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NOVEL DESIGN OF GAS GENERATOR SYSTEM USING HYBRID ROCKET MOTOR

Abstract

Turbopump system is a critical component in rocket propulsion, delivering propellants from the storage tanks to the combustion chamber at high pressure with high efficiency. Pumps are driven by either an electric motor or a turbine. The latter uses gas generator as the energy source due to its high-power output. Proper design and optimization of the gas generators are essential for the successful operation of the turbopump system. This study proposes a novel gas generator system that utilizes hybrid rocket technology instead of using conventional gas generator systems which require complex design. The study uses a combination of experimental and computational methods to evaluate the performance of proposed hybrid gas generator system. The hybrid motor utilizes a polymer-based fuel, and nitrous oxide as an oxidizer. After verifying the consistency of combustion of the hybrid motor in static hot-firing tests, a cooling system is integrated. The cooling system is placed after the nozzle of the hybrid motor, and it uses a heat exchanger to transfer heat from the combustion products to the coolant fluid for cooling. Prior to conducting integrated firing tests with this cooling system, the temperature and pressure of the products were calculated in MATLAB using NASA's Chemical Equilibrium with Applications (CEA) program, which models chemical reactions taking place in combustion chamber. The required flow rate for nitrous oxide and coolant is determined based on CEA outputs, and the injector area of nitrous oxide is calculated using the homogeneous equilibrium method (HEM) to account for two-phase properties of fluid. It is observed that the outputs of the computational model correlate well with the experimental data. The results demonstrate that the proposed novel hybrid gas generator system can effectively provide necessary gas stream with desired temperature for turbine operation. The findings of this study provide valuable insights into the design and performance of hybrid gas generator systems for rocket engines, with potential applications in space launch vehicles.