An Alternative Water Processor for Long Duration Space Missions

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A new wastewater recovery system has been developed that combines novel biological and physicochemical components for recycling wastewater on long duration human space missions. Functionally, this Alternative Water Processor (AWP) would replace the Urine Processing Assembly on the International Space Station and reduce or eliminate the need for the multi-filtration beds of the Water Processing Assembly (WPA). At its center are two unique game changing technologies: 1) a biological water processor (BWP) to mineralize organic forms of carbon and nitrogen and 2) an advanced membrane processor (Forward Osmosis Secondary Treatment) for removal of solids and inorganic ions. The AWP is designed for recycling larger quantities of wastewater from multiple sources expected during future exploration missions, including urine, hygiene (hand wash, shower, oral and shave) and laundry. The BWP utilizes a single-stage membrane-aerated biological reactor for simultaneous nitrification and denitrification. The Forward Osmosis Secondary Treatment (FOST) system uses a combination of forward osmosis (FO) and reverse osmosis (RO), is resistant to biofouling and can easily tolerate wastewaters high in non-volatile organics and solids associated with shower and/or hand washing. The BWP has been operated continuously for over 300 days. After startup, the mature biological system averaged 85% organic carbon removal and 44% nitrogen removal, close to stoichiometric maximum based on available carbon. To date, the FOST has averaged 93% water recovery, with a maximum of 98%. If the wastewater is slighty acidified, ammonia rejection is optimal. This paper will provide a description of the technology and summarize results from ground-based testing using real wastewater.