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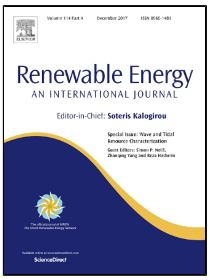

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Exergy based parametric analysis of a cooling and power co-generation system for the life support system of extravehicular spacesuits

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Abstract

Providing electric power and managing the thermal condition for the astronaut are two of the essential functions of the spacesuit life support system in a distance extravehicular activity. This paper proposed a new conceptual portable life support system which combines the cooling and power supply functions for the astronauts with the metal-hydride, fuel cell and absorption chiller. The cooling and power balance models were developed on basis of the first-law of thermodynamics. The second-law based entropy generation, exergy destruction and exergetic efficiency models of the integrated life support system were established. A parametric study was performed to evaluate the effects of varying working conditions, including the hydride metal types, operating temperatures of the fuel cells, heat transfer effectiveness of the evaporator and the concentration of the working fluid pair used in the absorption chiller, on the exergy-based performance of the new life support system. Results indicate that the energetic efficiency and the exergetic efficiency of the integrated PLSS can up to 86.98% and 59.07% respectively.

Keywords: Fuel cell, Metal hydride, Life support system, Cooling and power co-generation, Absorption chiller, Exergy analysis.

1. Introduction

The space suit is the key equipment for the astronaut working in space. It is not only a piece of clothing shielding the crew from radiation, but also a small spaceship which always protects the space explorers working and operating in challenging extravehicular activities (EVAs). In human spaceflight, the vital substances, such as air, water and food have to be supplied by a life support system (LSS) in order to provide a living environment for the crew. The principle tasks of a LSS also include the provision of the proper environmental conditions, the supply of the required substances and the removal or recycling of waste products [1]. The development effort for a new Extravehicular Mobility Unit (EMU) Portable Life Support System (PLSS) began for the Space Station Freedom in 1984[2]. The Apollo EMU could last for 8 hours at an