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FREE FLIGHT RE-ENTRY EXPERIMENT ON TRANSPIRATION COOLING HEAT SHIELD - TRACE ON REXUS 31

Abstract

In recent years, there has been a notable surge in momentum surrounding sustainability, reusability, interplanetary exploration, and the concept of new space, particularly focusing on the advancement of launch vehicles. Despite the pivotal role played by Entry Descent and Landing (EDL) mechanisms, these

technologies remain comparatively less mature and capable. Notably, presently employed heatshields often necessitate significant maintenance and lack rapid reusability, posing financial challenges and conflicting with advancements in the space industry.

In response to this gap, the opportunity presented by the Rocket Experiments for University Students (REXUS) program was seized to pioneer a radical EDL mechanism, challenging the prevailing state of the art in this domain. Our research identified transpiration cooling as the most promising alternative to traditional heatshields. This active cooling method boasts swift reusability, minimal maintenance requirements, high performance, and cost-effectiveness. To validate the method for use in space applications, a free flight experiment was carried out in the scope of the REXUS 31 cycle, comparing experimentally obtained data with analytical solutions.

This paper delves into the various subsystems, the encountered challenges, and the innovative solutions implemented to enable the execution of such an experiment within the limitations of the REXUS infrastructure. Additionally, it sheds light on the organizational dynamics and challenges faced by a team composed exclusively of students.

A comprehensive analysis of the transpiration cooling system's full flight is provided, encompassing key findings and a comparative assessment with conventionally used heat shields. The research outlined herein underscores the imperative for ongoing exploration and development of EDL mechanisms to meet the demands of future missions involving atmospheric re-entry.

By showcasing the viability of transpiration cooling as an alternative to traditional heatshields, this paper aspires to ignite further research interest in this realm and aims to contribute to the progress of space exploration technology.