398d Start-up Strategies of an Experimental Fuel Processor

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Rapid start-up is essential for successful commercialization of fuel processors which can deliver desired hydrogen flow rate to the fuel cell while maintaining acceptable carbon monoxide (CO) concentration. In this work, steady-state and dynamic models were developed to describe an experimental methane fuel processor which is intended to provide hydrogen for a Proton Exchange Membrane Fuel Cell (PEMFC) for the power generation (2-3KWe). The fuel processor consists of a burner, an autothermal reformer (ATR), three water gas shift reactors (HTS1, HTS2, and LTS), and a preferential oxidation reactor (PROX). Steady-state and dynamic analyses reveal that two factors play important roles for start-up time. One is the slow temperature propagation down toward the PROX exit which is due to enormous size of honeycomb catalyst, especially for LTS and PROX. The other is unacceptable high CO concentration. Ono et al. [1] formulate the start-up as an optimization problem for solid oxide fuel cell (SOFC) systems. Springmann et al. [2] show that the start-up time can be reduced by adjusting the feed ratios. Here, the feeding strategy is used to improve the cold start. A simple strategy is devised with a step increase in the methane feed rate (while keeping appropriate feed ratios) followed by a ramp down to the designed flow rate. The duration time and ramp-down slope are treated as design variables by minimizing the start-up time. The results indicate that the start-up time can reduced as much as 25% as compared to the case with nominal operating settings. Finally, the effects of material selection on start-up time are also explored. The results show that reactors with a low heat capacity carrier reduced start-up time significantly.

References

[1] Ono, H.; Sonoda, T.; Ohtani, Y.; Kuraseko, H.; Noda, M.; Hasebe, S. “Optimal Start-up Operation for Fuel Cell Systems”, Kagaku Kogaku Ronbunshu, 2003, 29, 477-482. [2] Springmann, S.; Bohnet, M.; Docter, A.; Lammd, A.; Eigenberger, G. “Cold Start Simulations of a Gasoline Based Fuel Processor for Mobile Fuel Cell Applications”, Journal of Power Sources, 2004, 128, 13–24.