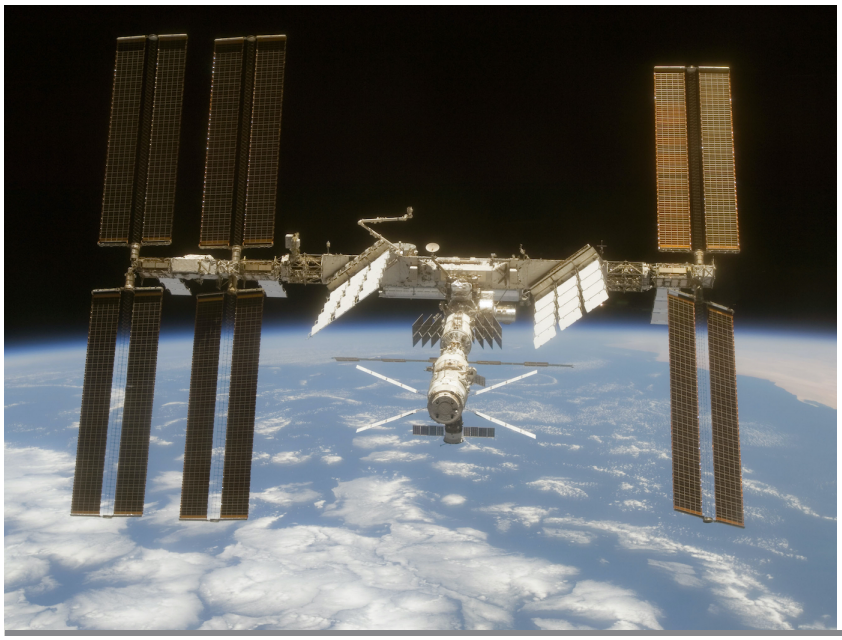

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Mechanical and Fluid Systems

Liquid Sorbent Carbon Dioxide Removal System

Using a 3D-Printed Capillary Microchannel Contactor

Innovators at the NASA Johnson Space Center (JSC), in collaboration with Jacobs Technology, and IRPI, have developed a reliable, efficient, and cost-effective carbon dioxide (CO2) removal and dehumidification system. The new system is designed for ventilation applications and utilizes a gentle, passive, and direct air/liquid contactor. The contactor is composed of a bifurcating manifold with 3D printed corrugated walls, that contain capillary channels onto which thin films of liquid sorbent are deployed. The liquid is held in place by surface tension and capillary forces. As the liquid is exposed to the air, it absorbs carbon dioxide and humidity from the environment. NASA's new CO2 removal system has significant advantages over current CO2 scrubbers. For example, the new system eliminates the need for large blowers and compressors that force air at high velocities through adsorption-based systems using solid sorbents.

BENEFITS

- Enables simplified system integration: Does not require large blowers and compressors that need to force air at high velocities through typical CO2 removal systems
- Offers a reliable, efficient design: Requires fewer moving mechanical parts than solid based systems and offers low weight, volume, and power requirements
- Presents improvements over current technologies: Liquid sorbents have favorable capacity, up to four times greater than current solid zeolites
- Facilitates simple regeneration techniques: Liquid sorbents have low regeneration temperatures, so the materials do not need to be heated to extreme temperature

THE TECHNOLOGY

NASA's Liquid Sorbent Carbon Dioxide Removal System was designed as an alternative to the current CO2 removal technology used on the International Space Station (ISS), which uses solid zeolite media that is prone to dusting, has a low absorption capacity, and requires high regeneration temperatures and frequent maintenance. Motivated by CO2 removal systems on submarines, NASA innovators began investigating the use of liquid sorbents. Liquid sorbents have a capacity four times greater than solid zeolites, require low regeneration temperature, and need fewer unreliable moving mechanical parts than solid based systems. While submarine CO2 scrubbers spray an adsorbing chemical directly into the air stream and allow the liquid to settle, NASA's new system uses a capillary driven 3D printed microchannel direct air/liquid contactor in a closed loop system. The Liquid Sorbent Carbon Dioxide Removal System is robust and reliable, while being low in weight, volume, and power requirements. The system is capable of reaching equilibrium when the liquid sorbent surface is being regenerated at a rate equal to the rate of absorption into the liquid.

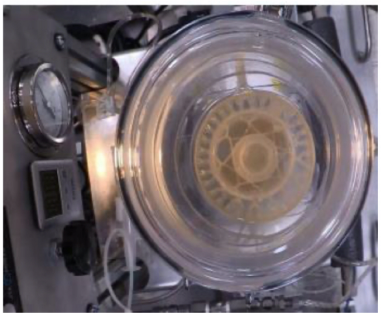

Figure 1

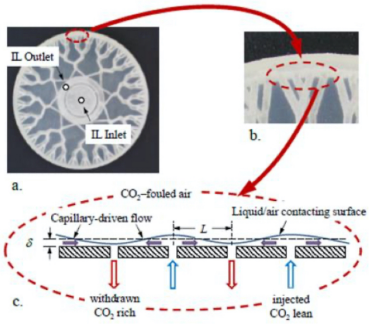

Figure 2

Figure 1: 3D Printed microchannel air/liquid contactor; Figure 2: (a) Isometric top view of contactor; (b) Close up view of microchannels; (c) Cross- section of contacting surface

APPLICATIONS

The technology has several potential applications:

- Aerospace
- Agriculture: Controlled Atmosphere Storage
- Automotive: Recirculating Air Conditioning Systems
- Chemical Manufacturing
- Commercial Space Flight
- Consumer Goods: Rebreathers for Scuba Diving
- First Responders: Rebreather Systems
- Marine: Submarines and Submersible Craft

PUBLICATIONS

Patent No: 11,058,990

"Liquid Behavior through a Capillary Microchannel Contactor in a Reduced Gravity Aircraft," Tanya Rogers, John Graf & Julia Worrell, 07/16/2017, https://ttu-ir.tdl.org/handle/2346/72942

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