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MOLTEN SALT REACTOR CONCEPTS FOR ADVANCED NUCLEAR ELECTRIC PROPULSION (NEP) SYSTEMS

Abstract

Molten Salt Reactors (MSRs) offer some intrinsic advantages for Nuclear Electric Propulsion (NEP) related to the use of liquid fuel. In particular, since heat is removed by convection rather than conduction in a molten fuel salt, it is possible to achieve relatively high power densities and operating temperatures in the core while maintaining low fuel pressures and temperature gradients. Moreover, an MSR can be designed to use relatively simple control systems, thanks to strong negative reactivity feedback coefficients. These design features are crucial for improving the reliability of a space nuclear reactor. The possibility of scaling up the power output of an MSR concept is also an interesting aspect for considering missions beyond NEP, such as surface power. Nevertheless, the design work of a space MSR poses significant technical challenges due to issues related to molten salt corrosion, materials selection, pump design, power conversion, and radiator systems. Like other space reactor concepts, these issues, along with nuclear tests and system integration considerations, must be addressed in the early stages of the design. The French National Center for Scientific Research (CNRS) is conducting design studies for a NEP engine based on an MSR. This paper provides a discussion of the various design options being investigated at the CNRS. In particular, the results of the detailed analyses performed for fast and thermal spectrum MSRs are discussed.