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GREEN PROPELLANTS: SELF-PRESSURIZATION BEHAVIOR MODELLING

Abstract

Satellite services have become critical elements within our modern technological society, their application ranging from space transportation to communications and remote sensing. However, satellite reliability on traditional propellants like hydrazine is posing significant environmental challenges, given its highly toxic nature. As such, there is an urgent need to explore alternative "green" propellants, where "green" is related to substances which are not only associated to low human toxicity values, but also to highly effective satellite propulsion systems. Furthermore, the reactivity concerns related to hydrazine family propellants have led to significant increases in costs, both for fueling of spacecraft and human safety during ground operations. One promising propellant among the one included in the aforementioned category is nitrous oxide. Nitrous oxide is highly attractive due to its self-pressurizing capability, which deletes the need for complex and heavy pressurization systems that are common in traditional propellants. Additionally, nitrous oxide is considered a greener and superior alternative to hydrazine due to its non-toxicity and lower environmental impacts.

In this paper, a new model of self-pressurization behavior based on a modified FML mass flow rate estimation is presented. The model allows to characterize pressure values of a self-pressurized propellant during tank's draining, combining boiling estimation with the aforementioned mass flow rate model. To validate this new model, a refuelling conceptual solution based on nitrous oxide propellant is detailed. Furthermore, a test plan including a microgravity experiment is explained.

The paper represents an important step and an advancement in the use of "green" propellants within the space industry. The presented model tries to reduce the uncertainties related to the self-pressurization technology, bringing to the elimination of toxicity concerns associated with traditional propellants like hydrazine.