Experimental study on a compact methanol steam reformer with Pd/Ag membrane

Abstract

The performance of high purity hydrogen production from methanol for a compact steam reformer with a hydrogen purification membrane was investigated experimentally. A 77 wt.% Pd/23 wt.% Ag membrane with 25μm thickness and CuO/ZnO/ Al2 O3 catalyst were used. Heating was performed by a Bunsen type burner using City Gas 13A. The methanol reforming and purification of H2 were investigated at different reference catalyst zone temperatures (589-689K), pressures at the retentate side (0.2-0.5MPa), steam to methanol(S/C) ratios (0.8-1.6) and reactant flow rates (1.7×10-4 to 4.4×10-4 mol/s). The results show that at high reference temperature, high pressure and certain points of the reactant flow rate, the maximum hydrogen permeation rate is obtained when the S/C ratio is around 1. The modified Sieverts' equation which considers the decrease in H2 concentration at the membrane surface, was proposed. The experimental result was lower than the permeation rate estimated by the modified Sieverts' equation, which is probably caused by the adsorption of non-H2 species during permeation. It is further demonstrated that the modified Sieverts' equation is able to estimate a more reasonable hydrogen permeation rate in comparison to the estimation by the ordinary Sieverts' equation. In addition, it is shown that the compact methanol steam reformer with a Pd/Ag membrane is able to produce high purity hydrogen with very low CO concentration, which fulfills the Polymer Electrolyte Fuel Cell (PEFC) requirement (<10ppm).