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3U-CUBESAT PAYLOAD FOR DEMONSTRATION OF IN-SITU RESOURCE UTILISATION AT C-TYPE NEAR EARTH ASTEROIDS

Abstract

In-Situ Resource Utilisation (ISRU) concepts are identified as a key technology advancement to extract resources in space in the interest of human exploration beyond Earth. Recent developments in CubeSat technology have increased their scientific capabilities to enable lower cost missions. CubeSat can now be viewed as a solution to demonstrate in situ aspects of ISRU technologies for proof-of- concept and a de-risking exercise prior to eventual full-scaled implementation. Within Cranfield University, we are working towards such CubeSat payloads for early stage in situ demonstration of ISRU processes. One of the approaches being considered is the use of hydrometallurgical metal extraction. Specifically, a payload design that performs low-temperature aqueous acid -based leaching of metal ions from suitable regolith. The payload is designed to fit into 3U-CubeSat form factor and the system is comprised of: (1) a sample acquisition subsystem based on counter rotating brushes, (2) extraction subsystem comprised of a multi-oven carousel, (3) acid solution handling subsystem, (4) metal purification subsystem, using electro-winning and (5) analytical subsystem using anodic stripping voltammetry. The work to be reported composed of three parts: (1) a description of the overall CubeSat payload system design, (2) laboratory based acid-leaching experiments and (3) the design of a relevant liquid handling breadboard subsystem. Laboratory hydrometallurgy H2SO4 acid leaching studies have been performed to extract metal ions from olivine mineral as a simulant relevant to C-type Near-Earth-Asteroid (NEA). Leaching samples were analysed to measure mineral swelling, changes in pH, and mineral consolidation. Initial acid concentration, mineral-to-acid volume ratio, degree of sample agitation (zero or agitated) and the reaction time have been varied. A combination of 5M H2SO4 concentration, 1:5 mineral-to-acid ratio, agitated and 144 hours reaction time were maximise for mineral dissolution at room temperature. These condition resulted in 51To demonstrate liquid handling of acid leaching solutions that will be compatible with microgravity use, a laboratory breadboard is being produced. It comprises a single oven, motor-driven plunger, pressurised leaching solution reservoir and valves. The design allows (1) estimation of regolith sample volume collected, (2) controlled leaching solution addition to and removal from the oven. Current testing involves demonstrating appropriate fluid handling required for final mission use.