Integration of FOB System to Crew Transfer Bag

National Aeronautics and Space Administration

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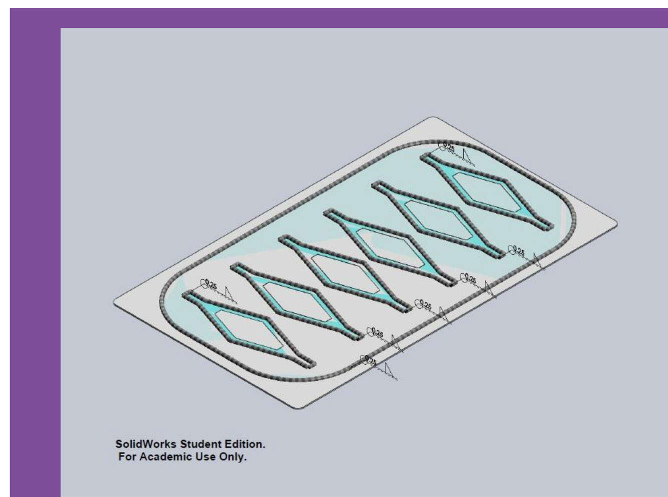
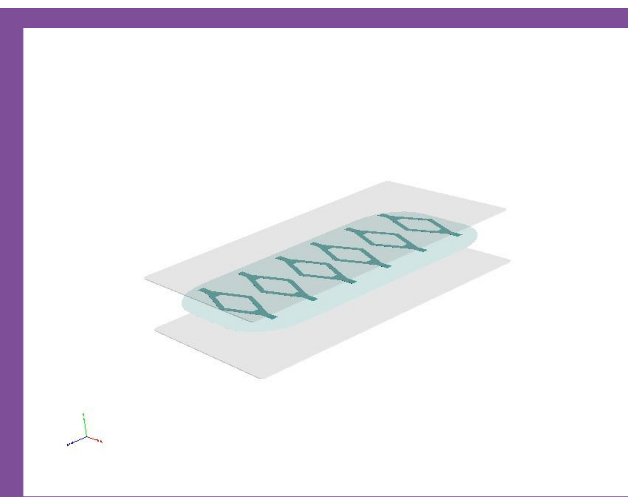
Abstract

All human space missions, regardless of destination, require significant logistical mass and volume. The amount required is a function of the mission duration. Reducing this logistical mass and volume by reusing items that would otherwise become trash can reduce launch weight and mission costs. During the summer of 2012, the Forward Osmosis Bag (FOB) flown on STS-135 in July 2011 was redesigned to improve overall efficiency of the fresh water production from grey water sources and to implement as part of the International Space Station (ISS) Crew Transfer Bags (CTB).

CTBs are fabric cargo containers, which conform to specific dimensional and material requirements for space flight. This poster describes the development of a Forward Osmosis Crew Transfer Bag (FO-CTB) that can be reused on orbit to provide radiation shielding and water recycling capacity. The design, construction, and testing of several prototype versions of FO-CTB are discussed. It has not yet been determined which design will be pursued for implementation.

