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Life support Challenges for Human Space Exploration (10)
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WATER WALLS: MASSIVELY REDUNDANT AND HIGHLY RELIABLE LIFE SUPPORT FOR LONG DURATION EXPLORATION MISSIONS

Abstract

The romance of the machine hits its limits in designing, building, and operating mechanically- driven life support systems for long duration space missions. The repeated episodes of failure and crisis on Mir and the ISS demonstrate the tremendous challenge of implementing a mechanical life support system over a period of years. Stated simply, it is not possible to launch all the necessary spare parts with the service technicians and repair shop to keep these systems operating reliably.

Water Walls presents an entirely different approach to long duration life support. Instead of providing one or two massive, heavy, extremely complex and expensive, sensitive, and eminently failure-prone pieces of mechanical equipment, the Water Walls approach provides a large number of repetitive, simple units to handle the same functions. Instead of the inelegant crisis/failure mode of mechanical ECLSS equipment, Water Walls units or modules are designed to have their capacity consumed gradually throughout the mission. As one unit is used up, the next in line takes over.

Water Walls (WW) will provide the key life support functions of CO2 removal, O2 revitalization, urine and gray water recycling, and solid waste processing. The WW basic unit is a polyethylene bag with one or more forward osmosis (FO) membranes in it, and valved orifices for input and output. Currently, the WW water processing function is fully mature, with FO bags available commercially. NASA Ames Research Center implemented an FO recycling system for urine and wash water in the new "Sustainability Base" green building. The next step is to complete development and implementation of solid waste processing. Finally, air processing is in basic and applied research for FO bags that will have an active membrane on the exterior of one side.

WW achieved its first TRL-7 flight experiment milestone in flying an FO bag experiment in a cargo transfer bag on STS-135, the last shuttle flight earlier this year. WW presents additional advantages for integrating life support into the architecture of a spacecraft or space habitat. The liquid-filled FO bags can provide a degree of non-parasitic radiation shielding. WW can also provide a food source from harvesting the algae used to replenish the atmosphere.