High-Temperature Salt-Cooled Reactor for Power and Process Heat

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Program: Integrated Research Program

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ABSTRACT

The objective of the Integrated Research Project (IRP) is to develop the path forward to a test reactor and ultimately a commercial high-temperature salt-cooled reactor (also called a Fluoride-salt High-Temperature Reactor [FHR]). This includes pre-conceptual designs of a test and commercial reactor. The high temperature capabilities (~700°C) imply an efficient reactor for converting heat into electricity using an open air-Brayton power cycle similar to that used in natural-gas fired power stations. This open cycle could eliminate the need for water to produce electricity and ease the siting of new nuclear power plants. The outlet temperatures are sufficiently high to provide heat for production of liquid fuels in refineries and biorefineries.

The FHR is a new reactor concept—about a decade old. It combines high-temperature graphite-matrix coated particle fuel developed for high-temperature gas-cooled reactors (fuel failure temperature > 1600°C), liquid salt developed for the molten salt reactors (boiling point > 1400°C), and safety systems originate from sodium fast reactors. This new combination of existing technologies creates the possibility of a large power reactor where catastrophic accidents would not be credible. The Three Mile Island and the more recent Fukushima accident resulted from radioactive decay heat generated after the reactors were shut down that overheated and destroyed fuel. The FHR fuel and coolant combination may allow decay heat to conduct to the environment without massive fuel failure even with large-scale structural and system failures.

The IRP combines the capabilities of the Massachusetts Institute of Technology (MIT), the University of California at Berkeley (UCB), and the University of Wisconsin at Madison (UW). MIT coordinates the effort and will focus on testing materials in the MIT reactor and developing a pre-conceptual design of a test reactor—the next major step. UCB will focus on thermal hydraulics and neutronics including tests using stimulants and development of a pre-conceptual design of a power station. UW will focus on testing materials for corrosion in their laboratories. The awards for MIT, UCB, and UW are respectively: $3850K, $2750K and $900K.