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ICE2THRUST: AN END-TO-END DEMONSTRATION OF THE IN-SITU RESOURCE UTILIZATION OF WATER FOR IN-SPACE PROPULSION

Abstract

The development of in-situ resource utilization (ISRU) capabilities has been celebrating several achievements in recent years with continuous advances in research and development. Especially the use of water as a resource is of continued high interest as it is expected that considerable amounts can be found at the lunar poles, on other planets and on asteroids. The combination of extracting water from regolith using thermal extraction methods with the Water-Electrolysis-Propulsion (WEP) technology, could lead to the first economically viable utilisation of resources mined in space. A satellite equipped with a WEP system is filled with water instead of the storable propellants (e.g. hydrazine, NTO, etc.) that are conventionally utilised for in-space propulsion. An electrolyser is used to split up the water onboard into gaseous hydrogen and oxygen. The generated gases can subsequently be used in chemical or electrical thrusters to propel the spacecraft.

The unique co-location of space-related research groups at Technical University of Munich (TUM) enables the combined research on WEP and space resource extraction methods to advance the complete value chain of ISRU. The Professorship of Lunar and Planetary Exploration Technologies and the Chair of Space Propulsion and Mobility have kick-started the project Ice2Thrust. Initially, an end-to-end ISRU process will be demonstrated by turning an ice-bearing soil analogue into thrust within a unified test set-up under vacuum conditions. The process includes the extraction of water from planetary regolith simulant, collecting, purifying, and feeding it to an electrolyser, where it is split into its components which are then combusted in a chemical thruster. The aim is to achieve an overall system TRL of 6 for the first time.

This paper details research and testing objectives as well as the applied methodology. The set-up of the WEP test rig, containing the electrolyser and the thruster, is described as well as the test rig for the thermal extraction of water from regolith simulant. The test results of the independent operation of both test benches under vacuum conditions are presented and evaluated in the context of the upcoming coupling of both set-ups. In addition, the roadmap towards the final end-to-end test is introduced.