NASA TECH BRIEF

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Air-Cured Ceramic Coating Insulates Against High Heat Fluxes

The problem: Supporting structures in areas adjacent to rocket engines must be protected from the intense heat fluxes in the rocket exhaust plumes. An air-cured, nonflammable, highly reflective, low-conductivity insulation capable of protecting the base rocket structure from temperatures exceeding 300°F under heat loads of 3,600 Btu/ft^2 (of which 60% to 80% is direct thermal radiation from the rocket plume, with convection accounting for the remainder) for periods of approximately 145 seconds was required.

The solution: A composite panel whose insulation properties depend on a highly reflective inorganic coating prepared from fibrous potassium titanate, asbestos fibers, and colloidal silica.

How it's done: The inorganic coating is prepared from commercially available fibrous potassium titanate, cut (0.5-inch-length) asbestos fibers, and a colloidal suspension of silica (silica sol) in water which serves as a binder. The asbestos fibers (10 parts by weight) are intimately blended with the fibrous potassium titanate (90 parts by weight), and the silica sol (420 parts by weight) is stirred into the blended solids to produce a workable plastic mixture. The mixture is trowelled into a reinforcement structure and rolled to provide an approximately 0.5-inch-thick layer of insulation. The panels are then air-dried over a period of 12 hours at 180°F. After drying, a film of nitrocellulose is applied to the insulation surface to protect it from dust and other contaminants that would degrade the reflectivity of the insulation. Before usage of the insulation, the nitrocellulose film is burned off, without leaving any residue.

The dried insulation has an average density of 46 to 50 pounds per cubic foot. Because drying occurs primarily from only one (the outer) surface, a desirable density gradient is produced in the slab of insulation. The outer reflective surface is dense, strong, and hard, while the inner layer is less dense and provides a barrier of lower thermal diffusivity. The insulation can be soaked in room-temperature water for 200 hours or in boiling water for 3 hours without seriously affecting its mechanical properties. Insulation specimens of 0.32-inch thickness showed a backface rise of 228°F when the reflective surfaces of the specimens were exposed to a radiant flux of 24 Btu/sq ft/sec for 145 seconds. When incorporated in a honeycomb structure, insulation specimens have withstood vibrations of 72 g. At this loading, failure occurred at the spot welds joining the reinforcement core to the basic honeycomb structure.

Notes:

1. This reflective insulating material should have advantageous application as backup reflectors for open electrical radiant space heaters, heat shields around furnace operations in industrial plants, coatings for tongs and other implements used to move material in and out of furnaces, and coatings on the inside of heat-treatment furnaces.
2. It should be possible to utilize relatively inexpensive modifications of the basic formulation in many industrial environments which are less severe than those for which the coating was developed.

(continued overleaf)

3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Marshall Space Flight Center
   Huntsville, Alabama, 35812
   Reference: B65-10357

Patent status: NASA encourages the immediate commercial use of this invention. It is owned by NASA, and a patent application has been filed. When patented, royalty free nonexclusive licenses for its commercial use will be available. Inquiries concerning license rights should be made to NASA, Code AGP, Washington, D.C., 20546.

Source: V. F. Seitzinger
(M-FS-150)