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Life support Challenges for Human Space Exploration (10)
Life Support Technologies and Systems (1)

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HUMAN CONTROL AND CLOSED ECOSYSTEM STABILITY

Abstract

Man-made Closed Ecosystems (CES) which have been suggested, theoretically and experimentally researched as a solution for long-term life support in space inevitably function at or near limits of their ecological stability due to significantly reduced 'buffer capacities' (amounts of accumulated in the system materials participating in the cycles of material transformations) compare to Earth's ecosystems and planetary Biosphere. As it was shown experimentally due to reduced 'buffer capacities' small size CESs have limited time of functionality in terms of efficient life support. This theoretical research and presentation specifically identifies as major areas of stability control within CES oxygen/carbon dioxide exchange, water cycle, and solid materials cycle. Three material cycles have different stability levels depending on system size and rates of material circulation within the system. Human 'intelligent' control applied carefully to major material cycles increases system stability but brings additional stress to human subjects as a 'target-link' inside the system. Balance has to be found between these two opposite tendencies in order to maintain general system life support function at the required levels for certain durations. Theoretical conclusions obtained from analysis of math models are illustrated by the results of CES testing (e.g. Biosphere of the Earth, Biosphere 2 in USA, CEEF in Japan, BIOS – 3 in Russian Federation, Lunar-Mars Life Support Test Project in USA). Analysis of the data from these experiments within suggested conceptual model can be used to identify and investigate limits of functional stability for newly introduced CES.