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Space Power Systems for Ambitious Missions (4)

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STARDUST TO ENERGY: THE UPCYCLING OF SOLAR WINDS FOR POWER GENERATION

Abstract

As mankind push the boundaries of exploration to approach the next frontier, the question about what will fuel our ambitious future missions has always been a constant reminder. Moreover, the rising global energy problems also require a focus on an alternate long-term energy solutions. One such possibility is utilising Helium-3 (He-3), which could be a potential fusion fuel source. Since the Moon lacks an atmospheric layer and is constantly bombarded by solar wind it could hold a large reserve of He-3. This study combines both modern methods of assessing lunar He-3 reserves with in-situ tactics thereby resulting in an integrated approach for utilising this potential source of power. Physical changes and space weathering have enabled regolith on the moon to retain He-3 that was deposited by solar wind. Regions such as "pyroclastic regoliths" characterised by high surface scattering mechanism and high dielectric constant are rich in He-3. Geographical variation in He-3 shows episodic weathering "episodes implying an underlying cyclicity due to sequential weathering processes". In-situ use of lunar He-3 is critical for manned lunar landings and base construction and later on for the future. Studies indicate that He-3 is primarily trapped in vacancies and interstitials of ilmenite crystals. The ideal heating temperature for He-3 release is at 1000 K, with a cumulative release rate of approximately 74%. This study provides theoretical foundation of reasons why in-situ He-3 utilisation should be considered as one for the future in terms of advanced space power system that's available for mankind. It emphasises scientific advancements required in space, technical operations, and energy analysis to effectively collect He-3 on the lunar surface. Thus, the study proposes a detailed research for advanced and ambitious space power system.

KEY WORDS – pyroclastic regolith, in-situ, solar wind, fusion, ilmenite crystals.