Development of Capabilities to Study the Thermodynamics of Nuclear Energy Related Infrastructure at the Utah Nuclear Engineering Program (UNEP)

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Program: General Scientific Infrastructure

ABSTRACT:

Objectives: The mission of the Utah Nuclear Engineering Program is to provide the highest quality environment in fostering education, research, and training in nuclear engineering by creating opportunities for creative and critical thinking. Recent growth of UNEP enabled expansion from the reactor and radiation detection facilities to a 2,000 sq. ft clean laboratory for radiochemistry, trace actinide analysis, and spectroscopy. While the reactor and radiation detection facilities are very well equipped for the detection of radiation, the facilities are lacking the infrastructure to study the actinides on a molecular and chemical level. The instrument to be purchased under this award (i.e. Isothermal Titration Calorimeter) will enable the measurement of thermodynamic properties greatly increasing the productivity of classroom based studies and research.

Project description and method: With $121,852 we are proposing to acquire an isothermal titration calorimeter (ITC) for the measurement of thermodynamic properties of actinide complexes, and the enhancement of our coursework and research efforts. ITC is a measure of the energetics of a reaction of the molecular interactions such as ligand bonding or interactions among components of multi-molecular complexes at constant temperature. Sustainable nuclear fission energy programs are based on the closure of the nuclear fuel cycle, which will likely involve reprocessing via solvent extraction approaches. The engineering basis for such reprocessing systems must be established from a strong foundation in the fundamental complexation chemistry requiring extensive knowledge on the thermodynamics of the system.

Impact: By upgrading the UNEP radiochemistry and spectroscopy lab, we will improve and further develop nuclear energy infrastructure and capabilities in support of nuclear energy-related engineering and science teaching and R&D efforts. Our radiochemistry and spectroscopy labs are in their infancy, but our undergraduate and graduate programs, and our on-going R&D, are all growing very rapidly in the number of students and research expenditures. We lack state of-the-art instrumentation to support and sustain this growth. Furthermore, our revised and highly modernized curriculum requires advanced and up-to-date instrumentation capable of thermodynamic measurements. The purchase of this ITC is critical to sustain and increase our growth in the number of students educated in our program and increase our R&D. With this new instrument, our radiochemistry and spectroscopy lab will become well-advanced, allowing for new research, the development of new laboratory practices as part of our modern courses, and the training of our students in modern and state-of-the-art techniques pertaining to nuclear energy and supporting knowledge.