

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Moon Exploration – Part 2 (2B)

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LUWEX VALIDATION OF LUNAR WATER EXTRACTION AND PURIFICATION TECHNOLOGIES FOR IN-SITU PROPELLANT AND CONSUMABLES PRODUCTION

Abstract

Sustainable space exploration necessitates advancements in In-Situ Resource Utilization (ISRU) technologies, particularly those utilizing local resources to generate products essential for robotic and human exploration. The ability to harness local resources, such as water, not only addresses the logistical challenges of transporting supplies from Earth but also significantly reduces the cost associated with space missions. Water, deemed by Leonardo da Vinci as the driving force of nature, emerges as a pivotal resource in space exploration. Serving as consumable for astronauts, radiation shielding, and being electrolyzed into hydrogen and oxygen—a highly effective rocket propellant combination—describes its versatile application. However, in-situ water extraction remains technically challenging, demanding further development.

The LUWEX project addresses the challenge by aiming to develop and validate a complete in-situ water process chain, covering extraction, purification, and quality monitoring. It envisions harnessing water from lunar regolith for propulsion, breathing gas, and electricity through fuel cells, thus enabling sustainable space exploration. The integrated test setup, designed to simulate lunar conditions using a lunar dust-ice simulant inside a thermal-vacuum chamber, intends to elevate the Technology Readiness Level (TRL) of the overall process chain from level 2 and 3 to level 4 – Functional verification and some subsystems even up to TRL 5 – Breadboards verification in relevant environment.

The paper discusses the project's objectives and corresponding methodology, emphasizing the development and validation of advanced water extraction, purification, and quality monitoring technologies. By

sublimating water through heat, collecting, and purifying, as well as validating the process chain, LUWEX seeks to contribute innovative lunar water extraction and purification systems for future European-led space exploration missions. In a laboratory environment, a combination of water ice particles and lunar regolith simulant was used to replicate lunar conditions in all steps. The paper gives an overview of the system design. In addition to detailing the technical project development roadmap, the paper lays out LUWEX's adaptability towards future exploration missions, underscores its projected potential and long-term goals, and outlines potential terrestrial application strategies. The shift towards sustainable practices enhances our capacity for long-duration missions by minimizing reliance on Earth-bound resources, thereby fostering the viability and affordability of space exploration.