ORACLE: AN ISRU TECHNOLOGICAL DEMONSTRATOR FOR OXYGEN PRODUCTION ON THE MOON

Francesco Latini[1], Simone Pirrotta[1], Raffaele Mugnuolo[1], Michéle Lavagna[2], Alice Dottori[2] and Ivan Troisi[2]
[1]Agenzia Spaziale Italiana, via del Politecnico, 00133, Roma, Italy
(francesco.latini@asi.it, simone.pirrotta@asi.it, raffaele.mugnuolo@asi.it)
[2]Politecnico di Milano, Department of Aerospace Science and Technology, via la Masa 34, 20156, Milano, Italy
(michelle.lavagna@polimi.it, alice.dottori@polimi.it, ivan.troisi@polimi.it)

In the current decade, the main target for robotic and human Exploration is the Moon; as such, the Earth's natural satellite is destination with highest priority and the central element in the Exploration roadmaps of the main national Agencies and institutions for the short and mid term plans, also in preparation of the next season oriented to Mars In the international scenario, the most relevant and wide program is the NASA "Artemis" recently started with the first mission launched on last November 16th; whichaims at bringing the man back on lunar soil and at building there in the coming years a permanent and sustainable human outpost, with an approach strongly open to the inclusion of internatonal partners. The goal of long term settlement isof fundamental importance for many reasons. Among them, is it worth to mention: it would demonstrate the capability of humans to adapt living on another celestial body; it could allow the possibility of extracting materials from the Moon, thus enabling the technology to do the same also on other celestials bodies; the outpost could be used as launch base for other missions, such as the one to reach Mars, due to the reduced escape velocity which would make the launch cheaper. However, before this scenario can be made possible, many challenges need to be tackled. The human base can be considered as sustainable only if it does not completely rely on Earth supplies to be habitable for long periods. It implies the necessity to develop technologies for the extraction and utilization of resources in situ, for example to obtain construction materials or oxygen and water to be used either as supplies for the astronauts but also as propellants. Regarding the extraction of oxygen, it can be performed either from the ice deposits on the poles through electrolysis of liquid water, once it is filtered from other chemical species, but also from the lunar regolith itself. Different processes have been proposed and tested in laboratory, to obtain oxygen from lunar regolith, each of them showing advantages and disadvantages [1]. In this context, Politecnico di Milano (PoliMi) and Italian Space Agency (ASI) are working to study and prepare a mission with the goal to validate on the Moon surface the effectiveness of a carbothermal process for oxygen extraction from lunar regolith [2]. Unlike other processes, whose yield of extraction depends on the composition of the regolith, this process shows a low sensitiveness with respect to this parameter. This is a major advantage because it allows the future potential production plants to be installed in different areas of the Moon surface. Furthermore, during the extraction process the regolith is expected to be heated up in the thermal range 1273-1373 K, below its melting temperature, thus avoiding several logistic and constructive issues (for example the discharge of the exhaust sample) [3]. The process has been successfully tested in laboratory and currently a phase A/B1 is in progress to perform the necessary analyses and trade-off studies. This is done to achieve a baseline for the design of the payload which would meet the requirements of mass, volume and power of one of the available landers. One of the most promising launch opportunities is through the Commercial Lunar Payload Services (CLPS) program run by NASA appointing several american industries to develope landing systems and to offer operation opportunities on the lunar surface on commercial basis to a wide class of payloads.. With CLPS, NASA intends to support the Artemis program in gaining data and developing new technologies useful for the future human base.The Italian ISRU demonstrator for the oxygen extraction has been proposed as valid candidate for a mission opportunity on a CLPS landerin the timeframe of 2028. In the present study phase, accommodation conditions and interfaces are considered for their impact on the design, together with the performances drivers.

References:

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