Virtual Design of a Four-Bed Molecular Sieve for Exploration

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Abstract

Aboard the International Space Station, carbon dioxide is removed from the atmosphere using a four-bed adsorptive separation process, referred to generally as a 4-Bed Molecular Sieve (4BMS). Experience with the current 4BMS design in space has led to a list of areas for improvement for a next-generation design, which is currently in development at NASA. Some of the major design improvements include using a different sorbent for CO2 and changing the sizes of the beds. Because 4BMS is a complex system and testing of new configurations is time-consuming and expensive, COMSOL modelling is being used to help guide the design. In this work, simulations of six new 4BMS configurations have been performed using a one-dimensional COMSOL model. The preliminary results show that reductions in desiccant bed size and sorbent bed size when compared to the International Space Station configuration are feasible while still yielding a process that handles at least 4.0 kg/day CO2. The results also show that changes to the CO2 sorbent are likewise feasible. Decreasing the bed sizes was found to have very little negative effect on the adsorption process; breakthrough of CO2 in the sorbent bed was observed for two of the configurations, but a small degree of CO2 breakthrough is acceptable, and water breakthrough in the desiccant beds was not observed. Both configurations for which CO2 breakthrough was observed still yield relatively high CO2 efficiency, and future investigations will focus on bed size in order to find the optimum configuration.

Figures used in the abstract

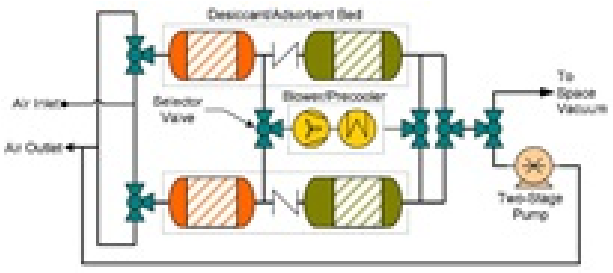

Figure 1: A simplified schematic of a 4BMS system.