World Academy of Science, Engineering and Technology
International Journal of Chemical and Molecular Engineering
Vol:11, No:03, 2017

Atmospheric CO2 Capture via Temperature/Vacuum Swing Adsorption in SIFSIX-3-Ni

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Abstract : Carbon dioxide capture has attracted the attention of many governments, industries and scientists over the last few decades, due to the rapid increase in atmospheric CO2 composition, with several studies being conducted in this area over the last few years. In many of these studies, CO2 capture in complex Pressure Swing Adsorption (PSA) cycles has been associated with high energy consumption despite the promising capture performance of such processes. The purpose of this study is the economic capture of atmospheric carbon dioxide for its transformation into a clean type of energy. A single column Temperature /Vacuum Swing Adsorption (TSA/VSA) process is proposed as an alternative option to multi column Pressure Swing Adsorption (PSA) processes. The proposed adsorbent is SIFSIX-3-Ni, a newly developed MOF (Metal Organic Framework), with extended CO2 selectivity and capacity. There are three stages involved in this paper: (i) SIFSIX-3-Ni is synthesized and pelletized and its physical and chemical properties are examined before and after the pelletization process, (ii) experiments are designed and undertaken for the estimation of the diffusion and adsorption parameters and limitations for CO2 undergoing capture from the air; and (iii) the CO2 adsorption capacity and dynamical characteristics of SIFSIX-3-Ni are investigated both experimentally and mathematically by employing a single column TSA/VSA, for the capture of atmospheric CO2. This work is further supported by a technical-economical study for the estimation of the investment cost and the energy consumption of the single column TSA/VSA process. The simulations are performed using gProms.

Keywords : carbon dioxide capture, temperature/vacuum swing adsorption, metal organic frameworks, SIFSIX-3-Ni
Conference Title : ICCME 2017 : International Conference on Chemical and Molecular Engineering
Conference Location : Osaka, Japan
Conference Dates : March 30-31, 2017