Designs

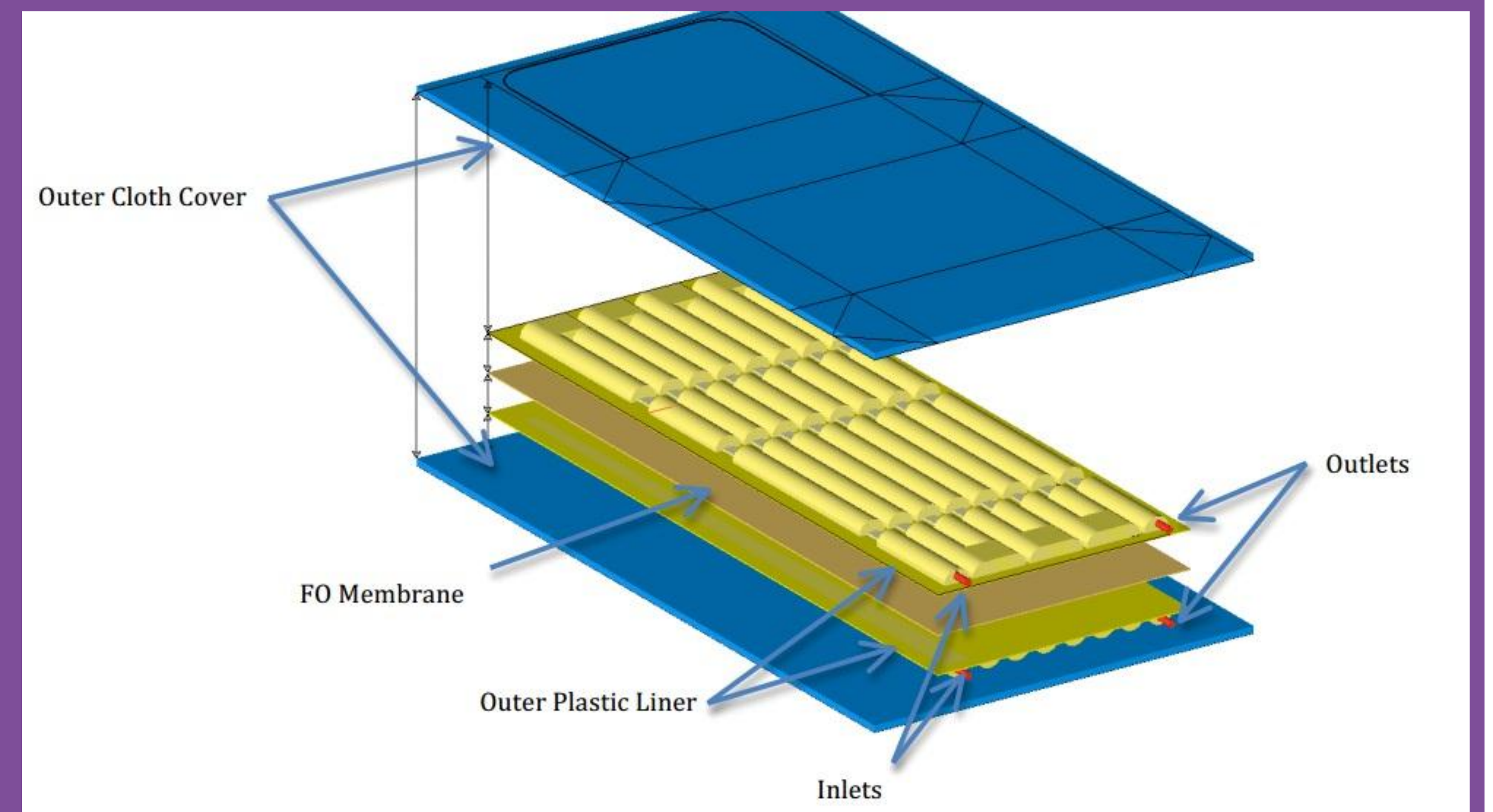

Concept design A for welds


Expanded view of concept design A


X-Pack commercial product


Possible material for bag plastic

Concept design B including Crew Transfer Bag



Background

2011 FOB Experimental Results

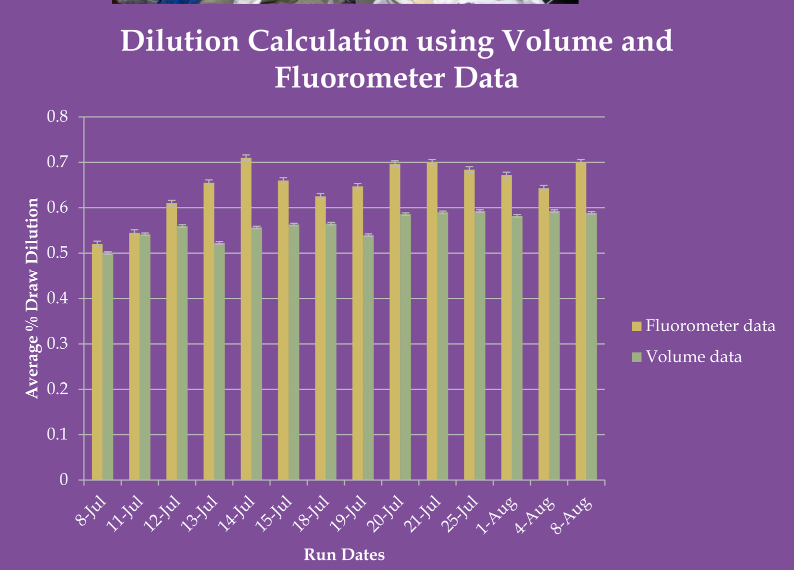
The results of the first microgravity testing of the FOB, conducted in 2011 on board the Space Shuttle STS-135 and ground testing at Kennedy Space Center & Ames Research Center quantified membrane wetting capacity, ion rejection, and fluid flux rate of the FOB.

On board STS-135, six FOB devices were tested for their ability to produce a purified liquid permeate from a wastewater feed solution containing 550 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 syrup concentrate containing the osmolytes fructose and glucose, a malic acid preservative, and 0.01% sodium fluorescein (w: v) tracer.

