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SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND DEVELOPMENT (D3)
Novel Concepts and Technologies to Enable Future Building Blocks in Space Exploration and Development (3)

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# INVESTIGATING EXTRA-TERRESTRIAL SURFACE REGOLITH TRANSPORT USING PNEUMATIC ACQUISITION TECHNIQUES

**Abstract**

Finding life on other planets and moons, evidence of its past existence, or the ingredients for its sustenance, is the paramount motivation for the development of planetary sample collection instruments. Numerous missions utilizing In-Situ Sample Processing have made it possible to draw valuable conclusions, but still not comparable to the potential value and scientific benefits of sample return. Physical remoteness and the presence of an atmosphere make a Mars Sample Return Mission an expensive and high risk prone affair. In order to partly reduce this risk, efforts are undertaken to design and improve the performance of a Pneumatic Regolith Acquisition Technique (a system that utilizes pressurized gas to force surface regolith samples to an on board storage). However, positive pressure pneumatic conveying systems rely on complex layouts for particle transport and require efficient designs: to function with redundancy and without human interaction in extraterrestrial environments, it becomes imminent to model and understand the gas-solid flow behavior under such conditions and put forth critical findings.

The paper will present a comprehensive study of fluidized granular flow in Martian gravity environment to better assist the design of equipment for future Mars-bound missions. The effects of pneumatic injection velocity vectors upon regolith volume fraction distribution and subsequent transport within the system have been characterized in a cylindrical pipe with inlets for gas injection onto the exposed regolith surface area. Previous studies demonstrating that 5 kg of soil can be lifted (from the regolith surface to a storage system on the lander) using 1 g of Nitrogen gas in Martian conditions have been used as a baseline for the analysis, and the critical flow modeling aspects concerned with the so-called “pneumatic injection-Martian Surface regolith zone” have been studied. Key gas nozzle design variations have been modeled and tested to maximize the mass of captured regolith. Swirl gas motion has shown to impart higher momenta per square millimeter as compared to direct downward injection of gas. Based on these findings, design adjustments are proposed that will improve gas- regolith mixing for efficient transport of the samples under Martian conditions.