

23rd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE EXPLORATION AND
DEVELOPMENT (D3)Interactive Presentations - 23rd IAA SYMPOSIUM ON BUILDING BLOCKS FOR FUTURE SPACE
EXPLORATION AND DEVELOPMENT (IPB)Author: Mr. Vishwajith Lal
Amity University, Dubai, United Arab EmiratesA FLEXIBLE THERMOELECTRIC COOLING SYSTEM FOR ASTRONAUT SUITS: A
LIGHTWEIGHT ALTERNATIVE TO LIQUID COOLING GARMENTS.**Abstract**

Extravehicular activities (EVAs) in space impose significant thermal regulation challenges on astronauts, necessitating the use of Liquid Cooling and Ventilation Garments (LCVGs). However, these systems are bulky, power-intensive, and add substantial weight to the extravehicular mobility unit (EMU). This paper presents the development and evaluation of an innovative flexible thermoelectric cooling system designed as a lightweight and efficient alternative for astronaut thermal management. The proposed system integrates thermoelectric modules (TEMs) into a flexible woven structure, allowing direct thermal contact between the astronaut's skin and the cooling element. Three distinct weaving techniques optimize heat dissipation, mechanical flexibility, and thermal uniformity. The cooling efficiency is analyzed under different power ratings to achieve optimal thermal rejection while maintaining low power consumption. Additionally, this system enhances astronaut mobility by eliminating the need for bulky liquid-circulating tubes. The effectiveness of this thermoelectric cooling system is evaluated through various methodologies, including thermal performance testing via heat flux sensors, temperature gradient analysis, and infrared thermography. Computational models employing finite element analysis (FEA) and computational fluid dynamics (CFD) optimize the thermal distribution and structural integrity of the woven layers. By significantly reducing weight and improving cooling efficiency, this novel thermoelectric cooling solution provides a transformative approach to astronaut thermal management. The findings contribute to the advancement of next-generation extravehicular suits, enabling extended EVA durations with enhanced comfort and reduced metabolic burden. This work aligns with efforts to develop lightweight, high-performance space suits for long-duration missions, including Artemis and deep-space exploration.