NASA Phase I Project Summary

Firm: Creare Incorporated
Contract Number: NNX12CE88P
Project Title: Water Recovery for Regenerative Life Support System

Identification and Significance of Innovation:

Thermal and environmental control systems for future exploration spacecraft must meet challenging requirements for efficient operation and conservation of resources. Regenerative CO_2 removal systems are attractive for these missions because they do not use consumable CO_2 absorbers. However, these systems also absorb and vent water to space along with carbon dioxide. The aim of this project is to develop an innovative water recovery system that minimizes water lost from regenerative CO_2 control systems. Specifically, we aim to develop a compact, efficient membrane water vapor exchanger (WVX) that will conserve water while meeting challenging requirements for operation on future spacecraft.

Technical Objectives and Work Plan:

The technical objectives for the WVX are high water recovery efficiency, low pressure losses, and compact size. To achieve these objectives, we worked with NASA and contractor engineers to identify the design requirements for the WVX. We created a design for a membrane WVX that has the potential for high water recovery efficiency, compact size, and very low pressure losses. The key innovation is a method for maintaining highly uniform flow channels in a WVX core built from water-permeable membranes. In Phase I we built a proof-of-concept WVX and measured its mass transfer efficiency and pressure drop. The proof-of-concept unit incorporates all the key design features of a prototypical unit, except that it is relatively small scale (1/23 relative to a unit sized for a crew of six) and some components were fabricated using non-prototypical methods. We also built a small test apparatus to measure leakage rate of CO_2 through prototypical materials. We used data from tests of the proof-of-concept WVX to validate our design models, then used these models to produce designs for a full-scale unit as well as a Phase II prototype.

Technical Accomplishments:

The proof-of-concept WVX achieved over 90% water recovery efficiency in a compact core in good agreement with our analysis models. Furthermore the overall pressure drop is very small and meets requirements for service in environmental control and life support systems on future spacecraft. These results show that our innovative design for the WVX core is effective at providing uniform flow for both humid and dry streams. Finally, our CO_2 leak tests shows that CO_2 diffusion through the water-permeable membranes will have negligible effect on the CO_2 partial pressure in the spacecraft atmosphere.

NASA Application(s):

The WVX can be an essential element of environmental and life support systems (ECLSSs) on future exploration spacecraft, which will need to use regenerable CO_2 absorbers without venting excessive water overboard. The WVX can also be applied to near-term upgrades to the space stations ECLSS, where it can play an important role in helping reducing use of consumables by helping to close the life support system.

Non-NASA Commercial Application(s):

Creare's water vapor exchanger makes highly efficient use of water-permeable membranes, and therefore offers a low-cost alternative to commercial membrane air dryers and humidifiers. Humidifiers

and water management components for fuel cell power systems—particularly as these systems are adopted for vehicles—will be an important commercial application.

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