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DOE/France

ABSTRACT

Thermochemical Hydrogen Production Process Analysis

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Argonne National Laboratory (ANL) has recently initiated a U.S. DOE-NE project to develop and apply a methodology for a consistent assessment of thermochemical hydrogen production cycle efficiencies (Nuclear Hydrogen Initiative Work Packages A2.1.1 and A2.1.2). Published cycle efficiencies suffer from inconsistent evaluation methodologies and potentially unreliable thermodynamic data. For example, published efficiencies for the most well known sulfur-iodine cycle vary from 28 to greater than 55 %. These differences can be attributed to various factors, such as changing the calculational method from essentially hand calculations in the 1970s to sophisticated computerized simulation programs currently available, improvements in process design and technologies, better heat matching, and different peak temperatures. Researchers have not always defined their efficiency estimates in terms of high or low heating value, or closed or open loop. The effect of cogeneration should be explicitly defined for comparison purposes. For the UT-3 calcium-bromine cycle, efficiencies are estimated to increase by 10% when cogeneration is included. Similar increases are predicted for the sulfur-iodine cycle. Cogeneration makes a huge impact on efficiency. Different thermodynamic databases have been used in the past and reasonable, but not necessarily transparent, estimates have been used when data are not available. These differences make it difficult to determine the best-estimate efficiency for the well studied sulfur-iodine cycle and almost impossible to fairly judge the merits of other potentially promising hydrogen production methods. The DOE Nuclear Hydrogen Research and Development Plan recognizes that a standardized process assessment methodology is needed as the program selects the most promising hydrogen production technologies to pursue.

CEA, Saclay, has been collaborating with the U.S. on the development of sulfur-iodine thermochemical hydrogen production processes. Several papers concerned with calculating the upper bound for the efficiency of the sulfur-iodine cycle have been published recently. These papers have considered the inadequacy of the thermodynamic data for the H_2O-HI-I_2-H_2 reactions and how these data impact overall efficiency.