HUMAN SPACE ENDEAVOURS SYMPOSIUM (B3)
New Technologies, Processes and Operating Modes Enabling Future Human Missions (7)

Author: Dr. Stefan Belz
University of Stuttgart, Germany, belz@irs.uni-stuttgart.de

Prof. Stefanos Fasoulas
University of Stuttgart, Germany, fasoulas@irs.uni-stuttgart.de
Prof. Ernst Messerschmid
University of Stuttgart, Germany, messerschmid@irs.uni-stuttgart.de

COUPLING OF POLYMER ELECTROLYTE MEMBRANE FUEL CELLS WITH LIFE SUPPORT SYSTEMS

Abstract

Polymer Electrolyte Fuel Cells (PEFCs) were applied in space at the first time during the Gemini program in the 1960s. In the Apollo missions that followed and in the Space Shuttle Alkaline Fuel Cells (AFCs) were used for electrical power generation due to higher electrical efficiency and lower system mass. In the mean time PEFCs have passed a significant development milestone for terrestrial applications, e.g. electro mobility. The components have been enhanced in a way that – from today's point of view – PEFCs offer a new perspective on space applications. Efficiencies and system masses compete against those of AFCs. A further advantage of PEFCs is a flexible integration in a crewed space system, i.e. a synergetic coupling with the life support system utilizing a joint infrastructure, concerning air, oxygen, and water. The technical integration aspect of such an approach was investigated by experiments. The measurement results of operating a PEFC with cathode gases of different oxygen concentrations that can be used in a crewed space system are presented and discussed. Measurement methods are voltage-current characteristics and electrochemical impedance spectroscopy. Additionally, cathode inlet gases and the product water were analyzed. From the technical point of view, higher oxygen concentrations mean that lower cathode gas flows are required. This in turn reduces the capability of carrying out product water from the cells as well as active convection as heat transfer mechanism and thus effects the thermal mangement of the PEFC. These influences were investigated and technical solutions are proposed. The experimental results show that synergistically integrated PEFCs offer a high potential of mass saving and increase of power efficiency. A first proposal for such a PEFC system is worked out.