NASA TECH BRIEF

NASA Pasadena Office

Granular Two-Phase Insulation Systems

A new insulation system, consisting of a matrix of loosely packed, hollow zirconia microspheres containing a small amount of dispersed tungsten powder, can be used to produce a minimum-cost, prototype test specimen. The combination specified was chosen because: (1) it represents the basic concept of a highly reflective dispersed phase in a low-density insulative matrix; (2) the materials are stable at 2200 K (3500° F); (3) the raw materials are readily available and reasonably inexpensive; and (4) the system can be easily prepared without a developmental effort. Screening tests at 2200 K showed this system to be better than all other candidate systems. Shrinkage was 5% or less, outgassing was negligible, and there was no reaction with the molybdenum can.

Any effective high-temperature insulation system must contain a means of dispersing or back-reflecting radiation. Reflective surfaces reduce radiation heat transfer, the dominant mode at higher temperatures, particularly above 1366 K (2000° F). The two essential ways of forming a system with a high proportion of reflective surfaces are: (1) Use multilayer system, alternating reflective foils with layers of low thermal conductivity materials; and (2) disperse reflective particles throughout a stable matrix.

Reflective surfaces can be suspended or formed in a refractory powder matrix by vapor deposition, precipitation, or decomposition. The most promising method involves coating the particles in a manner similar to that used to apply decorative films on ceramic pottery and dinnerware. The metal phase, a refractory or precious metal, is dissolved in an appropriate organic liquid. The solution is then mixed with the ceramic particles, and the excess solution is poured off for reuse. The film that remains on each particle is converted to the pure metal phase by thermal treatment. The refractory metals require a second heat treatment in hydrogen to reduce the oxide in the metal phase. The thickness is very small so that relatively little material is required.

Another method involves suspending a refractory metal powder in a phenolic resin that can be molded or extruded into various shapes. The phenolic is pyrolyzed to form a strong, yet porous, structure, or an organic-based paint containing suspended refractory or precious metal powder is successively applied as discrete layers on a fugitive mandrel. More metal powder is attached on the wet surface after each coating. The multilayered composite is pyrolyzed to form poorly bonded multilayers of a low-density carbon structure impregnated with refractory metal-oxide powder. A reduction reaction is required, provided that the refractory metal is oxidized during the pyrolyzation operation. Although both molybdenum and tantalum will carburize, the refractory metal carbide particles will still have a reflectance value of about 5% or more.

Several other combinations of materials are potentially useful. The ceramic matrix can be zirconia, thoria, carbon, or graphite, and the reflective powder can be tungsten, tantalum, columbium, molybdenum, rhenium, iridium, or ruthenium. The use of precious metals should not be

(continued overleaf)

excluded, because these metals can be painted or deposited as very thin layers so that only a relatively small amount of material would actually be required.

Notes:

1. Related information concerning wrapped multilayer insulations can be found in NASA Tech Brief B71-10289.
2. Requests for further information may be directed to:

   Technology Utilization Officer
   NASA Pasadena Office
   4800 Oak Grove Drive
   Pasadena, California 91103
   Reference: TSP71-10290

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to:

Patent Counsel
Mail Code 1
NASA Pasadena Office
4800 Oak Grove Drive
Pasadena, California 91103

Source: H. W. Carpenter of
Rockedyne Division
North American Rockwell Corp.
under contract to
NASA Pasadena Office
(NPO-12068)