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BIOCONVERSION OF HUMAN WASTE TO HYDRAZINE FOR SUSTAINABLE SPACE FUEL PRODUCTION: A STEP TOWARDS COMPREHENSIVE SPACE SUSTAINABILITY

Abstract

The escalating challenges of space sustainability and the necessity for innovative waste management solutions in extraterrestrial environments have prompted a paradigm shift towards the exploration of biological processes for resource utilization. In the wake of previous study on space sustainability, made by ICASI, this paper introduces a novel concept for the cultivation of anammox bacteria in space environments. Leveraging the inherent capabilities of anammox bacteria, we propose a biologically mediated conversion of human waste into hydrazine—a critical space fuel.

The proposed approach aims to integrate a closed-loop system within space habitats, wherein anammox bacteria actively participate in the comproportionation reaction to convert nitrite and ammonium ions derived from human waste into hydrazine, along with the generation of diatomic nitrogen and water. This transformative process aligns with the principles of space sustainability, offering a dual solution by efficiently managing waste while simultaneously producing a valuable space fuel resource.

The study encompasses a detailed exploration of the biological and engineering aspects of cultivating anammox bacteria in microgravity environments, considering factors such as nutrient availability, temperature regulation, and system scalability. Additionally, the potential benefits of this sustainable approach are discussed, including reduced dependence on external resource supply, minimized environmental impact, and enhanced space mission autonomy.

This paper advocates for the integration of anammox bacteria into space habitats as a transformative step towards achieving comprehensive space sustainability. By converting human waste into hydrazine through a biological process, we present a compelling solution that addresses both waste management challenges and the growing demand for sustainable space fuel sources. This research contributes to the ongoing efforts to establish self-sufficient and environmentally conscious human habitation beyond Earth.