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CARBON DIOXIDE REMOVAL SYSTEM FOR CLOSED LOOP ATMOSPHERE REVITALIZATION, CANDIDATE SORBENTS SCREENING AND TEST RESULTS

Abstract

Due to the difficulty and expense it costs to resupply manned-spacecraft habitats, a goal is to create a closed loop atmosphere revitalization system, in which precious commodities such as oxygen, carbon dioxide, and water are continuously recycled. Currently, the crew on the International Space Station (ISS) uses a 4-bed molecular sieve packed with zeolite crystals enclosed in a clay binder and silica gel as the carbon dioxide removal system. The water and carbon dioxide adhere to the zeolite crystals by adsorption and are regenerated by desorption. The benefit of the zeolites is that they can be continuously re-used. However, there are two major drawbacks to the current system; the first being that the fluidic motion between the pellets generates fines of dust that contaminate equipment on the space station, and the second is that the clay binder is a poor thermal conductor, limiting the escape of heat generated from the heat of adsorption and adversely requiring a large amount of energy to regenerate the material by desorption. Our aim is to test other sorbents for their capacity for future spacecraft missions, such as on the Orion spacecraft, or possibly lunar or Mars mission habitats to see if they would be better than the zeolite sorbents on the 4-bed molecular sieve. Some of the materials being tested are currently used for other industry applications. Studying these sorbents for their specific spacecraft application is different than for applications on earth because in space, there are certain power, mass, and volume limitations that are not as critical on Earth. In manned-spaceflight missions, the sorbents are exposed to a much lower volume fraction of CO2 than on Earth. For example, on space station, there is a 0.6% volume of CO2, where as these materials are exposed to 12-15% CO2 from smokestacks from coal-fired plants. Polyethylenimine (PEI) immobilized with polymethylmethacrylate (PMMA) at various weight ratios and the combination of PEI and CARiACT silica were tested for their CO2 capacity in an atmosphere like that of the ISS. Breakthrough tests were run to establish the capacities of these materials at a partial pressure of CO2 that is seen on the ISS. This paper discusses experimental results from benchmark materials, such as results previously obtained from tests on zeolite 5A, and the fore mentioned candidate materials for the Carbon Dioxide Removal Assembly (CDRA) system.