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Approaching Complete CO Conversion and Total H_2 Recovery for Water Gas Shift Reaction in a High-Temperature and High-Pressure Zeolite Membrane Reactor

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ABSTRACT

Water gas shift reaction of syngas and subsequent H_2/CO_2 separation are key operations for large-scale H_2 production from fossil fuels and agricultural and forestry biomass with CO_2 capture. In this study, a tubular zeolite membrane reactor has been demonstrated for the first achievement of nearly complete CO conversion and total H_2 recovery with simultaneous production of a high pressure pure CO_2 stream for water gas shift reaction at high temperature and high pressure. When operated at 500°C and 20 bar, the membrane reactor attained CO conversion >99.9% and H_2 recovery >99.9% with a high pressure pure CO_2 retentate under practically meaningful gas hourly space velocity of 15,000 h^{-1} and steam-to-CO ratio of 3.5. The zeolite membrane reactor with proven long-term stability is promising for further development and practical considerations.

Graphical abstract

A tubular zeolite membrane reactor has been demonstrated for high temperature and high pressure water gas shift reaction to achieve near complete CO conversion and H_2 recovery.

Keywords: water gas shift; zeolite membrane reactor; high temperature; high pressure.

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