Paper ID: 70817
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IAF SPACE PROPULSION SYMPOSIUM (C4)
Interactive Presentations - IAF SPACE PROPULSION SYMPOSIUM (IP)

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COMPARATIVE ANALYSIS OF NUMERICAL MODELS OF FILM AND REGENERATIVE COOLING IN THRUST CHAMBER AT HIGH PRESSURE

Abstract

A liquid rocket engines are the most efficient engines which utilizes the fuel and oxidizer at the cryogenic temperature and high pressure. During the developmental stage of liquid rocket engines, especially in the phase toward higher combustion chamber pressures, leads to a considerable increase in the heat flux from the working fluid to the walls of the combustion chamber and the exhaust nozzle high which results the nozzle material to lose its yield strength and starts to melting .To overcome this issue several cooling systems are introduced such as ablative cooling regenerative cooling and film cooling . The generative and film cooling are considered to be the best cooling systems to maintain the wall temperature. In, regenerative cooling the coolants are passed through circular tubes, channels around the combustion chamber or nozzle to cool the engine.The amount of heat that can flow into the coolant is controlled by many factors including the heat transfer coefficient, the velocity in the coolant channels and the velocity of the gas flow in the chamber or the nozzle.The Thermal conductivity of the chamber wall, the temperature difference between the chamber and the coolant.Two boundary layers will be formed one in the hot gas which flows through the chamber and the coolant within the channels.For effectively protecting the combustion chamber surface and the exhaust nozzle walls from thermal damage by the hot stream of gases, film cooling is used industrially in rocket engine such as Vulcain 2. A thin continuous coolant layer is injected between the hot fluid stream and the wall surface and forms a low-temperature film, decreasing the normally expected convective heat flux and providing thermal protection for the walls. The coolant may be in the form of gas or liquid, depending on the situation its used. To reduce the chamber wall temperature significantly and to decrease the heat flux in the chamber wall which is transferred from the hot gas in which film cooling comes into the picture.In this paper, the comparative study of the numerical analysis of design geometries of both regenerative and film cooling systems in the conventional cryogenic propellant combination such as Liquid Methane – Liquid Oxygen, Liquid Hydrogen – Liquid Oxygen and RP-1(Kerosene) - Liquid Oxygen will be analyzed respectively.