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CHALLENGES FOR MARTIAN EVA SUIT DESIGN

Abstract

Astronaut effectiveness on Mars will be determined largely by the ability of their suits to perform up to three EVAs per person per week for up to 70 weeks or more. Thus the ideal Mars EVA suit will need to be safe and comfortable for frequent use, be light enough for sustainable wear (ideally no more than 35 kg mass, 13.3 kg Mars weight), be flexible and dexterous for maximum human performance, able to thermo-regulate in the martian environment, have minimal preparation time for frequent use, be durable and easily serviced, can be worn 100s of times, able to support EVAs of at least two hours and up to eight, rapidly rechargeable with consumables, and readily cleanable, inside and out.

However, current gas pressure (GP) EVA suits are unable to sustain this activity. They are too heavy for safe locomotion under Mars gravity, internal pressure will limit mobility and dexterity, and these factors in combination with the high EVA rate is likely to result in an unacceptable frequency of injury, possibly over 300 for a six-person crew over a 540-sol surface stay. Further, extended pre-breathe time required by current suits will impose an increasing time penalty as the EVA rate increases. Addressing these issues is essential for successful human exploration of Mars.

Mechanical counter pressure (MCP) is a promising technology to meet these demanding objectives. It applies pressure to the human body, in whole or in part, via surface compression rather than with a gas. In this study, we have conducted a detailed analysis of Martian EVA requirements, and aligned these with GP, MCP and hybrid suit capabilities. As a result, we have found that MCP EVA suits have the potential to meet the severe mass and bulk limitations, be more comfortable, offer greater flexibility and dexterity, are potentially safer than GP suits and more likely to achieve the injury rate quotas, and are thus overall better suited to meet the mission goals. However, several key feasibility barriers exist for MCP uptake. Investing in MCP EVA suit technology may be essential for future Martian EVA.