December 1973 B73-10504

NASA TECH BRIEF

Ames Research Center

Reusable Silica Surface-Insulation Material

The problem:

To produce a reusable, rigid, low-density surface-insulation material which can be fabricated at minimal cost.

The solution:

Bond high-purity silica fibers with a particulate silica binder and then sinter to create fiber-to-fiber attachment.

How it's done:

The reusable surface insulation material was specifically developed for the manufacture of insulating tiles, but the material can be molded into other shapes as required. The basic raw materials are high-purity silica fiber (1 to 10 μm diameter), fumed-silica powder, and reagent-grade starch; the silica fiber and powder do not devitrify when held for prolonged periods of time at temperatures over 1100°C.

Only the purest materials are used, and care must be taken to avoid contamination during processing; accordingly, deionized water and stainless steel or polyethylene utensils and mixing vessels are used. The fibers are first washed in dilute hydrochloric acid to remove contaminants and then rinsed with deionized water; pure nitrogen is used for agitation of slurries.

The nature of each lot of fibers governs the details of the process; for example, washing may need to be repeated, less stable fibers are to be fired for a shorter time at a lower temperature, and fiber length may have to be modified because long fibers lead to stratification during molding and cracking of tiles during firing. To obtain finished tiles of a required density, trials will have to be made to establish shrinkage factors for each lot of fibers.

The binder for 250 to 600 grams of fiber is prepared by suspending 0.5 to 1.0% fumed silica and 0.025 to 1.0% starch in 1000 to 3000 grams of deionized water containing 1 to 5 ml of 15 *M* ammonium hydroxide. The binder mixture is homogenized in a high-speed mixer, and the dispersion is then blended with drained fibers and water in a V-blender for 30 to 60 minutes; pH is held at 9.0 with ammonium hydroxide. An intensifier bar in the V-blender is used to break up clumps of fiber. The resulting slurry is poured into a mold for either single-direction or multidirection pressing, and rapidly pressed at 69 to 138 kN/m^2. Final tile density is controlled by fiber content and molded dimensions; densities from 110 to 380 kg/m^3 can be obtained.

Tiles are placed in an oven and the temperature is raised at 11°C per hour to a maximum of 150°C; the total drying time is 18 hours. The tiles are taken directly from the oven and placed in a furnace which is free of alkali or alkaline earth oxide impurities. The temperature of the furnace is programmed to reach 1200° to 1300°C at a rate of 150°C per hour or less to avoid cracking of small (15 x 15 x 7.5 cm) tiles; however, the maximum temperature and the firing time at the high temperature is a function of the characteristics of the fiber being used. The starch burns away at about 530°C, leaving a pure silica unbonded structure.

Final tile properties are related to fiber-to-fiber sintering at least as much as fiber-to-binder sintering. Shrinkage and sintering are more rapid with binder

(continued overleaf)

than without, permitting shorter firing times and improved long-term stability of the tile. Warpage may be a problem; it can be caused during firing by temperature gradients in the tile or by sagging of the unsupported tile in the furnace. As a rule, about 0.5 cm of material is machined off a tile to obtain the finished size.

Reference:

Goldstein, H. E., Smith, M., and Leiser, D.: Research for Improvement of Silica Reusable Surface Insulation. NASA TM X-2719, March 15, 1973.

Note:

No additional documentation is available. Specific questions, however, may directed to:

Technology Utilization Officer
Ames Research Center
Moffett Field, California 94035
Reference: B73-10504

Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

NASA Patent Counsel
Mail Code 200-11A
Ames Research Center
Moffett Field, California 94035

Source: Howard E. Goldstein,
Marnell Smith, and Daniel Leiser
Ames Research Center
(ARC-10721)