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UTILIZATION OF GASEOUS CORE SUPER CRITICAL NUCLEAR REACTORS FOR SPACE POWER AND SPACE PROPULSION FOR DEEP SPACE MISSIONS

Abstract

One of the greatest challenges in spaceflight and space exploration is the availability of sufficient energy for deep space missions and sufficient specific impulse for deep space missions. In the case of a spacecraft, which is poised for deep space exploration, the greatest issue will be providing abundant power for propulsion, life support, navigation, deflectors, and computers as well as for exploratory sensors. In the case of a space station in space, the need for power becomes even more intense as there may be many more astronauts available on a space station and they will all require power in addition to the power required by the space station for daily activity as well as for labs and sensors. In a space station like ISS, it may be manageable by solar power and their means but in a space station with 20 or more people, the need for power may become unmanageable really fast. The same situation will also apply to habitats which may be constructed on the moon or on any of the Solar Planets. In all of these instances, solar powers and special batteries can be used to utilize the power curve requirements, but as stated before, this power is only available up to a certain threshold. Beyond this threshold, nuclear means need to be explored. Unfortunately, classic nuclear reactors may also not be sufficient for some applications and overall due to usage of water or liquid metals as a coolant in a fission reactor will not really be feasible in space applications as liquid behavior will be problematic in space. Thus, this paper deals with utilization of gaseous core nuclear reactors for space power applications, space propulsion systems and for powering space habitat applications. Basically, gaseous core nuclear reactors work with the fission principle, but they utilize gas based nuclear fuels such as Uranium Hexafluoride and thus there is no liquid that is utilized in the system. It deals with circulation of gases and gaseous nuclear fuel and thus it makes it more manageable in space environments including vacuum and microgravity. Furthermore, due to the fission kinetics and due to its supercriticality, the heat being generated is much higher than classic fission applications and this allows for extraction of more work and power from the nuclear reactor. This paper discusses the specifics and gives several examples as a case study for space power based applications.