IAF HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Utilization & Exploitation of Human Spaceflight Systems (3)

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TESTING OF IN-SITU RESOURCE UTILIZATION TECHNOLOGIES FOR FUTURE HUMAN MARS EXPLORATION WITHIN THE FRAMEWORK OF UPCOMING LUNAR MISSIONS.

Abstract

In-situ resource utilization (ISRU) is one of the key elements which will characterize future human space exploration initiatives. In the context of the development of a mission to Mars, given the large distance and long transfer time, it is fundamental to find a way to exploit at most the resources which the planet can provide us. The development of technologies in this field will be fundamental to reduce the costs of future deep space missions and increase their sustainability, allowing, for example, the production of propellant and the application of additive structure manufacturing directly on the surface. To date, it is widely confirmed that the lunar environment offers several elements which could be exploited in this sense and, at the same time, being again on the lunar surface offers a great opportunity to prepare at the best for Mars exploration. Indeed, in this study the ISRU technologies which will represent key elements in future Mars missions are taken into consideration, with a particular focus on those for which it will be possible to carry out testing campaigns in the context of upcoming lunar missions. At first, the main differences between the composition of Lunar and Martian regolith are investigated and discussed, identifying the problems that these differences would introduce and analysing the potential solution which could be adopted. A step-by-step methodology is adopted in order to define alternative scenarios which are later compared through trade-off analyses, identifying the appropriate figures of merit and defining those solutions for which the implementation in the context of a lunar mission will be considered feasible. Among these, structures/shelters built using regolith additive manufacturing and power-generating techniques necessary to provide the energy to perform in-situ propellant production from water are thoroughly investigated. Lastly, the potential leverage that these will have on the design and development of these technologies in the framework of a mission to Mars are discussed. This study is carried out in the framework of II Level Master's programme SEEDS (SpacE Exploration and Development Systems), a project born from

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