THERMOCHEMICAL HYDROGEN PRODUCTION WITH A HIGH TEMPERATURE ADVANCED NUCLEAR REACTOR*

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Currently there is no large scale, cost effective and environmentally attractive hydrogen production process available for commercialization, nor has such a process been identified. The U.S. Government through the Nuclear Energy Research Initiative (NERI) is funding a three-year development program to determine the potential for efficient, cost-effective, large-scale production of hydrogen using high temperature heat from an advanced nuclear power station.

This report will address the first phase of the project. In this phase we evaluated thermochemical processes which offer the potential for efficient, large-scale production of hydrogen from water, in which the primary energy input is high temperature heat from an advanced nuclear reactor. The result of the first phase was the selection of two processes for further detailed consideration.

The work in Phase 1 consisted of:

- A detailed literature search and development of a database of all published thermochemical cycles.
- A first round screening process to reduce the initial list to 20-30 cycles.
- A second round of screening to reduce the number of cycles to 3 or less.
- A report describing the results of Phase 1.

Ten databases were searched and over 800 literature references were located, representing over 100 thermochemical water-splitting cycles. After two rounds of screening two cycles were selected for final consideration: the adiabatic UT-3 cycle and the sulfur-iodine cycle. The adiabatic UT-3 cycle was invented at the University of Tokyo and has been extensively studied in Japan by a number of organizations. Its predicted efficiency is 40%. In a combined hydrogen/electric plant, overall efficiencies as high as 50% have been projected. The sulfur-iodine cycle has been under development since the early 1970s and improvements proposed by various researchers should further increase the already high predicted efficiency (52%) of this cycle.

Considering that a significant effort is already under way on the UT-3 cycle in Japan, we selected the sulfur-iodine cycle for further development in the USA.

We are working on establishing a cooperative program with our Japanese colleagues to foster joint development of both the UT-3 and the sulfur-iodine process. This may allow future selection of one thermochemical water-splitting cycle for scale-up and demonstration.

Our effort in Phases 2 and 3 will be aimed at incorporating the proposed improvements into the sulfur-iodine cycle and at adopting this process to a high temperature advanced nuclear reactor.

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