Ionic Liquids Enabling Revolutionary Closed-Loop Life Support

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Minimizing resupply from Earth is essential for future long duration manned missions. The current oxygen recovery system aboard the International Space Station is capable of recovering approximately 50% of the oxygen from metabolic carbon dioxide. For long duration manned missions, a minimum of 75% oxygen recovery is targeted with a goal of greater than 90%. Theoretically, the Bosch process can recover 100% of oxygen, making it a promising technology for oxygen recovery for long duration missions. However, the Bosch process produces elemental carbon which ultimately fouls the catalyst. Once the catalyst performance is compromised, it must be replaced resulting in undesired resupply mass. Based on the performance of a Bosch system designed by NASA in the 1990's, a three year Martian mission would require approximately 1315 kg (2850 lbs) of catalyst resupply. It may be possible to eliminate catalyst resupply with a fully regenerable system using an Ionic Liquid (IL)-based Bosch system. In 2016, we reported the feasibility of using ILs to produce an iron catalyst on a copper substrate and to regenerate the iron catalyst by extracting the iron from the copper substrate and product carbon. Additionally, we described a basic system concept for an IL-based Bosch. Here we report the results of efforts to scale catalyst preparation, to scale catalyst regeneration, and to scale the carbon formation processing rate of a single reactor.

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