NUCLEAR ENERGY RESEARCH INITIATIVE

Advanced Electrochemical Technologies for Hydrogen Production by Alternative Thermochemical Cycles

PI: Serguei Lvov, Pennsylvania State University

Collaborators:
Argonne National Laboratory
Tulane University
University of South Carolina

Project Number: 08-047

Program Area: Nuclear Hydrogen Initiative

Project Description

The main objective of this consortium is to establish the most efficient technologies for hydrogen production that are compatible with nuclear-generated heat sources. The heat produced by nuclear power plants can be utilized by moderate-temperature thermochemical cycles to convert steam into hydrogen and oxygen. Researchers will investigate a number of prospective thermochemical cycles and key reactions via experimental work and process simulation to evaluate their efficiency and viability for future sustainable energy infrastructure.

Several promising alternative thermochemical cycles merit further research: 1) three copper-chloride (Cu-Cl) reactions, 2) three calcium-bromide (Ca-Br) reactions, and 3) two active alloy metal reactions. Potential benefits of these cycles include medium temperature (≤ 600°C) operation, high efficiency, simple unit operations, and relatively simple separations. This project concerns the development of advanced electro-chemical technologies, which will lead to overall improvement in cycle performance. The work will focus on the following tasks: 1) development of membranes, electrocatalysts, electrode materials, and membrane electrode assemblies (MEA) for all of the cycles; 2) separation of reaction products; 3) identification and modeling of species involved in the electrochemical processes; and 4) flowsheet analyses to guide the experimental program towards higher efficiency and lower cost processes. The modeling and experimental work will be iterative. As the technology evolves, the flowsheets will be updated and optimized to find other opportunities for increasing efficiency and reducing costs.

Material demands for these alternative cycles are expected to be less severe than at the temperature required for the baseline sulfur cycle (i.e., 825°C). While this project is primarily concerned with alternative thermochemical cycles, the technologies developed will be applicable to Proton Exchange Membrane (PEM) electrolyzers and other hydrogen production processes.