

Modeling and analysis on cyclic operation of fiber sorbent for direct air capture

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A fiber sorbent is a gas separation system in which porous sorbent particles are dispersed in a fiber-shaped polymer matrix. The fiber sorbent offers lower pressure drop, improved mass/heat transfer, and faster thermal equilibrium attainment, compared to the conventional packed bed system. Such improvements make the concept of direct air capture (DAC), which has been considered to be uneconomical, a more competitive option for CO<sub>2</sub> capture. DAC with fiber sorbent has room for further improvement through systematic analysis on cyclic operation options and operating conditions. With a rigorous dynamic model, efficient operation strategy can be analyzed and suggested at the process level. To this end, this work aims to build a dynamic model for a fiber sorbent CO<sub>2</sub> capture module, and to analyze the energy consumption for various cyclic operation options. A rigorous dynamic model, considering transport resistance and momentum balance, is constructed in gPROMS and is validated with experimental breakthrough data. Then, both steam-assisted and non-assisted temperature vacuum swing adsorption (TVSA) cycles are evaluated with a systematic energy consumption analysis approach.