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HEAT TRANSFER ANALYSIS FOR AN ABLATIVE COMBUSTION CHAMBER: INSIGHTS & METHODOLOGIES

Abstract

To ensure the reliability and safety of rocket engines, a rigorous thermal analysis is essential to identify areas of high thermal stress and understand the heat flow. This paper presents a detailed thermal analysis of a composite combustion chamber which is subjected to 35kN of thrust and 3000C of temperature. The analysis is done with respect to the properties of other engine parameters, which utilize liquid oxygen and jet-fuel as propellants.

Utilization of finite-element analysis software to determine heat fluxes along the length of the combustion chamber enabled identification of high thermal stress locations. This was done in parallel to experimental ablation tests of composite samples to obtain accurate thermal values. With respect to the design of the engine, the calculation of the h-coefficients was conducted to determine the heat transfer values to further analyze the composite material.

The research conducted emphasizes the importance of following the proper analysis methodology to understand the heat flow in a combustion chamber, and utilize it as a model for future analyses. This methodology includes determining the heat transfer coefficients, analyzing the composite materials' thermal conductivity values, and using finite element analysis software to calculate heat fluxes along the length of the combustion chamber. Our analysis has revealed critical insights into the heat flow in the combustion chamber, highlighting areas of extreme stress values heat transfer inefficiencies.

In conclusion, the research provides a comprehensive thermal analysis of a rocket combustion chamber and highlights proper analysis techniques that should be used to understand the thermal properties during a rocket firing. While the paper does not provide design guidelines for improving rocket engine designs, it serves as a valuable reference for researchers and engineers to perform thermal analysis effectively.