Modeling Evolvable Water Recovery Systems for Short and Long-Duration Missions in Partial Gravity

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Abstract:

Water recovery technologies on the International Space Station (ISS) are designed and optimized for microgravity environments, thus creating a need for innovative systems optimized for mission operations in the presence of gravity. Alternative water recovery technologies under research by the Life Support Systems division were compiled into a series of Partial Gravity Water Recovery System (PGWRS) architectures. Individual unit processes were modeled via fundamental physical-chemical process equations to simulate their method of treatment, including chemical or biological oxidation, flash evaporation, filtration, or adsorption and ion exchange. Dimension and sizing data were then utilized to scale each architecture. Modeling was completed on an assortment of architectures assuming three scenarios in which treatment methods could take advantage of partial gravity: a short-duration mission with a temporary surface habitat, a longer duration mission with a more permanent habitat, and a long duration mission without resupply. Total system mass was estimated to quantitatively compare architectures within scenarios, but qualitative observations were also made regarding system robustness, flexibility, and capacity to meet more stringent demands. Technologies that traded most favorably between the scenarios were those that included a pre-oxidation stage to minimize mass loading to downstream absorption and ion exchange beds, exploited gravity in liquid-vapor separation processes, and reconstituted wastewater components into recyclable material streams.