World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:17, No:12, 2023

High Temperature and High Pressure Purification of Hydrogen from Syngas Using Metal Organic Framework Adsorbent

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Abstract : Hydrogen is considered as one of the most important clean and renewable energy carriers for a sustainable energy future. However, its efficient and cost-effective purification remains challenging. This paper presents the potential of using metal–organic frameworks (MOFs) in combination with pressure swing adsorption (PSA) technology for syngas based H2 purification. PSA process analysis is done considering high pressure and elevated temperature process conditions, it reduces the demand for off-gas recycle to the fuel reactor and simultaneously permits higher desorption pressure, thereby reducing the parasitic load on the hydrogen compressor. The elevated pressure and temperature adsorption we present here is beneficial to minimizing overall process heating and cooling demand compared to existing processes. Here, we report the comparative performance of zeolite-5A, Cu-BTC, and the mix of zeolite-5A/Cu-BTC for H2 purification from syngas typical of those exiting water-gas-shift reactors. The MOFs were synthesized hydrothermally and then mixed systematically at different weight ratios to find the optimum composition based on the adsorption performance. The formation of different compounds were characterized by XRD, N2 adsorption and desorption, SEM, FT-IR, TG, and water vapor adsorption technologies. Single-component adsorption isotherms of CO2, CO, CH4, N2, and H2 over single materials and composites were measured at elevated pressures and different temperatures to determine their equilibrium adsorption capacity. The examination of the stability and regeneration performance of metal–organic frameworks was carried out using a gravimetric system at temperature ranges of 25-150℃ for a pressure range of 0-30 bar. The studies of adsorption/desorption on the MOFs showed selective adsorption of CO2, CH4, CO, and N2 over H2. Overall, the findings of this study suggest that the Ni-MOF-74/Cu-BTC composites are promising candidates for industrial H2 purification processes.

Keywords : MOF, H2 purification, high T, PSA
Conference Title : ICAAMA 2023 : International Conference on Adsorption Analysis and Multicomponent Adsorption
Conference Location : Vienna, Austria
Conference Dates : December 25-26, 2023