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—ABSTRACT—

THE ADVANCED HIGH-TEMPERATURE REACTOR: MATCHING NUCLEAR POWER SYSTEMS TO THERMOCHEMICAL HYDROGEN PRODUCTION

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THE ADVANCED HIGH-TEMPERATURE REACTOR: MATCHING NUCLEAR POWER SYSTEMS TO THERMOCHEMICAL HYDROGEN PRODUCTION

C. W. Forsberg and P. S. Pickard

The demand for hydrogen (H_2) for the conversion of crude oil into clean fuels is growing rapidly. In the longer term, H_2 may even replace liquid fuels. Nuclear energy has been proposed as a source of high-temperature heat for production of H_2 using thermochemical cycles. Thermochemical cycles involve a series of chemical reactions in which (1) the overall reaction is "$2\ H_2O + \text{heat} \rightarrow 2\ H_2 + O_2$," and (2) all the other chemicals used in intermediate steps are recycled within the process. These cycles require high-temperature heat input (>750°C) and the interfacing of a nuclear plant with a complex chemical plant. This interface imposes requirements on both plants.

The proposed Advanced High-Temperature Reactor (AHTR) uses a graphite fuel and molten-salt coolant to deliver the heat at the required high temperatures and the preferred low pressures. The paper describes: (1) leading thermochemical cycles for H_2 production, (2) resultant interface requirements for using nuclear energy for production of H_2, (3) the implications of those requirements on the nuclear reactor, (4) a proposed AHTR to deliver the heat at the required temperatures, and (5) the specific issues associated with the nuclear/chemical interface.