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Brief 66-10288

NASA TECH BRIEF

Improved Thermal Insulation Materials Made of Foamed Refractory Oxides

The problem:

To develop improved lightweight, reflective thermal insulation materials. The materials should have a low bulk density and be capable of withstanding a heat flux of up to 40 Btu/ft/sec under mechanical vibrations of 60 cps. The adhesion of the materials to a load bearing substrate as well as self-cohesion must be sufficient to withstand a minimum flatwise tensile stress of 80 psi.

The solution:

A series of foamed refractory oxides having a density of 30 to 100 lb/cu ft, depending on composition.

How it's done:

The foamed refractory oxides consist basically of granular zircon ($ZrO_2 \cdot SiO_2$) or mullite ($3Al_2O_3 \cdot 2SiO_2$). These materials have a low thermal expansion coefficient which provides high thermal shock resistance.

The zircon or mullite grains, 74 microns or less in diameter, are mixed into a slurry with water and an alkali silicate binder. A whipping agent is added, and the slurry is foamed by a high speed, blade type mixer. Protein materials, such as egg albumen, are used to form a fine bubble structure and stable suspension. Anionic surfactants may also be used. Inorganic fibrous materials are added to increase strength, enhance moisture resistance, and minimize drying shrinkage of the foam. Aluminum silicate, silica, glass, zirconia, boron, alumina, and silicon carbide fibers are suitable for this purpose. A complexing agent is added to retard migration of the alkali silicate binder and to impart resistance to bond deterioration by water. The preferred agent is sodium silicofluoride. Alkaline earth or zinc oxides can also be used. The addition of small amounts of clay aids in maintaining the suspension of the refractory grains when the foams are cast and cured by heating in an oven.

The composition of a typical foamed ceramic in percent by weight is as follows:

Refractory oxide grain	54–75
Water	8–16
Silicate binder	14–30
Clay	0–2.0
Whipping agent	0.15–1.0
Sodium silicofluoride	1.0–3.0
Fibers	1.5–10

Notes:

1. A foamed zircon ceramic had a density of 52 lb/cu ft, a conductivity of less than 0.1 Btu/hr/ft/°F in the range from room temperature to 1300°F, and conductivities of 0.166 and 0.290 Btu/hr/ft/°F at 1835°F and 2300°F, respectively. A 0.5-inch-thick slab remained intact when subjected to a heat flux of 40 Btu/ft/sec, with simultaneous vibration of 60 cps at a double amplitude displacement of 0.5 inch and acceleration of 90g. The skin exhibited a reflectance of over 90 percent in the 0.8 to 1.8 micron wavelength range.
2. A related innovation is described in NASA Tech Brief B65-10357, November 1965. Inquiries may also be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama 35812
   Reference: B66-10288

(continued overleaf)

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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