INTERNATIONAL NUCLEAR ENERGY RESEARCH INITIATIVE

Further Investigations of the Interface between SCWR and Cu-Cl Cycle, a Moderate Temperature Thermochemical Cycle

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Project Abstract

The goals of this project are 1) to assess the economic potential of the optimized copper-chlorine (Cu-Cl) thermochemical cycle for producing hydrogen and 2) to determine the viability of the CANDU Mark-2 super critical water reactor as the heat source. The Cu-Cl cycle shows promise for heat source temperatures of about 600°C. This cycle consists of three thermal reactions for generating H_2, O_2, and HCl and one electrochemical reaction:

#	Reaction Stoichiometry	Temperature (°C)
1	$2Cu + 2HCl(g) \rightarrow 2\ CuCl(l) + H_2(g)$	425-450
2	$4CuCl(s) \rightarrow 2CuCl_2(a) + 2Cu$	<100
3	$2CuCl_2 + H_2O(g) \rightarrow Cu_2OCl_2\ (s) + 2HCl(g)$	300-375
4	$Cu_2OCl_2\ (s) \rightarrow 2CuCl(l) + ½O_2(g)$	450-530

Proof-of-principle experiments show that the chemistry is viable and a simulation using assumed parameters resulted in an efficiency of 43 percent (LHV). Researchers plan experimental work to determine optimum operating conditions for the hydrolysis and the electrochemical reactions, updating their model as experimental data are obtained. They will use sensitivity analyses to fine-tune operating parameters and to determine the effect of parameters that are not easily varied in the laboratory, such as pressure.

Workscope

The following tasks comprise the main elements of this project:

- Decide on an electrochemical cell concept
- Determine optimum conditions for hydrolysis reaction
- Conduct preliminary efficiency and cost analyses
- Determine optimum conditions for electrochemical cell
- Conduct laboratory-scale demonstration of all component reactors