Carbon Dioxide Collection and Purification System for Mars

Abstract

One of the most abundant resources available on Mars is the atmosphere. The primary constituent, carbon dioxide, can be used to produce a wide variety of consumables including propellants and breathing air. The residual gases can be used for additional pressurization tasks including supplementing the oxygen partial pressure in human habitats. A system is presented that supplies pure, high-pressure carbon dioxide and a separate stream of residual gases ready for further processing. This power-efficient method freezes the carbon dioxide directly from the atmosphere using a pulse-tube cryocooler. The resulting CO2 mass is later thawed in a closed pressure vessel, resulting in a compact source of liquefied gas at the vapor pressure of the bulk fluid. Results from a demonstration system are presented along with analysis and system scaling factors for implementation at larger scales.

Trace gases in the Martian atmosphere challenge the system designer for all carbon dioxide acquisitions concepts. The approximately five percent of other gases build up as local concentrations of CO2 are removed, resulting in diminished performance of the collection process. The presented system takes advantage of this fact and draws the concentrated residual gases away as a useful byproduct. The presented system represents an excelient volume and mass solution for collecting and compressing this valuable Martian resource. Recent advances in pulse-tube cryocooler technology have enabled this concept to be realized in a reliable, low power implementation.

System Implementation

- Schematic
- Operation

Performance estimates

- Power Requirements
- System Mass

Test Hardware

- Test System Design
- Test Results

Conclusions

- Future Work

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