NASA TECH BRIEF

NASA Pasadena Office

NASA Tech Briefs announce new technology derived from the U.S. space program. They are issued to encourage commercial application. Tech Briefs are available on a subscription basis from the National Technical Information Service, Springfield, Virginia 22151. Requests for individual copies or questions relating to the Tech Brief program may be directed to the Technology Utilization Office, NASA, Code KT, Washington, D.C. 20546.

Evaluation of Thermal Insulation Materials

A study of thermal insulation materials and their potential application in the Viking-1973 soft-lander mission to Mars has resulted in the accumulation of a significant body of data on a silicone-bonded fiberglass, an isocyanurate foam, and two dozen other types of insulators. The data provide useful guidelines for the design of thermal insulation systems for everyday applications.

The candidate thermal insulation materials used in the study are commercially available; they were selected on the premise that they should withstand heat sterilization, outer space, and the Martian atmosphere. The study was performed in five phases: (1) Selection of candidate materials; (2) Definition of specific tests to simulate the Mars mission environments; (3) Selection of two materials on the basis of results of screening tests; (4) Definition and design of applicable insulation systems; (5) Subjecting the selected materials and insulation systems to significant Mars mission environmental conditions.

The environmental parameters considered most significant were heat sterilization (135°C for 384 hours in dry nitrogen), vibration, landing shock, and exposure to the Martian surface environment; launch venting was also identified as a critical parameter. Rapid screening tests were used for determining resistance of candidate materials to heat sterilization; in a thermogravimetric apparatus, samples were heated at 5° per minute to 235°C (100°C above the heat sterilization temperature) in order to accelerate long-term changes which might occur during an actual 384-hour sterilization cycle. The thermal diffusivity test involved transient heating of the materials by a milliwatt heater in the center of a 15-cm cube of the sample; the power input was selected to provide a heater temperature rise of 10°C in 12 minutes. The thermal conductivity was derived from analysis of the temperature rise per unit heat input; the tests were performed in vacuum, at ambient atmospheric pressure, and in a simulated Martian atmosphere.

Interpretation of the results of the screening tests led to the selection of an isocyanurate foam and a silicone-bonded fiberglass for further study; accordingly, these materials were fabricated into insulation system modules (ISM) of the forms which prior study had indicated to be optimum for the nature of the insulating material. The foam material was bonded into a foam sandwich structure which took advantage of the load-carrying capability of the foam to provide a structure weight half as large as that required for the silicone-bonded fiberglass. Bonded fiberglass was selected over unbonded material because its inherent resiliency allowed a loose lay-up in an ISM design with a beaded and corrugation-stiffened structure.

Insulation system modules were exposed to the actual sterilization test (135°C, 384 hours) and to a thermal performance test (relative heat loss in vacuum and in a Martian atmosphere). Unfortunately, the foam ISM fragmented during a preliminary pumpdown of the test chamber even though foam samples had successfully withstood numerous pumpdown cycles in the screening tests. The remaining silicone-bonded fiberglass ISM successfully underwent the launch vibration test [16.1 g (rms)], the landing shock test [120-g pulse for 12.8 msec], and an exhaustive thermal conductivity test covering the predicted range of Martian atmospheric pressure, temperature, and gas compositions.

(continued overleaf)

Note:

The following documentation may be obtained from:

National Technical Information Service
Springfield, Virginia 22151
Single document price $6.00
(or microfiche $0.95)
Reference:

NASA CR-109612 (N70-25585), Martian Soft Lander Insulation Study.

Source: O. J. Wilbers, J. C. Conti,
J. V. McGee, and J. I. McPherson of
McDonnell Douglas Corporation
under contract to
NASA Pasadena Office
(NPO-11586)