Predicting the efficiency of oxygen-evolving electrolysis on the moon and Mars

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Lomax and Just on parabolic flight. Credit: The University of Manchester

Scientists at The University of Manchester and The University of Glasgow have today provided more insight into the possibility of establishing a pathway to generate oxygen for humans to potentially call the moon or Mars 'home' for extended periods of time.

Creating a reliable source of oxygen could help humanity establish liveable habitats off-Earth in an era where space travel is more achievable than ever before. Electrolysis is a popular potential method which involves passing electricity through a chemical system to drive a reaction and can be used to extract oxygen out of lunar rocks or to split water into hydrogen and oxygen. This can be useful for both life support systems as well as for the in-situ production of rocket propellant.

Until now however, how lower gravitational fields on the moon ($1/6^{th}$ of Earth's gravity) and Mars ($1/3^{rd}$ of Earth's gravity) might affect gas-evolving electrolysis when compared to known conditions here on Earth had not been investigated in detail. Lower gravity can have a significant impact on electrolysis efficiency, as bubbles can remain stuck to electrode surfaces and create a resistive layer.

New research published today in *Nature Communications* demonstrates how a team of researchers from The University of Manchester and the University of Glasgow undertook experiments to determine how the potentially life-giving electrolysis method acted in reduced gravity conditions.

Lead engineer of the project, Gunter Just, said that they "designed and built a small centrifuge that could generate a range of gravity levels relevant to the moon and Mars, and operated it during microgravity on a parabolic flight, to remove the influence of Earth's gravity.

"When doing an experiment in the lab, you cannot escape the gravity of Earth; in the almost zero-g background in the aircraft, however, our electrolysis cells were only influenced by the centrifugal force and so we could tune the gravity-level of each experiment by changing the rotation speed. The centrifuge had four 25 cm arms that each held an electrolysis cell equipped with a variety of sensors, so during each parabola of around 18 seconds we did four simultaneous experiments on the spinning system.

"We also operated the same experiments on the centrifuge between 1 and 8 g in the laboratory. In this configuration we had the arms swinging so that the downwards gravity was accounted for.It was found that the trend observed below 1 g was consistent with the trend above 1 g, which experimentally verified that high gravity platforms can be used to predict electrolysis behavior in lunar gravity, removing the limitations of needing costly and complex microgravity conditions. In our system, we found that 11% less oxygen was produced in lunar gravity, if the same operating parameters were used as on Earth."

The additional power requirement was more modest at around 1 %. These specific values are only relevant to the small test cell but demonstrate that the reduced efficiency in low gravity environments must be taken into account when planning power budgets or product output for a system operating on the moon or Mars. If the impact on power or product output was deemed too large for a system to function properly, some adaptations could be made that may reduce the effect of gravity, such as using a specially structured electrode surface or introducing flow or stirring.

More information: Bethany Lomax, Predicting the efficiency of oxygen-evolving electrolysis on the Moon and Mars, *Nature Communications* (2022). DOI: 10.1038/s41467-022-28147-5

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