NASA TECH BRIEF

Thermal Calibration Target

The problem:

To provide a calibrated blackbody source for use in calibrating the response of a medium resolution infrared radiometer for use on a meteorological satellite.

The solution:

A blackbody surface, measuring 6 × 7 inches, is made up of 20° angle grooves, each about 3/8-inch wide. The surface is constructed from knife-edged copper bars so that a sharp edge and groove are possible. Two thermocouples are potted into holes drilled in the blackbody so that the temperature of the blackbody can be determined. One thermocouple is used as a temperature controller sensing element and the other to provide an independent temperature readout for checking the accuracy of the controller.

Cooling coils are mounted to a heat conductor which is attached to the blackbody target. When liquid nitrogen (LN_2) is pumped through the cooling coils a heat sink is created which acts in opposition to the heat that is supplied to the blackbody by means of a heating blanket. The cooling coils are arranged on the conductor so that the maximum heat flow from the blackbody to the heat sink is limited to approximately 300 watts. By limiting the heat flow to 300 watts a relatively rapid increase in target temperature can be achieved without requiring an excessively large amount of heating power. Also, it is not necessary to accurately control the LN_2 flow (except to keep flow in excess of 300 watts cooling capacity).

At a LN_2 flow rate of 1 liter per minute, the blackbody can be cooled from room temperature to near LN_2 temperature in approximately 3 hours. When full heating power is applied to the heating plate, the blackbody temperature can be raised from 90°K to 330°K in 1 hour.

How it's done:

The blackbody is first cooled to near LN_2 temperature with no heat being supplied to the heater blanket, by pumping LN_2 through the cooling coils. After the blackbody has been cooled temperatures above 90°K are obtained by setting the temperature control dial of the temperature controller located in the control console to the desired blackbody temperature.

The error signal generated by the voltage difference between the temperature dial setting and the thermocouple located on the blackbody is used to control the amount of heat supplied to the blackbody heating plate. When a stable blackbody temperature is reached, the null meter on the temperature controller will read zero. Under this condition the blackbody will be at the desired temperature and the heat flow into the blackbody (from the heater blanket and ambient environment) will be in balance with the heat flow out of the blackbody (to the cooling coil heat sink).

Notes:

1. This approach provides a means of accurately controlling the temperature of a thermal calibrating device over a wide temperature range without the need for controlling a LN_2 input to the device. It also utilizes the advantage of the availability of LN_2 to achieve the required thermal control. This approach could be extended to other applications requiring the accurate control of a thermal calibrating device over the subject temperature ranges, where LN_2 is readily available.
2. Documentation is available from:
   Clearinghouse for Federal Scientific and Technical Information
   Springfield, Virginia 22151
   Price $3.00
   Reference: TSP69-10419

(continued overleaf)

Patent status:

No patent action is contemplated by NASA.

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