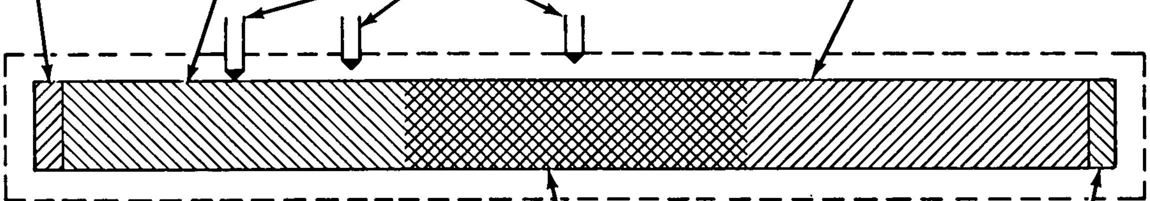
NASA TECH BRIEF

Method of Measuring Thermal Conductivity of High Performance Insulation



A method has been developed for accurately measuring the thermal conductivity of high-performance sheet insulation as a more discrete function of temperature than could be measured by previous methods. The new method permits measurements to be made at temperature drops of only approximately 10° F (compared to at least 200° F previously required) across the insulation and ensures measurement accuracy by minimizing longitudinal heat losses in the system.

This method of measurement employs a silicone resin–fiberglass tube approximately 3 feet long, with a 3-inch outside diameter and a 1/16-inch wall, as the support for the insulation. Heater wires of 6-mil copper are wound around the entire length of the support tube. The windings constitute 5 heaters. The "test heater," one foot long, is at the center portion of the tube. Two "longitudinal heaters" bracket the test heater to simulate the infinite cylinder effect. Two "end heaters," each 1 inch long, complete the unit. Separate variable power controls, one for each of the 5 heaters, ensure a uniform temperature over the entire length of the unit. Test specimens of the insulation are wrapped around the heater wires. Thermocouples are positioned to monitor temperatures at both the inner and outer surfaces of the insulation specimens.

To make a series of measurements, the conductivity apparatus with the insulation wrapping is mounted in a jacketed vacuum chamber. The chamber is evacuated and the fluid flow is started in the jacket on a heating or cooling cycle to attain the desired ambient temperature in the chamber. When this temperature is reached, electric power is turned on to the heaters under the insulation specimen until the 10° F differential temperature inside-to-outside the insulation is reached. The temperature gradients within the specimen are held to a minimum by manipulating the individual heater controls as the differential temperature is approached. The voltages across the individual heaters are monitored as the test proceeds. A data point is considered to have been attained when the longitudinal temperature gradients are less than 0.05° F/ft for a period of at least three hours. The time

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required to attain a significant data point averages from 18 to 24 hours. At this time (at thermal equilibrium), the thermocouple readings are converted to yield the outer and inner surface temperatures of the insulation (and the values of the longitudinal temperature gradients). The value of the heat flux is calculated from the measured current and voltage in the test heater. Since the internal and external radii and length of the insulation are known, the thermal conductivity is readily calculated by substituting the values of the experimental data into the standard log mean temperature formula. Slight temperature variations from the thermal equilibrium point and longitudinal gradients can be taken into account analytically.

Note:

Details concerning this method of measurement may be obtained from:

Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
Reference: B68-10013

Patent status:

No patent action is contemplated by NASA.

Source: E. H. Hyde
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