14th HUMAN EXPLORATION OF THE MOON AND MARS SYMPOSIUM (A5)
Long Term Scenarios for Human Moon/Mars Presence (2)

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ESA LUNAR IN-SITU RESOURCE UTILISATION (ISRU) BREADBOARDING ACTIVITIES AND CONCEPTUAL DESIGN FOR A LUNAR DEMONSTRATOR

Abstract

This paper addresses the final results of the "ISRU Architecture and Technology Study", an ESA Study performed by an Italian-Belgian consortium, consisting of Carlo Gavazzi Space, Politecnico di Milano and Space Applications Services, aimed at assessing the feasibility of producing oxygen in lunar environment extracting it from regolith. The study concentrated its effort on the Carbothermal Reduction process with non-molten phase using Methane. The paper focuses on the results obtained from an experimental test campaign on a process breadboard. The activities have been conducted by Politecnico di Milano, Chemistry, Material and Chemical Engineering Department. Here, the tests were aimed, at first, at understanding the behaviour of the Carbothermal Reduction with Methane when a solid-gas reaction is implemented and, then, at verifying the efficiency, in terms of capability to extract oxygen (via water) from the raw material, of such a process. Extensive preliminary investigations have been performed also in TGA (Thermal Gravimetric Analysis) in order to drive the experimentation on the breadboard. For the tests, two different lunar simulants, the NU-LHT-2M and the JSC-1A, have been used in order to have representative material of both the main lunar regions, Highlands and Maria, and then to be able to estimate the behaviour of the process also with respect to the different lunar soil compositions. The paper addresses also the results of the definition of a Lunar ISRU System based on the results of the testing on the mentioned process. Technology developments identified during the study have been investigated to assess their criticality and to define the conceptual approach to their solution. This activity led to the definition of the requirements for a Lunar ISRU Demonstrator. Particular emphasis is given in the paper to the conceptual design of such Demonstrator. Here, it has been conceived in order to be compatible with the ESA Lunar Lander currently in Phase B1 of its development.