DIFFERENTIAL METHOD OF MEASURING SPECIFIC HEAT OF METALS DURING THEIR RAPID HEATING

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The specific heat of metals subjected to rapid heating is usually determined by plotting the temperature of the investigated metal against time. This necessitates repeated measurement of the temperature T at different times (see [1], for instance). By differentiating T with respect to the time τ the specific heat

$$c = \frac{P}{(mdT)/d\tau} \tag{1}$$

can be calculated. Here m is the mass of the wire and P is the power.

Below we discuss a variant of the rapid-heating method in which the required derivative $dT/d\tau$ at a particular point and, hence, the specific heat at the corresponding temperature are determined in a single heating.

The setup for measurement of the specific heat of metals by the proposed method is shown in Fig. 1, where 1 is the specimen, 2 is a time relay, 3 is an amplifier (a), 4 is a Schmitt trigger (T), 5 is a timer, 6 is a dc potentiometer, and 7 is a fast key.

Closure of the circuit containing the storage battery E, the ballast resistor R_δ, and the investigated wire R_T initiates heating of the wire, thus reducing its resistance and increasing the voltage drop on it. When the voltage on the wire reaches a particular level U_1, equal to the voltage drop on the resistance R_1, the threshold circuit A_1, T_1 triggers the timer. When the voltage on the wire reaches the level U_2 (voltage drop on R_1+R_N) the second threshold circuit A_2, T_2 operates and the timer stops. Thus, the interval of time $\Delta\tau$ in which the voltage on the wire increases by $\Delta U = U_2 - U_1$ is measured directly. In the case of small values of ΔU the approximate value of the derivative is

$$dU / d\tau = \Delta U / \Delta\tau \tag{2}$$

The value of this derivative must be assigned to the mean voltage

$$U = {}^1/_2 (U_1 + U_2) \tag{3}$$

Substituting Eqs. (2) and (3) in Eq. (6) of [1], we obtain

$$c = \frac{\alpha R_0 U (E - U)^3 \Delta\tau}{mR^2 E \Delta U} \qquad \left(\alpha = \frac{1}{R_0}\frac{dR}{dT},\ R = R_\delta + R_i\right) \tag{4}$$

Here R_0 is the resistance of the investigated specimen at 0° C, m is the mass of the wire, E is the emf of the storage battery, R is the sum of the ballast and internal resistances of the storage battery, and α is the temperature coefficient of the resistance of the investigated metal.

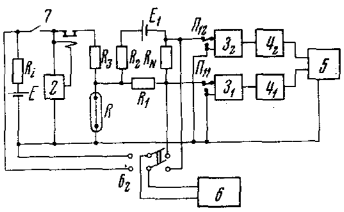

Fig. 1

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To test this method we measured the specific heat of platinum at temperatures of 450-1300° K. The platinum wire was 0.05 mm in diameter and 200 mm long. The two identical threshold circuits, consisting of broadband amplifiers A_1, A_2 and Schmitt triggers T_1, T_2, and the timer were similar to those described in [1]. The voltage E of the storage battery was 110 V, and the resistance R was 24-50 ohm. The rate of heating of the wire was 30-100 thousand deg/sec. The value of ΔU varied from 0.7 to 1.5 V, and $\Delta\tau$ at different temperatures varied from 200 to 1500 μsec. For this range of ΔU the derivative $dU/d\tau$, calculated from formula (2), was practically independent of ΔU.

The obtained results of measurement of the specific heat of platinum agreed within the limits of experimental error with the data published in [1]. A provisional estimate of the error of measurement of specific heat by the proposed method is about 2%.

LITERATURE CITED

1. O. A. Kraev and R. A. Fomin, "Method of measuring the specific heat of metals during their rapid heating," PMTF [Journal of Applied Mechanics and Technical Physics], no. 4, 1967.