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舱外航天服生命保障冷电联储系统性能分析

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Characteristic Analysis of Extravehicular Spacesuit Life Support Cooling-power Integrated System

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摘要

基于质子膜燃料电池(PEMFC)和热驱制冷,提出一种舱外航天服冷电联储方法,根据热力学总能理论,通过能量的梯级利用和不同形式的能量联产来实现舱外航天服生命保障系统冷电联储、能源转化和环境控制一体化。对舱外航天服生命保障冷电联储系统进行了热力学分析,表明本文舱外航天服生命保障系统冷电联储方案与传统方案相比,能达到减少航天员出舱活动携带物品种类和提高能源利用率的目的。并重点对冷电联储系统储氢冷却器相关参数的选取对系统一次能源利用率及系统整体质量的影响进行分析,结果表明$LaNi_5$和$LmNi_{4.9}Sn_{0.1}$较适合用于本文提出的舱外航天服生命保障冷电联储系统。

关键词： 舱外航天服 冷电联储 燃料电池 热驱制冷 储氢合金 生命保障

Abstract:

Based on the techniques of proton exchange membrane fuel cell (PEMFC) and heat-driven cooling system, a method of combined cooling-power for the life support system of an extravehicular activity spacesuit is proposed in this paper. This method aims to realize the integration of cooling and power, the transient of different energies and the control of the environment for the life support system of the extravehicular activity spacesuit with the theory of thermal board total energy which points the energy step used, heat recovery and the combined generation of different forms of energy. Thermodynamic analysis of the system is performed. Compared with the separate method used in the traditional spacesuit, the combined method can decrease the kinds of materials, and provide more efficient use of resources. In addition, the H_2 utilization coefficient and the total mass of the whole integrated system which are influenced by the different thermal parameters chosen for the hydrogen storage cooler are analyzed in detail, which demonstrates that $LaNi_5$ and $LmNi_{4.9}Sn_{0.1}$ can be considered for this cooling-power integrated system.

Keywords: extravehicular spacesuit cooling-power integration fuel cell heat-driven cooling metal hydride life support

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