NUCLEAR ENERGY RESEARCH INITIATIVE

The Sulfur-Iodine Cycle: Process Analysis and Design Using Comprehensive Phase Equilibrium Measurements and Modeling

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Related Program: NHI

Project Description

Of the many thermochemical hydrogen cycles that have been proposed for the centralized production of hydrogen from nuclear power, the Sulfur-Iodine (SI) cycle has been identified as one of the most promising and is of international interest. However, the SI cycle involves complex, highly non-ideal phase behavior and reactions. Many of the performance projections associated with this technology are currently based on uncertain and incomplete data. Thus, thermodynamic measurements and physical property models for this cycle have been identified as basic research requirements for the successful development of a future hydrogen economy.

This project will be performed by an experienced team of academic, industrial, and DOE national laboratory experts, who will assess the true potential of the SI cycle. Work will focus on three research areas: thermodynamic measurements, physical property modeling, and process modeling. For the first time, researchers will measure comprehensive phase equilibrium data for the process-limiting Hydrogen-Iodine (HI) dissociation section of the SI cycle. The team will use a unique, integrated approach that will allow for highly efficient exploration as well as feedback among the three focus areas. That is, researchers will use data from initial property and process modeling to guide the selection of conditions for experimental measurement. Then, as measurements become available, property models will be refined and provided for the process modeling effort. Finally, updated process modeling results will be used to identify additional experiments that are most critical for minimizing the remaining process uncertainties.

Work Scope

The scope of work will consist of (i) new, comprehensive phase equilibrium data for the SI cycle over wide ranges of conditions that have not previously been investigated, (ii) development of properties models for the phase behavior and properties of chemical systems critical to SI cycle analysis for which no adequate models currently exist, and (iii) establishment and dissemination of a comprehensive and reliable process modeling capability for thermochemical cycle analysis. Specific deliverables will include comprehensive phase equilibrium measurements for the HI dissociation step of the SI cycle, property models for all process streams, and an optimized flowsheet model for the SI cycle.