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IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Interactive Presentations - IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (IP)

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ECODESIGN OF IN-SPACE PROPULSION SYSTEMS

Abstract

The space industry is on a path towards adopting more sustainable practices, necessitating a thorough assessment of both the technologies it employs and its design methodologies. The focus here is on transitioning to eco-friendlier designs for in-space propulsion systems, taking a broader approach to sustainability which goes beyond selecting less-toxic propellants. The goal is to reduce the environmental footprint of these propulsion systems throughout their "cradle-to-gate" lifecycle, from the manufacturing of components to the integration of the spacecraft at launch sites.

The proposed eco-design methodology unfolds in two stages: first, by evaluating the environmental impact of current propulsion systems, and second, by identifying and implementing strategies to mitigate these impacts. Both phases are performed within the context of mission scenarios, ensuring that the system's ability to fulfil the mission requirements remains unchanged. This eco-design approach focuses on using the unique benefits of eco-friendlier propellants while carefully managing the specific challenges each one presents.

The analysis uses the European Space Agency's Life Cycle Analysis (LCA) framework to study the environmental effects in the 17 categories defined by the Product Environmental Footprint (PEF) guidelines. It begins by reviewing propellant choices, building on data collected during the 2016 ESA study on Space Propellants and by integrating novel, industry-relevant propellants. The goal is to evaluate both traditional and eco-friendlier propellant alternatives and to consider how space mission designs can reflect current industry trends. Additionally, the study applies the results from the LCA to investigate eco-design alternatives. This approach helps in making well-informed decisions between the different propellants and their related architectures, using a single score to simplify comparisons and facilitate decision-making.

This exploratory work highlights the advantages of adopting "greener" propulsion technologies and promotes the incorporation of eco-design principles into the innovative design processes of the space sector. The aim is to promote a more sustainable framework for space missions, ensuring that environmental considerations are integral to the development of future propulsion systems.