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A TECHNOLOGY FOR IMPROVING REGENERATIVE COOLING IN ADVANCED CRYOGENIC ROCKET ENGINES FOR SPACE TRANSPORTATION

Abstract

Regenerative cooling of thrust chamber is the unique solution for the thermal management of high heat flux generated inside the combustion chamber of Cryogenic rocket engine. The high heat flux with a combustion temperature of 3500 K is produced, due to the huge energy release by the combustion of Liquid Oxygen and Hydrogen. The inner shell material generally used is copper alloy which has higher thermal conductivity (300W/mK) at elevated temperatures. Heat is transferred from combustion hot gas to coolant through the channels separated by copper shell. Coolant stratification is occurring inside the channels due to the temperature gradient of the coolant and aspect ratio of the coolant passages. Coolant stratification reduces the heat transfer and results in higher chamber wall temperature. A novel technique of providing copper foam inside the channels which will act as an infinite fin and also act as barrier for coolant stratification, which will improve the heat transfer to the coolant more effectively. Experiments are conducted with simulated hot gas chamber coolant channels using water as the coolant. Copper foam with high porosity is selected to fill the channels. Hot tests are conducted by passing the hot gas generated with a kerosene combustor. Hot tests are carried out with copper foam filled coolant channels and measured the coolant temperature rise pressure drop across the channels. Tests are repeated with similar hot gas condition, but without inserting copper foam inside the channels. An increase of 34of multi-start cryogenic engines for future space transportation systems, where a lower throat wall temperature of engine with augmented heat transfer by using copper metal foams inside the coolant channels. Simulations are carried out for the operating Cryogenic engines with copper foam insert only at the throat regime and computed the reduction in nozzle throat wall temperatures impact in coolant pressure drop. This paper details the Specification of copper foam, hardware design, experiments measurements and the application of the augmentation of heat transfer coefficient in working Cryogenic Engines estimating the improved life cycle.