Optimization for Improving Efficiency on Membrane Reactor for WGS Reaction

D.Y. Shin[1], T.E. Kim[1], J.Y. Lee[1]

[1]Altsoft Inc., Seoul, South Korea

Abstract

Hydrogen production by water gas shift reaction(WGSR) in Integrated Gasification Combined Cycle (IGCC) plant is the most popular process in the world. Traditional hydrogen production process by WGSR is consist of two processes due to its' considerable exothermic equilibrium reaction ; the first operation is for quick reaction at high temperature (300°C-500°C) and the other is for getting high conversion of carbon monoxide at low temperature (200°-25°C). Recently, membrane reactor for WGSR (WGSR-MR) has been studied to improve the thermal efficiency of the hydrogen production process and reduce the cost. Pd-based membrane is useful for selectively extracting hydrogen. WGSR can be more activated by this feature. Also, thermal efficiency can be enhanced because sweep gas removes the heat for exothermic reaction.

In previous study, the modeling for WGSR-MR has been performed with reference to Chein paper[1] and effects of various operating conditions were evaluated for conversion for carbon monoxide and hydrogen flux. In this continuous study, sensitivity analysis is performed for operating conditions to improve efficiency for carbon monoxide and hydrogen removal in reactor and the reactor is optimized through parametric study with selected conditions. For this work, COMSOL Multiphysics® and Chemical Reaction Engineering Module are used : "Transport of Concentrated Species", "Free and Porous Media Flow", and "Heat Transfer in Fluid" interface are used to study mass, momentum, and heat balance for mixture of gas. These physics interfaces are coupled with each other. The objective function of WGSR-MR model is related with CO conversion and hydrogen removal at outlet of sweep gas.

Reference

[1] R.Y. Chein et al., Sweep gas flow effect on membrane reactor performance for hydrogen Production from high-temperature water-gas shift reaction, J Membrane Sci, Vol 475, p. 193 (2015)
[2] Cornaglia et al., Production of ultrapure hydrogen in a Pd-Ag membrane reactor using noble metals supported on La-Si oxides. Heterogeneous modeling for the water gas shift reaction, J Hydrogen Energy, Vol 38, p. 10485 (2013)
[3] Adams and Barton, A dynamic two-dimensional heterogeneous model for water gas shift reactors, J Hydrogen Energy, Vol 34, p. 8877 (2009)
[4] Augustine et al., High pressure palladium membrane reactor for the high temperature water-gas shift reaction, Vol 36, p.5350 (2011)

Figures used in the abstract

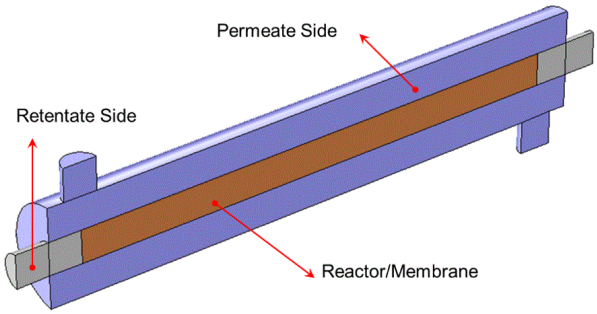

Figure 1: Geometry for WGSR-MR