Modeling of thermally-coupled monolithic membrane reformer for vehicular hydrogen production

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A B S T R A C T

A thermally-coupled monolithic membrane reformer (TMMR) is a heat and membrane integrated reformer for portable hydrogen production. This study simulates the TMMR using Aspen Plus software to find the appropriate monolith design and operation parameters to achieve optimal energy efficiency and hydrogen production within a small volume reactor. Different types of fuels, *i.e.* methane, methanol and ethanol, and various operating conditions, including molar flow rate of fuel (0.01–0.05 mol/s for combustion and 0.1–0.5 mol/s for reforming) and reforming pressure (3–5 atm), were investigated via thermodynamic equilibrium analysis. When methanol and ethanol were used as feedstocks, a reverse water-gas-shift reaction occurred, resulting in a decrease of energy efficiency. While using methane as a feedstock with a specific molar flow rate of 0.03 mol/s for the combustion reaction, 0.30 mol/s for the reforming reaction, and a reforming pressure of 4 atm, significant improvement of efficiency was observed. At the same time, the performance of the TMMR design was simulated based on the surface area of different sizes and configurations of monolith, *i.e.* parallel and checked arrangements, by using a kinetic-based model approach. The highest efficiency achieved was from the checked arrangement of monolith with 200 cpsi of cell density, 150 mm of diameter and length, and