Modeling of Micro-Tubular Solid Oxide H₂O/CO₂ co-Electrolysis Cell for Syngas Production

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In this paper, a one dimensional chemical equilibrium co-electrolysis model is established to reveal the high temperature H₂O/CO₂ co-electrolysis process in a micro-tubular cell. The model has been roughly validated by the experimental data, systematically demonstrating the effects of current density, cell length, operating temperature and inlet gas flow rate on the products composition as well as the syngas quality. It is indicated that increasing both the electrolysis current and cell length will lead to an improved conversion rate of H₂O and CO₂ as well as an increased yield of H₂ and CO. High-quality syngas with 100% CO₂ and steam conversion rate as well as ideal H₂/CO ratio of 2 is achieved when the 15-cm cell is exposed to a 50-sccm cathode gas stream consisting of 56.67% H₂O + 33.33% CO₂ + 10% H₂ at 800 °C and 1.0 Acm⁻². It is also found that the operating temperature, which is strongly associated with the equilibrium of reverse water gas shift reaction, plays an important role in the as-products properties. A constant H₂/CO ratio of 2 is achieved at 817.5 °C. Besides, reducing the inlet gas flow rate is beneficial to increase the conversion rate of H₂O and CO₂, but decrease the syngas production rate.

Keywords: Micro-tubular solid oxide electrolysis cell, Co-electrolysis process, Syngas production, Chemical equilibrium co-electrolysis model

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