Three FOB devices were physically mixed by hand for 2 minutes after loading to augment membrane wetting for comparison with three unmixed devices. Flux rate and salt rejection were determined at 6- and 24-hour intervals.

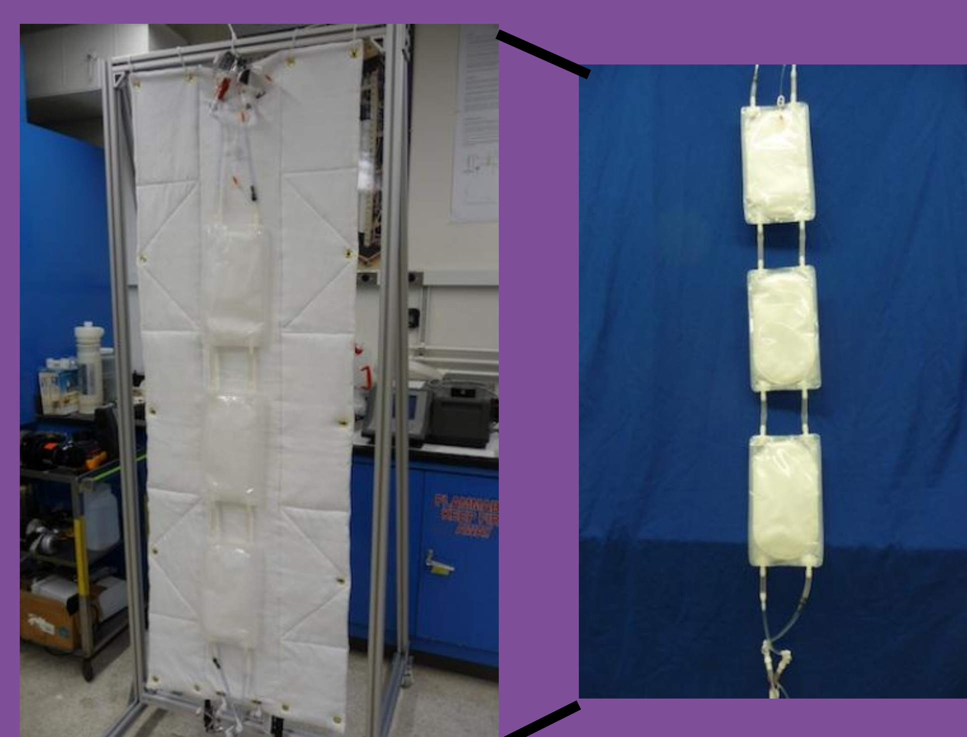
The results of this flight experiment demonstrate that the FO process works in microgravity. However, flux rates are reduced. This reduction appears to be no more that 50%. Flight data exhibited an error of about 33%.

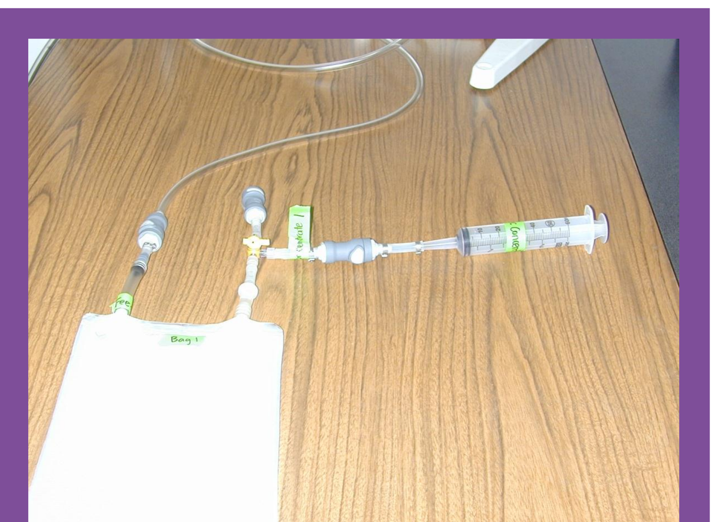

Astronaut conducting Flight experiment data



Draw solution flux determined by dilution of fluorescein dye after 5 hours. Averages of all runs each day are shown for both volume and fluorometer data sets.

Process





Three FOB (Forward Osmosis Bags) are connected in series.

The FOB is injected with osmotic concentrate via syringe on the “Draw” side.

The FOB is filled with 3.0 L of hygiene water via gear pump.

Discussion

In mid- September the FOB-CTB prototype will be demonstrated at Johnson Space Center.

At that time, the functionality of this system will be analyzed using TOC analysis of final draw solution and comparison of ending volumes to measure flux.

Based on previous experiments, we expect to see between 50 and 60% water recovery and little to no contamination of hygiene water on the draw side.

Acknowledgments

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