SPACE LIFE SCIENCES SYMPOSIUM (A1)
Environmental Control, Life Support and EVA Systems (6)

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BIO-ISRU: A NEW APPROACH FOR PRODUCING OXYGEN AND RECYCLING CARBON ON THE MOON

Abstract

Introduction: In-situ production of consumables (mainly oxygen) using local resources (In-Situ Resource Utilization-ISRU) will significantly facilitate current plans for human exploration and settlement of the solar system, starting with the Moon. With few exceptions, nearly all technology development to date has employed an approach based on inorganic chemistry [1]. None of these technologies include concepts for integrating the ISRU system with a bioregenerative life support system and a food production system. It is known however that bacteria are able to efficiently dissolve different rocks, including lu-nar regolith simulants. As the regolith minerals and glasses dissolve, their bound oxygen and im-planted carbon and hydrogen become available for utilization at a lunar outpost. The cyanobac-teria can extract many needed nutrients directly from the dissolved regolith. Our concept for the development of a biotechnological loop for in-situ resources extraction, propellant and food production at the lunar outpost is based on the cultivation of litholytic cyanobacteria with lunar regolith in a geobioreactor. Sunlight provides most of the energy needed for growth of the bacteria colony within the geobioreactor. As a result of pilot studies, we are developing a concept for a semi-closed integrated system that uses a bioreactor containing cyanobacteria for extracting useful elements from the regolith [2]. This bioreactor can revitalize air by utilization or scrubbing of excess CO2 and production of O2. While originally focused on breathing oxygen, a the geobioreactor can be scaled up to produce useful oxidizer for rocket engines. An addition of a methanogen bioreactor provides the potential to produce fuel for propellant. Some components of cyanobacterial biomass can be used directly as nutritional supplements. Such a system could be the foundation of a self-sustaining extraterrestrial outpost. Perspectives: The most critical conclusion is that a semi-closed life support system tied to an ISRU biofacility might be more efficient for support of an extraterrestrial outpost than closed environmental systems. Such a synthesis of technological capability could decrease the demand for energy, uplift mass, and overall cost of future exploration.

References : [1] Allen, C. C. et al. (1996) J. Geophys. Res. 101, 26085-26095. [2] Brown I.I. et al. (2007) Rutgers Symposium on Lunar Settlements, 79.