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PROTOTYPIC CENTRIFUGAL FUEL ELEMENT TEST STAND FOR EVALUATING CENTRIFUGAL NUCLEAR THERMAL PROPULSION ENGINE COMPONENTS

Abstract

Centrifugal Nuclear Thermal Propulsion (CNTP) is an advanced nuclear thermal propulsion (NTP) design that can attain twice the specific impulse of traditional solid fuel NTP engines, and approximately four times the specific impulse of chemical rockets. The high specific impulse is achieved by bubbling hydrogen propellant through a rotating annulus of high temperature liquid uranium. The rotation is provided by a turbine connected to the porous wall boundary at the uranium outer radius. Due to this complex nature of the CNTP design, little experimental work has been conducted to investigate component and system level interactions to assess viability of the design. This work details the development and operation of a low fidelity test environment to analyze the performance and behavior of one centrifugal fuel element (CFE) system from the CNTP design. The test environment simulates the flow of cryogenic hydrogen propellant through a porous wall medium and liquid uranium with surrogate materials: nitrogen in place of hydrogen, and Galinstan in place of liquid uranium. The test stand allows for evaluation of the complex CFE environment from the component level to the system level. Initial experiments show promising results, indicating feasibility of the CFE design. However, further experimentation and component level design optimization is necessary.