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

Thermodynamics Laboratory

Stage 2

Measurement of longitudinal expansion of solids as a function of temperature

Lecture 4

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The purpose of the experiment:-

Finding the longitudinal expansion coefficient of metals

Used equipment's :-

Longitudinal expansion system, thermometer, heater, baker, metal tubes of different length and material, expansion gauge.

Theory :-

The change in the temperature of the material leads to changes in the other properties of the material, and the most prominent of these changes is the change in the dimensions of the material or the change in its state. Raising the temperature of a substance leads to an increase in the vibrational energy of its atoms or molecules, and when the amplitude of vibration of those particles increases, this means an increase in the rate or average distance between atoms or molecules, meaning that all dimensions of the material will change, increasing with the increase in its temperature and shrinking with the decrease in its temperature.

The phenomenon of changing the dimensions of matter due to a change in its temperature is called thermal expansion.

It is well known that most objects expand when their temperature increases, and the amount of material expansion by heating depends on the amount of cohesive forces between its particles. For a solid, the amount of its expansion by heating is very small due to the large cohesion forces between its particles, while the expansion of liquids is greater than the expansion of solid bodies by heating. As for gases, their expansion by heating is much greater than that of liquids, because the cohesive forces between gas molecules are almost non-existent.

This phenomenon plays a major role in many engineering applications, for example, spaces are left between iron connections in buildings, bridges, railways and highways to give room for expansion and contraction. If this is not done, the building can crack, bridges collapse, and railways can be bent by thermal expansion of the materials it is made of. **The thermal expansion of objects is the result of a change in the distances between molecules and atoms of matter.**

longitudinal expansion:

The expansion occurs on all dimensions of the body, such as length, width, and thickness, and the percentage of increase is according to the geometric dimensions of the material, and the amount of increase is directly proportional to the original length, so the increase is in length more than in width or thickness.

Experiments have shown that the change in length is directly proportional to the change in temperature and the original length, so the equation for the change in length can be written as follows:

$$\Delta L = \propto L \Delta T$$

OR

$$\Delta S = \propto * S_{\circ} * \Delta\theta$$

We can define the coefficient of longitudinal expansion as the amount of change in length for every degree Celsius change in temperature.

Factors on which longitudinal expansion depends:

1. original length of the body.
2. The amount of increase in body temperature.
3. Body material type.

Work steps :-

1.Recording the original length of the metal whose longitudinal expansion coefficient is to be measured (So or Lo)

2.Heating a certain amount of water until we get steam, then passing the steam inside the metal tube until its temperature rises to (To or 0o =70 °C), then we stop. Then record the increase in

length(S, or Li)

3.Record the increase in length (Sz or Lz) with the decrease in temperature for every 10 degrees

4. Arrange the readings as in the table below. A relationship is drawn graphically between the change in length (AS mm) on the y-axis as a function of the change in temperature (40 °C) on the x-axis