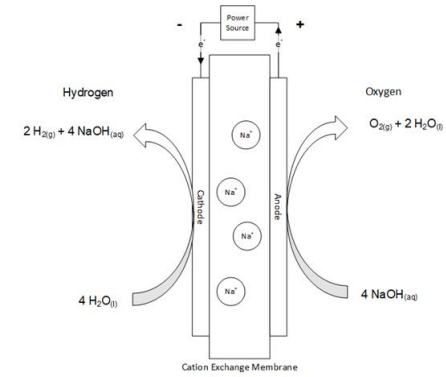
ROBUST ELECTROLYZER FOR LUNAR ISRU APPLICATIONS. R. C. Utz, M. C. Miller, S. Pass, and Thomas I. Valdez, Teledyne Energy Systems Inc. (10707 Gilroy Road, Hunt Valley, MD 21031) thomas.i.valdez@teledyne.com

Introduction: The National Aeronautics and Space Administration (NASA) is seeking industry support to develop a pathway for human spaceflight into cis-Lunar space and for the habitation of planetary bodies. NASA is specifically working towards the capability to sustainably live beyond the Earth [1]. In-situ resource utilization (ISRU), the production of mission critical consumables on planetary bodies used for human exploration that would otherwise be brought from Earth, has been identified by NASA as an exploration element that has no flight precedent. Teledyne Energy Systems Inc. (TESI) is developing a robust electrolyzer for Lunar ISRU Applications. The TESI ISRU electrolyzer is intended to support the generation of hydrogen and oxygen from ice mined from the Moon.

Discussion: Research on electrolyzers for use in space applications has primarily focused on the development of proton exchange membrane (PEM) technology. PEM-based electrolyzers will not have acceptable durability without a robust water di-ionization system when being fed water from ice mined on the Moon. A water processing subsystem to remove ion contaminants from the ISRU water feed stock will require maintenance that may add complexity and thus lower system reliability [2]. The TESI ISRU electrolyzer is based on a cation exchange membrane that is robust to contaminants found in Lunar regolith. During oxygen generation, a solution of Lunar regolith infused water (testing will occur with a Lunar regolith simulant) is introduced to the anode compartment of the TESI ISRU electrolyzer and is electrochemically oxidized to oxygen gas, water, and sodium ions as power is driven into the electrolyzer. The sodium ions are then conducted across a cation conducting membrane to the cathode. At the cathode, the sodium ions electrochemically reduce water to form sodium hydroxide and hydrogen gas. A functional schematic of the TESI ISRU electrolyzer is shown as Figure 1. The anode and cathode catalysts of the TESI ISRU electrolyzer consist of nickel-alloy catalyst. This system is inherently robust to the contaminants found in ice mined from the Moon. The electrolyzer is operated in a dual irriguous (dual-feed/ flooded) configuration to maximize oxygen production.



Anode (+): $4\ NaOH_{(aq)} \rightarrow 4e^- + 4\ Na^+ + O_{2(g)} + 2\ H_2O_{(l)}$

Cathode (-): $4\ Na^+ + 2\ H_2O_{(l)} + 4\ e^- \rightarrow 2\ H_{2(l)} + 4\ NaOH_{(aq)}$

Cell: $2\ H_2O_{(l)} \rightarrow 2\ H_{2(l)} + O_{2(g)}$

Figure 1: Functional schematic of the TESI ISRU electrolyzer.

It is anticipated that the TESI ISRU electrolyzer will produce 1.1 kg of oxygen per hour when fed 6.7 kW of electrical power. The goal for the electrolyzer performance is to meet a metric of 5.6 W/(kg O_2/hr) while operating on a simulated Lunar ISRU water feed stock.

Conclusion: This paper will review the advantages of the TESI ISRU electrolyzer versus state-of-the-art technology. Special attention will be given to understanding electrolyzer failure mechanisms with respect to contaminants that can be found in Lunar regolith. The design, development and testing of the TESI ISRU electrolyzer will be discussed. The ISRU community will be apprised of an ISRU design concept for the production of hydrogen and oxygen reactants.

Acknowledgements: This work is funded in part by internal research and development funds and by NASA through the NASA NextSTEP-II ISRU program office. The authors would like to thank the NASA NextSTEP-II ISRU program office for their support.

References:

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