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OVERVIEW OF THE HIGH PERFORMANCE CENTRIFUGAL NUCLEAR THERMAL PROPULSION SYSTEM

Abstract

Space nuclear propulsion (SNP) could help enable the advanced exploration, utilization, and colonization of space. Both nuclear thermal propulsion (NTP) and nuclear electric propulsion (NEP) show tremendous potential. An SNP system will only be developed and utilized if it is safe, affordable, reliable, and has performance that is enabling for missions of interest. This provides a unique challenge for entry-level SNP systems. While nearly all fission systems can be designed to be safe (meeting the requirements of NSPM-20), there are typically trade-offs between affordability, reliability, and performance. High Performance NTP (HPNTP) systems can be defined as systems capable of providing ¿ 20,000 N of thrust at a specific impulse greater than 1300 s. This presentation will focus on one HPNTP concept, the Centrifugal Nuclear Thermal Rocket (CNTR). The CNTR is designed to enable both a relatively short (420 day) round-trip mission to Mars (including 6 weeks at Mars) and have an acceptable advancement degree of difficulty (AD2). The basic design and operation of the CNTR is described in Allen et al., 2020. The CNTR uses a combination of flow geometry and centrifugal force to enable a high propellant exhaust temperature (¿ 4000 K) while maintaining structural materials, moderators, and other components at ¡ 1000 K. The reactor comprises 19 fuel cylinders, each approximately 1 m in length and 0.1 m in diameter and partially filled with metallic uranium fuel enriched to ¡ 20Two near-term CNTR proof-of-concept experiments are also discussed. The first experiment will demonstrate the feasibility of the flow geometry and the second experiment will demonstrate the required compatibility between the cylinder wall, the liquid metallic uranium fuel, and the propellant.