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Systems and Infrastructures to Implement Future Building Blocks in Space Exploration and Development (2)

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CO2 HYDROGENATION AND WATER ELECTROLYZER TANDEM SYSTEM TO GENERATE OXYGEN AND WATER

Abstract

The Japan Aerospace Exploration Agency (JAXA) is now developing life support systems for closed environments in space, and the reduction reaction of carbon dioxide is an important technology for the sustainable manned operations in space. This work focuses on the development a novel CO2 hydrogenation reactor thermally coupled with a water electrolyzer. The system is able to produce water and methane during the hydrogenation reaction of CO2, this reaction is also known as 'the Sabatier reaction' and plays an important role in the current life support systems onboard the International Space Station (ISS). Hydrogen and oxygen are produced through the water splitting process. Currently, the operation temperature of the Sabatier reactor onboard the ISS is above 590 degrees Celsius, this implies some thermal management challenges in controlling the reactor temperature. The novelty of this system consists in the low operation temperature of the Sabatier reactor and its thermal coupling with the water electrolyzer, we are targeting to operate the reactor below 250 degrees Celsius. By reducing the operation temperature of the Sabatier process, the methane and water production efficiency is increased and the challenges in controlling the reactor temperature are reduced. The purpose of coupling the Sabatier process with the water electrolyzer is to exchange the heat regenerated by the CO2 hydrogenation reaction with the water electrolyzer in order to maximize the overall efficiency of the system. In this presentation an exergy analysis of the CO2 hydrogenation and water splitting processes will be introduced. Also, the performance of the CO2 hydrogenation reactor and water electrolyzer will be presented.