Multiphysics Modeling of Engineered Structured Sorbents for the Adsorption of Carbon Dioxide and Water Vapor from Manned Spacecraft Atmospheres

In NASA's Vision for Space Exploration, humans will once again travel beyond the confines of earth's gravity, this time to remain there for extended periods. These forays will place unprecedented demands on launch systems. They must not only blast out of earth's gravity well as during the Apollo moon missions, but also launch the supplies needed to sustain a larger crew over much longer periods. Thus all spacecraft systems, including those for the separation of metabolic carbon dioxide and water from a crewed vehicle, must be minimized with respect to mass, power, and volume. Emphasis is also placed on system robustness both to minimize replacement parts and ensure crew safety when a quick return to earth is not possible.

This paper describes efforts to improve on typical packed beds of sorbent pellets by making use of structured sorbents and alternate bed configurations to improve system efficiency and reliability. The development efforts described offer a complimentary approach combining testing of subscale systems and multiphysics computer simulations to characterize the regenerative heating substrates and evaluation of engineered structured sorbent geometries. Mass transfer, heat transfer, and fluid dynamics are included in the transient simulations.