University of Al-Mustaqbal
College of Science
Department of Medical Physics

Thermodynamics Laboratory

Stage 2

Joule equivalent

Lecture 3

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The purpose of the experiment:-

Determination the thermomechanical equivalent value (Joule equivalent) using the electrical method

Used equipment's :-

Calorimeter, suitable resistance, heat insulation sleeve, DC source, rheostat, thermometer, weigher, voltmeter, ammeter, and stopwatch.

Theory :-

When the voltage difference (V) is applied to both ends of a resistance

(R), an electric current (I) passes through the resistance. If this is for a period of time (t), then the electrical work done on the wire is given by the following relation .

$$W = I^2 . R\, t = I\, V\, t \ldots\ldots (1)$$

Because of this work, the temperature of the wire will rise, which will lead to heat transfer from it to the water and the calorimeter. When finding the ratio between the electrical work and the amount of heat that entered the water and the calorimeter, it is found to be equal to a constant called the Joule constant.

$$J = W / Q \ldots\ldots.(2)$$

If we put the resistance (R) in a calorimeter containing water and pass a current through this resistance, then by applying the law of conservation of energy, the amount of heat lost by the resistance is equal to the amount of heat gained by the water and the calorimeter

If we symbolize the amount of heat gained by water (Qw), then:-

$Q_w = M_w .C_w .\Delta T$ ..... (3)

where (M_w) is the mass of water, (Cw) is the specific heat of water, (ΔT) is the change in temperature of water.

The amount of heat gained by the calorimeter (Qc) is:-

lc = M_c C_c ΔT..... (4)

Where (Mc) is the mass of the calorimeter, and (Cc) is the specific heat of the calorimeter.

From equations (3) and (4) we find that the acquired energy is given by the relation:-

Q = (T2 - T1) (Mc Cc + Mw Cw)..... (5)

Since (Ty and T2) are the initial and final temperatures, respectively, of water and calorimeter, and by substituting equation (1) and (5) in (2), we find that:-

J = I V t / (T2 - T1) (Mc Cc + Mw Cw)……. (J / Call)

I electric current

V voltage difference

T Time

M_C Mass of calorimeter

Mw Mass of water

C_C specific heat of the calorimeter.

Cw is the specific heat of water

Ex : If a current of 0.7 amperes passes for 2 seconds in a calorimeter containing water and generates a voltage difference of 1 volt, as the temperature rose from 20 Celsian to 80 Celsius, calculate a joule equivalent. If you know that the heat capacity of the calorimeter is 0.897, the heat capacity of water is 1, the mass of the calorimeter is 50 grams and the mass of water is 20 grams?

$$J = I V t / (T2 - T1) (Mc Cc + Mw Cw)$$

$$= \frac{0.7 \times 1 \times 2}{(80 - 20)(0.05 \times 0.897 + 0.02 \times 1)}$$

$$= 0.36 \text{ J / cal}$$