NUCLEAR ENERGY RESEARCH INITIATIVE

Development and Analysis of Advanced High-Temperature Technology for Nuclear Heat Transport and Power Conversion

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Project Number: 05-079

Collaborators: None

Related Program: Gen IV

Project Description

This three-year project will research advanced high-temperature heat transport and power conversion technology, in support of both the Nuclear Hydrogen Initiative and Generation IV. It will focus on fundamental and applied questions about high-temperature heat transport using different combinations of gases (helium) and liquids (molten fluoride salts). Selection of the working fluid is a major design issue for the Next Generation Nuclear Plant (NGNP), which will employ a 50 MWt high-temperature intermediate loop to demonstrate production of nuclear hydrogen.

The project makes contributions in four interrelated areas. First, researchers will develop detailed reference designs for the NGNP intermediate heat exchanger system, evaluating different heat transport fluids (high-pressure helium, intermediate-pressure helium, and molten salt) for hydrogen production. Second, they will conduct integral experiments to study transient high-temperature heat transport, generating experimental data for model development and code verification. Third, they will evaluate improvements to high-temperature multi-reheat helium Brayton cycle technology which will increase efficiency 5 to 10 percent and roughly double the power density. Fourth, researchers will conduct additional analysis work to further initial designs of the molten salt-cooled Advanced High Temperature Reactor (AHTR), which is a potential high-temperature heat source for electricity and power production.

Work Scope

- Develop intermediate heat exchanger design parameters and conduct a detailed design analysis comparing the various candidate fluids (high and intermediate pressure helium and molten fluoride salts). Evaluate both metallic and ceramic variants of each fluid, and generate a detailed analysis for safety, stored energy, and reliability.
- Design, construct, and perform scaled, transient, heat transport experiments to characterize the proposed fluids.
- Develop detailed design and analyses of multiple-reheat helium Brayton power conversion systems for the AHTR and for application to modular Lead Fast Reactor.

- Develop intermediate heat transfer loop designs for AHTR based on results of the preceding tasks.