—ABSTRACT—

HYDROGEN PRODUCTION PROCESS REQUIREMENTS AND NUCLEAR REACTOR OPTIONS

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Nuclear energy has the potential to become the primary method for the production of hydrogen. Several methods of hydrogen production are being investigated: nuclear-heat-assisted steam reforming of natural gas, hot electrolysis (electrolysis at ~800EC), and thermochemical processes. Thermochemical processes use high-temperature heat (750 to 900EC) and water to yield hydrogen and oxygen. The hydrogen production processes impose multiple requirements on the reactor: (1) delivery of high-temperature heat over a relatively small temperature range, (2) barriers to prevent migration of radioactive tritium from the reactor to the product hydrogen, (3) a low pressure interface to prevent reactor or chemical plant transients from impacting the other facility, (4) transport of heat over some distance to allow physical separation of the chemical and nuclear facilities for safety, and (5) appropriate scale of operation. There are multiple candidate reactors: (1) modular helium reactors (coated particle fuel with helium cooling), (2) the advanced high-temperature reactor (coated-particle fuel with molten salt cooling), (3) the molten salt reactor (molten salt coolant with the fuel dissolved in the salt), (4) lead-cooled fast reactors (oxide fuel in metal clad with molten lead coolant), and (5) sodium-cooled fast reactors (oxide fuel in metal clad with molten sodium coolant). The hydrogen chemical plant requirements are defined and compared with the characteristics of the different reactors. Advantages and disadvantages of various options are described and discussed.