(HT1-7) Thermal Linear Expansion of Solids

Aim of experiment

Determination of the coefficient of linear expansion of metal rods.

Apparatus

Steam Chamber- Boiler- Heater, Thermometer- Rubber Tubing- Beaker, Metal rods- Dial Gauge.

Theory of experiment

The dimensions of most metals increase with an increase in temperature. Consider a rod of length L_o at temperature T_o, and whose length L at higher temperature T.

Figure 1. Thermal conductivity apparatus

The difference in length $\Delta L = L - L_o$ is the amount of rod that expanded due to heating, where it was found that the change in length ΔL of a metal rod is proportional to its original length L_o and also is proportional to the change in temperature ΔT of the material.

$$\Delta L \alpha L_o \qquad (1)$$

$$\Delta L \alpha \Delta T \qquad (2)$$

From 1 and 2, one get

$$\Delta L \alpha L_o \Delta T$$

$$\Delta L = \alpha L_o \Delta T \qquad (3)$$

Where, α is a constant of proportionality, and is called coefficient of thermal linear expansion which is defined as the fractional change in length per degree rise in temperature. The formula for the coefficient of thermal linear expansion α may be written

$$\alpha = \frac{\Delta L}{L_o \Delta T}$$

The coefficient of linear expansion is related to that of volume expansion coefficient of isotropic material by the relation

$$\gamma = 3\alpha$$

Procedures

1. Measure the length of a metal rod before insertion into the apparatus, L_o.
2. Mount the metal rod inside steam jacket.
3. Insert the thermometer into the steam jacket, making sure that the thermometer does not touch the rod.
4. After waiting a few minutes for the temperature to stabilize, record the temperature of the water in the jacket (which is also the temperature of the rod) as T_o in a Table.
5. Adjust the dial gauge at its zero reading.
6. Allow steam to flow through the jacket and when the temperature reach 45^oC record the dial gauge reading (ΔL)
7. Repeat this measurement at 75^oC and 95^oC respectively.
8. Calculate α for each temperature.
9. Calculate the average value of α .

Results

L_o=	cm	T_o =	^oC

$T\,^oC$	$\Delta T = (T - T_o)\,^oC$	ΔL cm	α $(^oC^{-1})$
45			
75			
95			
		α_{av} =	$^oC^{-1}$

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