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BENEFICIATION OF LUNAR REGOLITH – DEVELOPMENT OF AN EXPERIMENTAL SETUP FOR TECHNOLOGY EVOLUTION

Abstract

Our solar system is full of resources that potentially can be exploited to greatly reduce the material required to be launched from Earth. Among these resources are oxygen, water ice, hydrates, metals, regolith, rare earths, chemical compounds, volatiles and rare isotopes. Utilizing space resources would enable e.g. propellant production, in-space manufacturing or the construction of large structures which would otherwise be very expensive or not possible at all with material launched from Earth. Beneficiation of regolith material is the initial step for almost all ISRU processes that make use of regolith and its constituents. This pre-processing includes the separation of the raw material into feedstocks for subsequent utilization processes. This separation is achieved by making use of the physical properties of the regolith constituents and typically involves particle size separation, magnetic separation and electrostatic separation. All these separation processes are so called dry-separation techniques, which do not need water. The mineral ilmenite (iron titanium oxide) is relatively common on the surface of the Moon. However, the ilmenite content in the top layer of the lunar surface varies greatly by location. Ilmenite can be reduced with hydrogen to iron, titanium dioxide and water. The water is then electrolyzed to regenerate the hydrogen and to produce oxygen. This way ilmenite can provide three valuable resources for space exploration. However, the efficiency of the reduction of ilmenite is reduced in the presence of other regolith constituents and therefore it is necessary to separate those from the ilmenite prior to the reduction process. Some research and innovation for lunar regolith beneficiation exists, but the involved technologies are not yet ready to be deployed during a space mission. This paper describes one attempt to increase the technology readiness level of regolith beneficiation technologies. To achieve this goal, an experimental setup was developed, built and tested. This setup is designed in a multi-stage approach incorporating different separation technologies in a process chain, which allows reliable and efficient beneficiation. The initial configuration of the beneficiation experiment allows the separation and enrichment of ilmenite, which was tested with lunar regolith simulant.