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ON THE DEVELOPMENT OF A UREA FUEL CELL INTERFACED DOC SYSTEM: HARVESTING ENERGY FROM WASTEWATER

Abstract

Due to the high cost of delivering supplies to space, the recovery of potable water from spacecraft wastewater is critical for life support of crewmembers in long-term missions (i.e. 120-400 days). NASA estimates that during manned space missions 60 g/person·day of urine is produced, with urea and various salts as its main components. A Direct Osmotic System has been developed by NASA Ames Research Center and is employed in this research. DOC is a source-separated integrated membrane treatment process designed for the reclamation of spacecraft wastewater. The system consists of three subsystems: the forward osmosis/reverse osmosis (FO/RO); the direct contact membrane distillation (DCMD), and the aqueous phase catalytic reactor (APCO). The FO/RO recycle hygiene water while the DCMD recycle urine and humidity condensate. The APCO is a post treatment step for both the FO/RO and DCMD products into potable water. The two major disadvantages of the DOC system is that the waste stream must be separated in order to prevent premature fouling of the FO/RO membrane and the high power consumption of the DCMD subsystem. Therefore, in order to eliminate such drawbacks a urea electrochemical bioreactor is interfaced along with the FO/RO subsystem to harvest urea while generating power in the same process. Thus, in this research we explore the utilization of urease enzymes (EC 3.5.1.5) to convert urea to nitrogen using a two step process of urease catalyzed decomposition of urea to ammonia followed by the electrochemical decomposition of ammonia to nitrogen. Urease was immobilized on granulated activated carbon to serve as a bio-reaction platform, while platinum was electrodeposited on boron-doped diamond electrodes by cycling the potential to attain active electrodes. Samples from NASA Ames Research Center water recycling equipment, containing urine, were used to test the herein proposed system.