

20th IAA SYMPOSIUM ON VISIONS AND STRATEGIES FOR THE FUTURE (D4)
Innovative Concepts and Technologies (1)

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MARSOASIS® ATMOSPHERE PROVISION AND REVITALIZATION

Abstract

Self-sufficient and robust life support systems are crucial to sustain crews on long-duration missions beyond Earth orbit, and are expected to demand system closure through minimal use of expendables. Deep-space missions will undoubtedly require crop production as a key element of food provision to the crew. Crop production systems also provide other life support functions such as carbon dioxide reduction to oxygen, water recovery, and waste recycling. MarsOasis® integrates prior research and concepts into a complete greenhouse design and operational prototype to demonstrate important technology innovations that include a deployable rigidizing structure, smart-hybrid lighting, and in-situ carbon dioxide (CO₂) sequestration for plant atmosphere provision. Further, atmosphere environmental conditions (pressure, temperature and humidity) and its gas composition must be controlled within allowable parameters. Plants cannot tolerate ethylene, carbon monoxide is toxic to humans, and elevated levels of CO₂ (partial pressures > 2 mm Hg) pose a concern to both plants and humans. For the MarsOasis® greenhouse, an atmosphere management system filters dust, compresses the gas flow, selectively captures and delivers CO₂ to the greenhouse, controls the humidity, and selectively removes ethylene and oxygen. A supported ionic liquid membrane, a principal component within this system, captures CO₂ from the Mars atmosphere while rejecting carbon monoxide. Aprotic task specific ionic liquids have negligible vapor pressure, are chemically and thermally stable, and are selective for gas adsorption depending on the cation-anion pair forming the ionic liquid. These characteristics make them ideal for gas separation processes. This paper presents the MarsOasis® concept and describes the system under development for atmosphere provision and revitalization.