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Corresponding author: HEIZMANN Sören
e-mail of corresponding author: s.heizmann@tum.de
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Title

Investigation of a Cathode-Vapor-Feed Electrolyser for a Water Electrolysis Propulsion System

Authors

Sören HEIZMANN [1], Armin Herbertz [2], Juliusz Saryczew [3], Chiara Manfletti [4]*

** Corresponding author*
[1] Technical University of Munich (TUM), Chair of Space Propulsion and Mobility, 85221 Ottobrunn, Germany, s.heizmann@tum.de
[2] European Space Agency (ESA), 2201 AZ Noordwijk, Netherlands, armin.herbertz@esa.int
[3] European Space Agency (ESA), 2201 AZ Noordwijk, Netherlands, juliusz.saryczew@esa.int
[4] Technical University of Munich (TUM), Chair of Space Propulsion and Mobility, 85221 Ottobrunn, Germany, chiara.manfletti@tum.de

Abstract

The technology of Water Electrolysis Propulsion (WEP) is experiencing a continuously increasing interest in the space propulsion community. Within the concept of WEP, a satellite is filled on ground with pure water instead of highly toxic propellants. Once in space, an electrolyser is used to split up the water into hydrogen and oxygen and to store the produced gases temporarily in intermediate storage tanks. Subsequently, the gases can be used to operate different kinds of chemical and electrical thrusters. One of the two key focus points for the maturation of the technology is the electrolyser. PEM-electrolysers using the Cathode-Vapor-Feed (CVF) concept are currently considered to show the most promising capabilities for use within a WEP propulsion system. However, only very limited data about the concept's performance is publicly available so far. Within the European Space Agency (ESA) it has therefore been decided to develop a prototype and to thoroughly test it in order to identify any areas which require additional research.

This paper describes the design of the developed electrolyser prototype and presents various test results, incl. polarization curves, transient behavior as well as voltage fluctuations during nominal operation. The test results also include measurement data for different temperatures. The interpretation of these results includes an examination of the voltage efficiency, faradaic efficiency and cell efficiency of the electrolyser as well as an evaluation of the reproducibility of the measurements. The electrolyser was found to have the ability to achieve current densities of more than 300 mA/cm^2. However, a performance collapse was observed at temperatures of 80°C and high current densities and further investigation is required to fully understand the underlying causes.

In addition, the design of the corresponding test bench which has been specifically developed is covered in a complementing paper [1]. The results of this study are therefore providing a deeper understanding of the CVF electrolyser, which will be beneficial in the further development of this technology towards its market readiness. The presented data can therefore support upcoming system and mission analyses for spacecraft missions aiming to use Water Electrolysis Propulsion and have the potential to serve as reference data for future research in the area. Furthermore, the electrolyser will be used for future activities and research at the European Space Research and Technology Centre (ESTEC).

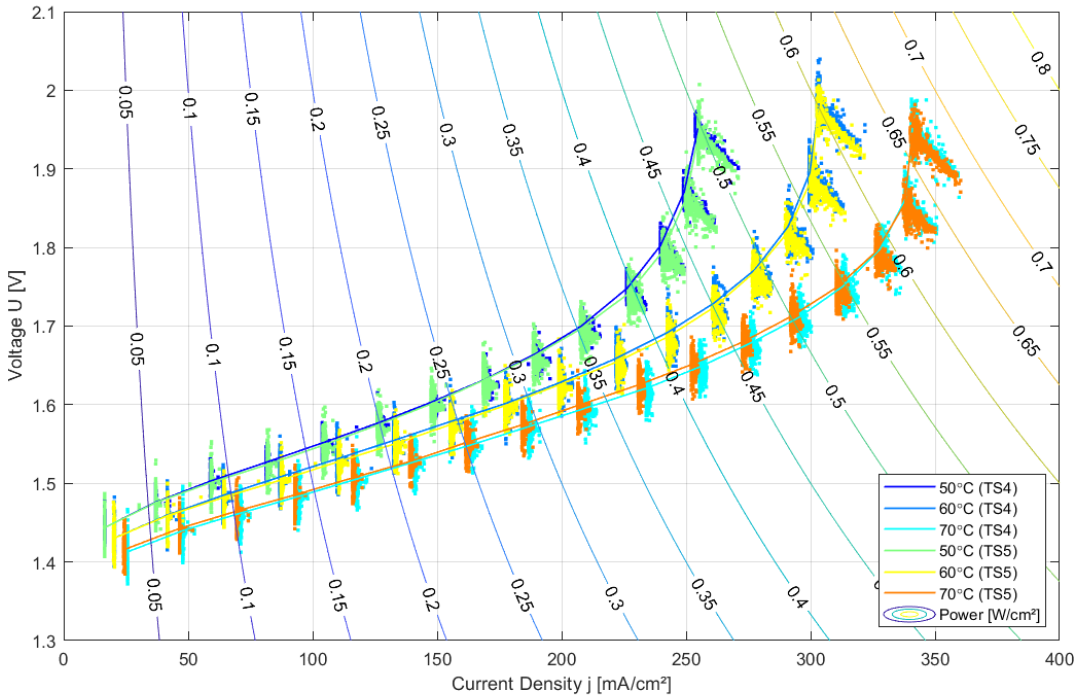

Figure 1: Comparison of the Polarization Curves at different Temperatures obtained during Test Series 4 and Test Series 5

References

[1] Saryczew, J.; Bürgler, B.; Heizmann S.; Herbertz A.: Development of a Test Bench for Electrolyser Performance Evaluation for Water Electrolysis Propulsion, 34th International Symposium on Space Technology and Science, Kurume, Japan, June 2023 (to be published)