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NASA TECH BRIEF

Porous Ceramic Cures at Moderate Temperatures, Is Good Heat Insulator

The problem: To develop a foamed-in-place refractory material that would provide good thermal insulation, mechanical support, and vibration shielding for enclosed objects at temperatures up to 3000° F. The preparation of conventional foamed refractory materials required long curing times (as much as 48 hours) and high temperatures (at least 700° F), rendering such materials unusable for in-place potting of heat-sensitive components.

The solution: A foamed ceramic material that has the requisite thermal insulation and strength, and also displays other properties that suggest a wide range of applications. The uncured material consists of a slurry formed by mixing the following ingredients:

Ingredient	Percent by Weight
Orthophosphoric acid (85%)	40–60
Aluminum hydroxide	10–55
Bentonite	0.7–4.0
Metal powder (e.g., aluminum, magnesium, tin, zinc) 15 ±5 microns	0.1–0.5
Silica powder, 10–20 millimicrons	0–0.5
Aluminum phosphate	Balance of mixture after selection of other ingredients

(The inclusion of the powdered silica in the slurry is not an absolute necessity, but does allow more convenient handling of the "green" material).

How it's done: The ingredients are stirred together at room temperature, and the resulting slurry is poured into an enclosure around the objects to be potted. The slurry is then allowed to react until foaming has subsided. The foamed material is cured by heating it at temperatures between 140°F and 210°F. The heating time required varies with temperatures, shorter periods being needed at 185°F. If the cover is removed after the first half hour of curing, this temperature need be maintained for only 3 to 4 hours.

The physical properties of the foamed ceramic material are:

Density. The porosity and density of the foamed material can be accurately controlled by varying the particle size and the amount and kind of metallic powder used. It is possible to vary the porosity of the material from approximately 5% to 90% by volume, with a corresponding density variation of 140 lbs per cubic foot to 19 lbs per cubic foot.

Thermal Shock. Specimens of the cured foamed material were thermally shock-tested by heating them to 930°F, 1830°F, and 2730°F, and immediately immersing them in water at room temperature. No degradation of the material was observed in these tests.

Thermal Conductivity. Tests were performed by applying a propane-torch flame to the surface of a 1-inch sample in which a carbon resistor was potted. No electrical variation was detected in the potted resistor, indicating that the ceramic has a very low thermal conductivity, although no quantitative data have been obtained.

Water Solubility. After 7 hours in boiling water the material experienced negligible weight loss.

Machinability. The molded material is easy to form and may be cut with a hacksaw, shaped with a wood rasp, and ground with an abrasive wheel.

Adherence Properties. The foamed ceramic will adhere readily to metals, but not to plastics.

Colorability. Small percentages of standard second-phase ceramic coloring materials (chromium oxide for

(continued overleaf)

green, iron oxide for beige, etc.) can be added to the basic mixture, producing permanent insoluble coloring.

Notes:

1. Aluminum has been found to give the best results in reacting with the orthophosphoric acid to produce hydrogen for foaming action. Other metals may be substituted, depending on the desired application.
2. Suggested applications for this material are: home and factory insulation; building material furnace insulation; potting material for electronic modules; steampipe insulation; fireproof acoustic tile; thermally insulated containers; and fire-protection barriers.
3. Inquiries concerning this innovation may be directed to:

   Technology Utilization Officer
   Goddard Space Flight Center
   Greenbelt, Maryland, 20771
   Reference: B65-10058

Patent status: NASA encourages commercial use of this innovation. Inquiries about obtaining rights for its commercial use may be made to NASA, Code AGP, Washington, D.C., 20546.

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