Flight Testing of the Forward Osmosis Bag for Water Recovery on STS-135

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The Forward Osmosis Bag (FOB) is a personal water purification device for recovery of potable liquid from almost any non-potable water source. The FOB experiment was flown as a sortie mission on STS-135/ULF7 using flight-certified materials and a design based on the X-Pack™ from Hydration Technology Innovations (Albany, OR). The primary objective was to validate the technology for use under microgravity conditions. The FOB utilizes a difference in solute concentration across a selectively permeable membrane to draw water molecules from the non-potable water while rejecting most chemical and all microbial contaminants contained within. Six FOB devices were tested on STS-135 for their ability to produce a potable liquid permeate from a feed solution containing 500 mL potassium chloride (15 g L^{-1}) amended with 0.1% methyl blue dye (w:v) tracer against an osmotic gradient created by addition of 60 mL of concentrate containing the osmolytes fructose and glucose, and 0.01% sodium fluorescein (w:v) tracer. Three FOB devices were physically mixed by hand for 2 minutes by a crewmember after loading to augment membrane wetting for comparison with three unmixed FOB devices. Hydraulic flux rate and rejection of salt and dye in microgravity were determined from a 60-mL sample collected by the crew on orbit after 6 hours. Post-flight analysis of samples collected on orbit demonstrated that the Forward Osmosis Bag achieved expected design specifications in microgravity. The hydraulic flux rate of water across the membrane was reduced approximately 50% in microgravity relative to ground controls that generated an average of 50 mL per hour using the same water and osmolyte solutions. The membrane rejected both potassium and chloride at >92% and methyl blue dye at >99.9%. Physical mixing of the FOB during water recovery did not have any significant effect on either flux rate or rejection of solutes from the water solution. The absence of buoyancy-driven convection in microgravity suggests that mass transport was dominated by diffusion, slowing the rate of permeate production across the membrane. It is possible that a predicted reduction in concentration polarization at the membrane surface that may have acted to increase the rate of permeate production in microgravity was negligible under the described test conditions.