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Author: Ms. Margarita Belali
National Technical University of Athens, Greece

UTILIZING COMPUTATIONAL MODELLING TO ADVANCE CISLUNAR ECLSS STRATEGIES: ANALYZING GAPS AND EXPLORING OPPORTUNITIES

Abstract

The Lunar Gateway, integral to the Artemis missions, heralds a new era in lunar exploration, transcending its role as a mere space station. It acts as a catalyst for enduring space exploration, enhancing global collaboration, and furthering the disciplines of Science, Technology, Engineering, Arts, and Mathematics (STEAM). As it will be in a lunar orbit, it will work as an unparalleled platform for scientific endeavors and serve as a conduit to Martian exploration. This initiative is crucial for the upcoming decades' crewed missions, stressing the need for advanced Environmental Control and Life Support Systems (ECLSS) as we are referring to missions beyond Low Earth Orbit (LEO). The efficacy of ECLSS is vital for the survival of humans on prolonged lunar and Martian sojourns. To surmount the challenges of designing these systems under microgravity, our methodology incorporates sophisticated computational modeling alongside physics and mathematics to devise reliable solutions. Our investigation is centered on understanding ECLSS through computational analysis. This phase involves initial analyses to identify gaps and set the stage for future optimizations. We delve into the HALO (Habitation and Logistics Outpost) and I-HAB (International Habitat) space modules—key habitats for astronauts that integrate subsystems for life support, waste management, radiation protection, and scientific apparatus. Computational modeling aids in establishing standards for ongoing scientific exploration and the refinement of ECLSS.The University of West Attica's Fluids Laboratory (Athens, Greece) and the advisory team from the Deep Space Initiative (Colorado, USA) back this endeavor. By employing Computational Fluid Dynamics (CFD), we aim to gain insights into the interaction between environmental control systems and human physiology, guaranteeing life support systems that are both efficient and conducive to astronaut health. Our objective is to enhance human activity in space, prioritizing safety, sustainability, and the comprehensive well-being of astronauts. Through this endeavor, we aspire to develop innovative solutions that not only protect space habitats but also foster a deeper connection with the universe and the Earth's crisis treatment.