Chair of Space Propulsion and Mobility (Prof. Manfletti)
TUM School of Engineering and Design
Technische Universität München

Bachelor Thesis / Semester Thesis

Experimental Investigation of the Flow Behaviour of a Capillary Fed Water Electrolyser Separator for Space Applications

Profile: Student of chemistry or chemical engineering with prior laboratory experience, for example through laboratory courses.

Topic

Water Electrolysis Propulsion (WEP) is a key technology for high-performance green propellants in space exploration. By utilizing pure water as a propellant, spacecraft can avoid toxic chemicals, and mission lifetimes can be extended through in-situ resource utilization. However, the separation of gas and liquid is a major challenge because in zero-gravity the buoyancy of gas cannot be used.

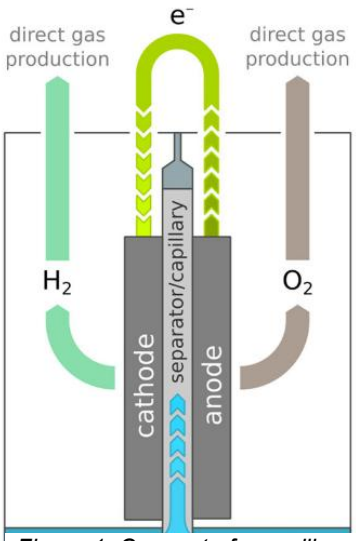

Figure 1: Concept of a capillary fed water electrolyser [1]

A breakthrough solution is Capillary-Fed Electrolysis (CFE). In this architecture, water is supplied to the electrodes via capillary-induced transport through a porous, hydrophilic separator. This leads to inherently bubble-free operation, where hydrogen and oxygen are produced directly in gas collection chambers. Terrestrial research has shown energy efficiencies of up to 98% (1.51 V at 0.5 A/(cm^2)), significantly outperforming commercial systems[1]. The thesis shall therefore evaluate the CFE concept for space applications, focusing on the physical-chemical limits of capillary transport and the potential for a simplified, pump-free stack design. The thesis shall analyse theoretical boundaries and optimal material parameters of capillary flow under zero-gravity conditions. To lay the foundation for CFE electrolyser designs it shall identify suitable separator and electrode materials and experimentally evaluate some selected materials for their suitability in a prototype.

Tasks

- Familiarization with the WEP and CFE electrolyser technology
- Identification and evaluation of physical laws describing capillary flow
- Experiment design and conduction to test selected separator materials for their capillary flow capabilities for a CFE electrolyser
- Analysis of various material parameters (e.g. porosity, pore size, tortuosity) and physical limitations
- Investigate electrolyte concentration gradients in the separator
- Evaluate the Separator-Electrode interfaces
- Documentation and presentation of the work

Contact

Application deadline: Please submit your application by October 15th.The thesis can start from October 15th, with the exact starting date to be agreed upon individually.

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[1] A. Hodges *et al.*, "A high-performance capillary-fed electrolysis cell promises more cost-competitive renewable hydrogen," *Nat Commun*, Mar. 2022, doi: 10.1038/s41467-022-28953-x.