Performance comparison of different membrane micro-channel reactors for methanol production from biogas and hydrogen
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Abstract: In this research, the models of different membrane micro-channel reactors (MMR) for methanol synthesis from biogas and hydrogen were developed. MMRs combining reaction and separation by membrane in a single unit were simulated based on two-dimensional pseudo homogeneous models using COMSOL Multiphysics program. Biogas was fed to the MMRs where CO₂ in biogas was separated through a membrane to react with H₂ in a reaction channel coated with CuO/ZnO/Al₂O₃ catalyst to form methanol. Three configurations of MMR were investigated including 1) addition of CO₂ into only 1 side of a reaction channel, 2) addition of CO₂ into both sides of a reaction channel and 3) combined addition of CO₂ into a reaction channel while simultaneously removal of water from the reaction. In case 3, Argon acts as carrier gas for permeation side. The yields of methanol achieved from each configuration were 14.602%, 15.59% and 22.17%, respectively under conventional condition. It was found that the configuration 3 outperformed the others because the removal of water in the system can shift the equilibrium of the reactions to the forward side. The effects of operating parameters including inlet temperature, pressure and flow rate in case 3 were investigated by sensitivity analysis. The optimal condition was 533 K, 50 bar and 1.2×10⁻⁶ kg/s.

Case 1

![Case 1 Diagram](image1)

Case 2

![Case 2 Diagram](image2)

Case 3

![Case 3 Diagram](image3)

Keywords: Methanol production; Membrane micro-channel reactor; Biogas