258a Thermodynamic Efficiency Analysis of the S-I Process for Nuclear Hydrogen Production

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The Sulfur-Iodine process for thermochemical water decomposition (1) is considered a leading candidate for large-scale production of hydrogen using nuclear energy. Since the nuclear plant will likely be the biggest component of the capital cost, net thermal efficiency, which is a measure of the hydrogen fuel value obtained per unit of nuclear reactor heat output, will be a key determinant of economic feasibility. Many analyses of the net thermal efficiency have been carried out, with results ranging from 35% to 57%, depending strongly on system assumptions and often on results from models which are subject to considerable uncertainty (1-4). This work develops a procedure to calculate a set of upper-limit efficiencies that minimize model dependence and maximize generality through careful statements of overall, sectional and equipment-based system reversibilities and integrated energy utilization (5). From these results, extensions are made to determine the consequences of process changes, as well as their sensitivities, either by modification of flows and states or by expected corrections to model predictions based on data and other information. This effort is intended to step toward a reliable benchmark procedure for objectively evaluating alternative processes, a way to improve existing processes, and a path to focus needed fundamental research.

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