On the Performance Potential of Bioelectrochemical Life Support Systems

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An area of growing multi-disciplinary research and revolutionary development for bio-processing on Earth is bioelectrochemical systems. These systems exploit the capability of many microorganisms to act as biocatalysts, enhancing the performance of electrochemical processes which convert low-value materials into valuable products. Many varieties of such processes hold potential value for space exploration as means to recycle metabolic waste and other undesirable materials or *insitu* resources into oxygen, water, and other valuable substances. However, the wide range of possible reactants, products, configurations, and operating parameters, along with the early stage of development and application on the ground necessitate thorough consideration of which, if any, possibility(ies) could outperform existing technologies and should thus receive investment for space applications. In turn, the decision depends on the theoretical and practical limits of performance and the value of the reactant-product conversions within spaceflight scenarios, and should, to the greatest extent possible, be examined from the perspective of a fully designed, integrated system, rather than as an isolated unit lacking critical components like valves and pumps. Herein, we select a series of possible reactant-product conversions, develop concept process flow diagrams for each, and estimate theoretical and (where sufficient literature data allows) practical performance limitations of each. The objective was to estimate the costs, benefits, and risks of each concept in order to aid strategic decisions in the early-phase technology development effort.

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