Mechanics/Machinery

Deployable Crew Quarters

Lyndon B. Johnson Space Center, Houston, Texas

The deployable crew quarters (DCQ) have been designed for the International Space Station (ISS). Each DCQ would be a relatively inexpensive, deployable box-like structure that is designed to fit in a rack bay. It is to be occupied by one crewmember to provide privacy and sleeping functions for the crew. A DCQ comprises mostly hard panels, made of a lightweight honeycomb or matrix/fiber material, attached to each other by cloth hinges. Both faces of each panel are covered with a layer of Nomex cloth and noise-suppression material to provide noise isolation from ISS.

On Earth, the unit is folded flat and attached to a rigid pallet for transport to the ISS. On the ISS, crewmembers unfold the unit and install it in place, attaching it to ISS structural members by use of soft cords (which also help to isolate noise and vibration). A few hard pieces of equipment (principally, a ventilator and a smoke detector) are shipped separately and installed in the DCQ unit by use of a system of holes, slots, and quarter-turn fasteners.

Full-scale tests showed that the time required to install a DCQ unit amounts to tens of minutes. The basic DCQ design could be adapted to terrestrial applications to satisfy requirements for rapid deployable emergency shelters that would be lightweight, portable, and quickly erected. The Temporary Early Sleep Station (TeSS) currently on-orbit is a spin-off of the DCQ.

This work was done by William C. Schneider, Kriss J. Kennedy, and Nathan R. Moore of Johnson Space Center and James Mabie of Muniz Engineering. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-23132-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Nonventing, Regenerable, Lightweight Heat Absorber

Lyndon B. Johnson Space Center, Houston, Texas

A lightweight, regenerable heat absorber (RHA), developed for rejecting metabolic heat from a space suit, may also be useful on Earth for short-term cooling of heavy protective garments. Unlike prior space-suit-cooling systems, a system that includes this RHA does not vent water. The closed system contains water reservoirs, tubes through which water is circulated to absorb heat, an evaporator, and an absorber/radiator. The radiator includes a solution of LiCl contained in a porous material in titanium tubes.

The evaporator cools water that circulates through a liquid-cooled garment. Water vapor produced in the evaporator enters the radiator tubes where it is absorbed into the LiCl solution, releasing heat. Much of the heat of absorption is rejected to the environment via the radiator. After use, the RHA is regenerated by heating it to a temperature of 100 °C for about 2 hours to drive the absorbed water back to the evaporator. A system including a prototype of the RHA was found to be capable of maintaining a temperature of 20 °C while removing heat at a rate of 200 W for 6 hours.

This work was done by Michael G. Izenson and Weibo Chen of Creare Inc. for Johnson Space Center. Further information is contained in a TSP (see page 1).

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to MSC-23914-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Miniature High-Force, Long-Stroke SMA Linear Actuators

Stroke forces, stroke lengths, cycle speeds, and structural strengths are increased.

John H. Glenn Research Center, Cleveland, Ohio

Improved long-stroke shape-memory-alloy (SMA) linear actuators are being developed to exert significantly higher forces and operate at higher activation temperatures than do prior SMA actuators. In these actuators, long linear strokes are achieved through the principle of displacement multiplication, according to which there are multiple stages, each intermediate stage being connected by straight SMA wire segments to the next stage so that relative motions of stages are additive toward the final stage, which is the output stage.

Prior SMA actuators typically include polymer housings or shells, steel or aluminum stages, and polymer pads between successive stages of displacement-multiplication assemblies. Typical output forces of prior SMA actuators range from 10 to 20 N, and typical strokes range from 0.5 to 1.5 cm. An important disadvantage of prior SMA wire actuators is relatively low cycle speed, which is related to actuation temperature as follows: The SMA wires in prior SMA actuators are typically made of a durable nickel/titanium alloy that has a shape-memory activation temperature of 80 °C. An SMA wire can be heated quickly from below to above its activation temperature to obtain a stroke in one direction, but must then be allowed to cool to somewhat below its activation temperature (typically, to ≤ 60 °C in the case of an activation temperature of 80 °C) to obtain a stroke in the opposite direction (return stroke). At typical ambient temperatures, cooling times are of the order of several seconds. Cooling times thus limit cycle speeds. Wires made of SMA alloys having significantly higher activation temperatures [denoted ultra-high-temperature (UHT) SMA alloys] cool to the required lower return-stroke temperatures more rapidly, making it possible to increase cycle speeds.

The present development is motivated by a need, in some applications (especially aeronautical and space-flight applications) for SMA actuators that exert higher forces, operate at greater cycle speeds, and have stronger housings that can withstand greater externally applied forces and impacts. The main novel features of the improved SMA actuators are the following:

- The ends of the wires are anchored in compact crimps made from short steel tubes. Each wire end is inserted in a tube, the tube is flattened between planar jaws to make the tube grip the wire, the tube is compressed to a slight U-cross-section deformation to strengthen the grip, then the crimp is welded onto one of the actuator stages. The pull strength of a typical crimp is about 125 N — comparable to the strength of the SMA wire and greater than the typical pull strengths of wire-end anchors in prior SMA actuators. Greater pull strength is one of the keys to achievement of higher actuation force.
- For greater strength and resistance to impacts, housings are milled from aluminum instead of being made from polymers. Each housing is made from two pieces in a clamshell configuration. The pieces are anodized to reduce sliding friction.
- Stages are made stronger (to bear greater compression loads without excessive flexing) by making them from steel sheets thicker than those used in prior SMA actuators. The stages contain recessed pockets to accommodate the crimps. Recessing the pockets helps to keep overall dimensions as small as possible.
- UHT SMA wires are used to satisfy the higher-speed/higher-temperature requirement.

This work was done by Mark A. Cummin, William Donakowski, and Howard Cohen of MIGA Motor Co. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18267-1.

“Bootstrap” Configuration for Multistage Pulse-Tube Coolers

Lyndon B. Johnson Space Center, Houston, Texas

A “bootstrap” configuration has been proposed for multistage pulse-tube coolers that, for instance, provide final-stage cooling to temperatures as low as 20 K. The bootstrap configuration supplants the conventional configuration, in which customarily the warm heat exchangers of all stages reject heat at ambient temperature. In the bootstrap configuration, the warm heat exchanger, the inertance tube, and the reservoir of each stage would be thermally anchored to the cold heat exchanger of the next warmer stage. The bootstrapped configuration is superior to the conventional setup, in some cases increasing the 20 K cooler’s coefficient of performance two-fold over that of an otherwise equivalent conventional layout. The increased efficiency could translate into less power consumption, less cooler mass, and/or lower cost for a given amount of cooling.

This work was done by Ali Kashani and Ben Helvensteijn of Atlas Scientific for Johnson Space Center. Further information is contained in a TSP (see page 1).
MSC-23500-1

Reducing Liquid Loss During Ullage Venting in Microgravity

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A centripetal-force-based liquid/gas separator has been proposed as a means of reducing the loss of liquid during venting of the ullage of a tank in microgravity as a new supply of liquid is pumped into the tank. Centripetal-force-based liquid/gas separators are used on Earth, where mechanical drives (e.g., pumps and spinners) are used to impart flow speeds sufficient to generate centripetal forces large enough to effect separation of liquids from gases.

For the proposed application, the separator would be designed so that there would be no need for such a pump because the tank-pressure-induced outflow speed during venting of the ullage would be sufficient for centripetal separation. A relatively small pump would be used, not for separation, but for returning the liquid recovered by the separator to the tank.

This work was done by Bich Nguyen and Lauren Nguyen of The Boeing Co. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-23230-1