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MOON LIVING FERMENTERS: AN IN-SITU RESOURCE UTILIZATION TECHNOLOGY DEMONSTRATOR

Abstract

A sustainable human exploration of the Moon and Mars will require the production of basic resources that will supply a mission with air, propellant, and water. The development of novel technological processes that provides these resources totally or partially *in-situ* are thus critical to achieve this ambitious goal from a strategic perspective. In this context, by-products of microbial fermentation processes, such as H_2 or CH_4 can be used as a source of fuel or serve as substrates for the chemical catalysis of water.

MoonLiFe (Moon Living Fermenters) instrument aims to validate the use of lunar regolith as a nutritional supplement for wild-type or genetically engineered microorganisms. A remotely activated fluidic system will provide multiple serial dilutions to empirically determine and optimize the best regolith concentration *in-situ* under lunar environmental conditions, including the lunar gravity field and surface radiation. Additionally, this technology demonstrator aims to explore the possibility of interlacing various microbial cultures that can feed on gaseous by-products produced *in-situ* to deliver bioconversion end-products, such as CH_4. Using the abundance of mineral salts in the Moon regolith, including Iron, Sodium, Magnesium, and Phosphorous, as a source of micronutrients together with adequate doses of sunlight and Carbon, we propose a system of interlaced microbially catalyzed reactions that will produce targeted quantities of O_2, CO_2, and CH_4.

In this work we shall present the main results from the development of the MoonLiFe engineering model to:

1. Characterize an operational window for sustained microbial growth under controlled lunar-analogue conditions.
2. Optimize the growth conditions and assist the adaptation of microorganisms to lunar-analogue conditions using lunar regolith simulant as substrate.
3. Validate fermentation processes of interest to produce essential resources for future human and robotic exploration.
4. Demonstrate Technological Readiness Level 4, including a regolith sample acquisition and distribution system.