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Systems and Infrastructures to Implement Sustainable Space Development and Settlement - Technologies (2B)

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FUNDAMENTAL RESEARCH TO ENABLE IN-SITU RESOURCE UTILIZATION FOR NASA'S ARTEMIS PROGRAM AND BEYOND TAKING PLACE AT THE GLENN RESEARCH CENTER

Abstract

Transitory crewed missions to the surface of other planetary bodies will require finite amounts of resources to support them. Crossing the boundary into extended stay durations and colonization will require exponentially more. The high cost and distance of transported consumables in an Earth-dependent model is not sustainable. There will be a threshold where it becomes more advantageous to produce resources in-situ as opposed to transporting them from Earth. The hurdle is that there is still much fundamental understanding needed of the characteristics, behavior and optimal handling of regolith to deliver desired mission objectives. A team of researchers and engineers at NASA's Glenn Research Center (GRC) in Cleveland, Ohio, are working to ensure concepts and technologies are ready to support when the mission architecture is primed for ISRU to activate. Through analytical modeling and initial lab-scale testing, researchers are establishing concepts that mature to more sophisticated tests in relevant environments. Numerous studies are underway assessing fundamental behaviors of regolith during various steps of a conceptual ISRU production plant. With an aim to reduce excavation forces, GRC has performed excavation tests utilizing ultrasonic frequencies in regolith simulant both in ambient and vacuum conditions and will test this year in reduced gravity on a parabolic flight. The team is also assessing how efficiently water vapor can be collected from the icy regolith during transport from the excavation site to the processing plant. A subscale soil bin mockup is being tested both on a vibratory table as well as chilled under vacuum to assess the sublimated water capture rate from the transportation vibrational forces. Another subscale model was tested using heat as the catalyst to sublimate the water vapor. Both of these experiments are assessing the water capture rate using a simplified seal-less system, with open gaps to the surrounding lunar environment. For ISRU processing reactors requiring a pressure seal from the external vacuum environment, testing has been performed, both in ambient and vacuum conditions, assessing the viability of using the regolith itself as a columnated pressure seal. There is also testing taking place assessing ice growth rates at various temperatures and pressures to inform models for an

ice tanker transportation concept. This fundamental research, among other related projects, is providing vital data to inform ISRU processing plant architecture and advance the technologies for future missions, benefitting the ISRU community at large.