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DYNAMIC CHARACTERISTICS OF HYDROGEN PEROXIDE ELECTRIC PUMP DURING PULSE IGNITION PROCESS OF HYBRID ROCKET ENGINE

Abstract

The electric pump for delivering hydrogen peroxide in the advanced hybrid rocket engine is a crucial component that can significantly enhance engine performance. Previous studies have primarily focused on the design of electric pumps and the evaluation of engine performance, with limited research on the dynamic characteristics of electric pumps during hybrid rocket engine operation. This study numerically and experimentally investigated the variation patterns and mechanisms of the internal flow field parameters within the transient process of the electric pump in a hybrid rocket engine employing a pulse ignition scheme. The simulation and experimental results indicate that the application of a pulse ignition scheme in a hybrid rocket engine induces a water hammer resulting from the operation of the valve downstream of the electric pump, leading to significant fluctuations in both mass flow rate and pressure within the electric pump. The dramatic pressure variation in the main flow field within the electric pump leads to pressure variations in the secondary flow passages. With a narrow gap in the electric motor, the insulation sheath of the stator windings is of weak strength, introducing a potential risk of rupture. Severe fluctuations of mass flow rate and pressure also lead to extreme variations in operating parameters such as torque, rotational speed, force and current of the electric pump. The findings of present study can provide a theoretical and experimental background for the aerospace community to explore the ignition strategies of hydrogen peroxide electric pumped-pressure hybrid rocket engines.