Manufacturing & Prototyping

Nearly Seamless Vacuum-Insulated Boxes

Elimination of most seams would reduce leakage of heat.

Lyndon B. Johnson Space Center, Houston, Texas

A design concept, and a fabrication process that would implement the design concept, have been proposed for nearly seamless vacuum-insulated boxes that could be the main structural components of a variety of controlled-temperature containers, including common household refrigerators and insulating containers for shipping foods. In a typical case, a vacuum-insulated box would be shaped like a rectangular parallelepiped conventional refrigerator box having five fully closed sides and a hinged door on the sixth side. Although it is possible to construct the five-closed-side portion of the box as an assembly of five unitary vacuum-insulated panels, it is not desirable to do so because the relatively high thermal conductances of the seams between the panels would contribute significant amounts of heat leakage, relative to the leakage through the panels themselves. In contrast, the proposal would make it possible to reduce heat leakage by constructing the five-closed-side portion of the box plus the stationary portion (if any) of the sixth side as a single, seamless unit; the only remaining seam would be the edge seal around the door.

The basic cross-sectional configuration of each side of a vacuum-insulated box according to the proposal would be that of a conventional vacuum-insulated panel: a low-density, porous core material filling a partially evacuated space between face sheets. However, neither the face sheets nor the core would be conventional. The face sheets would be opposite sides of a vacuum bag. The core material would be a flexible polymer-modified silica aerogel of the type described in "Silica/Polymer and Silica/Polymer/Fiber Composite Aerogels" (MSC-23736) in this issue of *NASA Tech Briefs*. As noted in that article, the stiffness of this core material against compression is greater than that of prior aerogels. This is an important advantage because it translates to greater retention of thickness and, hence, of insulation performance when pressure is applied across the thickness, in particular, when the space between the face sheets is evacuated, causing the core material to be squeezed between the face sheets by atmospheric pressure.

Fabrication of a typical vacuum-insulated box according to the proposal would begin with fabrication of a cross-shaped polymer-modified aerogel blanket. The dimensions of the cross would be chosen so that (1) the central rectangular portion of the cross would form the core for the back of the box and (2) the arms of the cross could be folded 90° from the back plane to form the cores of the adjacent four sides of the box. Optionally, the blanket could include tabs for joining the folded sides of the blanket along mating edges and tabs that could serve as hinges for the door.

Vacuum bags in the form of similar five-sided boxes would be made of a suitable polymeric film, one bag to fit the outer core surface, the other to fit the inner core surface. By use of commercially available film-sealing equipment, these box-shaped bags would be seamed together to form a single vacuum bag encasing the box-shaped core. Also, a one-way valve would be sealed to the bag. Through this valve, the interior of the bag would be evacuated to a pressure between 1 and 10 torr (approximately between 0.13 and 1.3 kPa). The polymer-modified aerogel core material is known to perform well as a thermal insulator in such a partial vacuum.

This work was done by Christopher J. Stepanian, Danny Ou, and Xiangjun Hu of Aspen Aerogels, 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-23735-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Quick-Change Ceramic Flame Holder for High-Output Torches

In addition to jet engine simulation, this technology can be used in torches for forging and pottery kilns.

Langley Research Center, Hampton, Virginia

Researchers at NASA's Langley Research Center have developed a new ceramic design flame holder with a service temperature of 4,000 °F (2,204 °C). The combination of high strength and high temperature capability, as well as a twist-lock mounting method to the steel burner, sets this flame holder apart from existing technology.

This design features the following:

- Enables about double the torch output without damaging the torch.
- Can operate at a higher temperature [4,000 °F (2,204 °C)] than stainless steel [1,600 °F (870 °C)].
- Allows the torch to be optimized for different applications (e.g., may use a mixing nozzle or a supersonic nozzle).
- Can be used with either venturi or forced draft burners.
- Is easily replaceable without tools.
- Operates without torch / holder rusting together after use.
- Permits a modified torch to still use a conventional flame holder.