellants with sustainable alternatives is crucial to address environmental concerns and meet new legislative requirements. Ethanol emerges as a promising candidate due to its versatility and benign properties. Utilizing NASA CEA software alongside Julia/python for advanced modeling, we conducted a comprehensive analysis of ethanol with various oxidizers, including nitrous oxide and liquid oxygen, across different upper-stage engine configurations. This analysis encompasses key performance parameters such as thrust and specific impulse, as well as detailed emission profiles to assess environmental impact. Our approach involves optimizing propellant combinations, adjusting area ratios, and manipulating chamber pressures to meet the specific demands of upper-stage applications. Emphasis is placed on minimizing the need for cryogenic propellants while promoting bio-based emissions. This combined performance and emissions analysis not only aims to improve propulsion efficiency but also seeks to reduce costs associated with hazardous gas generation, storage, and venting. By advancing bio-based upper-stage rocket systems, we support a more sustainable and economically viable path for future space exploration.