Abstract

Fluoride salts have superior thermophysical properties compared to conventional reactor coolants, and are potentially attractive coolants for high-temperature, low pressure reactors called Fluoride salt-cooled High temperature Reactors (FHRs). The US Department of Energy has initiated an Integrated Research Project (IRP) led by Massachusetts Institute of Technology (MIT) to develop the technical basis to design, develop and license commercially attractive FHRs. The FHR is a new reactor concept with coolant temperature at ~700 °C that combines existing technologies of TRISO high temperature fuel, fluoroide salt coolant, high-temperature low pressure plant design such as sodium cooled fast reactors, and utilizes high-efficiency air Brayton cycle. The base technologies for the FHR have been demonstrated, including the graphite-matrix coated-particle fuel, fluoride salt coolant flibe, a mixture of lithium-7 fluoride and beryllium fluoride (66.7% 7LiF-33.3% BeF2), and structural material Alloy-N (also called Hastelloy®-N) developed by ORNL specifically for the MSR program, and has outstanding corrosion resistance with fluoride salts and good creep resistance in the temperature range of interest. Under the IRP, three irradiation experiments with Flibe salt and proposed FHR materials have been performed at the 6 MW MIT Research Reactor (MITR). The emphasis of these experiments is placed on candidate FHR materials corrosion performance under irradiation, radioactive gaseous species transport, and the
challenges in tritium control. Several FHR designs have been proposed at national laboratory and universities. At MIT, we developed a 10 MWt Transportable FHR (TFHR) design with up to 5-year fuel cycle for off-grid electricity generation and remote industrial applications. The TFHR has a compact core and simplified system design with a design goal to be easily transported by a truck, or a train or an airplane. Passive safety design and low fission product inventory offer opportunities for autonomous reactor control innovation. In addition, a subcritical facility driven by the MITR has been designed to accelerate the demonstration of the TFHR. Initial neutronic analysis has shown that the subcritical facility can produce up to 1 MW of fission power with multiple full-width partial-height prismatic fuel assemblies operating with a power density up to 30% of a proposed TFHR. This option would allow code benchmarking and validation, and integrated systems and component testing as a major step toward building the demonstration reactor.

About the Speaker

Dr. Lin-wen Hu is an international leader with more than 20 years’ experience in fluid dynamics and heat transfer, nuclear systems design, safety, and nuclear technology applications. She obtained her PhD degree from MIT Nuclear Engineering Department, and is currently Director of Research and Services division at MIT Nuclear Reactor Laboratory (NRL). Dr. Hu successfully integrated NRL’s research capabilities and expertise into national programs, such as the National Science User Facilities, and expanded her group which now consists of reactor experiments, reactor physics analysis, neutron activation and elemental analysis, and neutron beam applications groups. Dr. Hu served on numerous U.S. and international technical committees including National Academies of Sciences study committees, International Group of Research Reactors steering committee, American Nuclear Society Isotope and Radiation division executive committee. Dr. Hu currently leads several research projects including MITR Low Enrichment Uranium fuel design conversion study, Fluoride salt-cooled High-temperature Reactor (FHR) design, modeling and safety analysis, fluoride salt and materials irradiation testing, and Transient Reactor Test Facility (TREAT) modeling and instrumentation design. Dr. Hu has authored over 200 technical publications.