THERMAL EXPANSION

Experiment Report

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Objectives

This experiment was carried out among 2 members of the group. The objective is to measure the coefficients of linear expansion for a few selected metals.

Theory

Thermal expansion is the tendency of matter to change in shape, area, and volume in response to a change in temperature. Temperature is a monotonic function of the average molecular kinetic energy of a substance. When a substance is heated, the kinetic energy of its molecules increases.

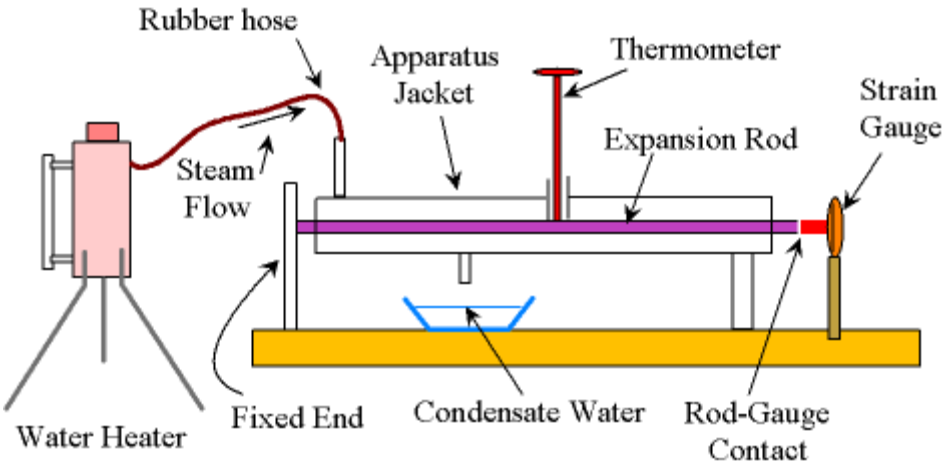
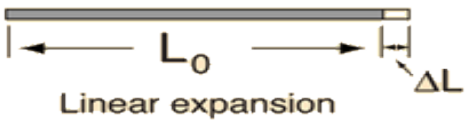


Fig. 1: Linear Expansion Apparatus

The Coefficient of thermal expansion describes how the size of an object changes with a temperature change. Specifically, it measures the fractional change in size per degree change on the temperature at a constant pressure.

$$\Delta L = \alpha L_0 \Delta T$$
$$L - L_0 = \alpha L_0 \Delta T$$
$$L = L_0 [1 + \alpha \Delta T]$$

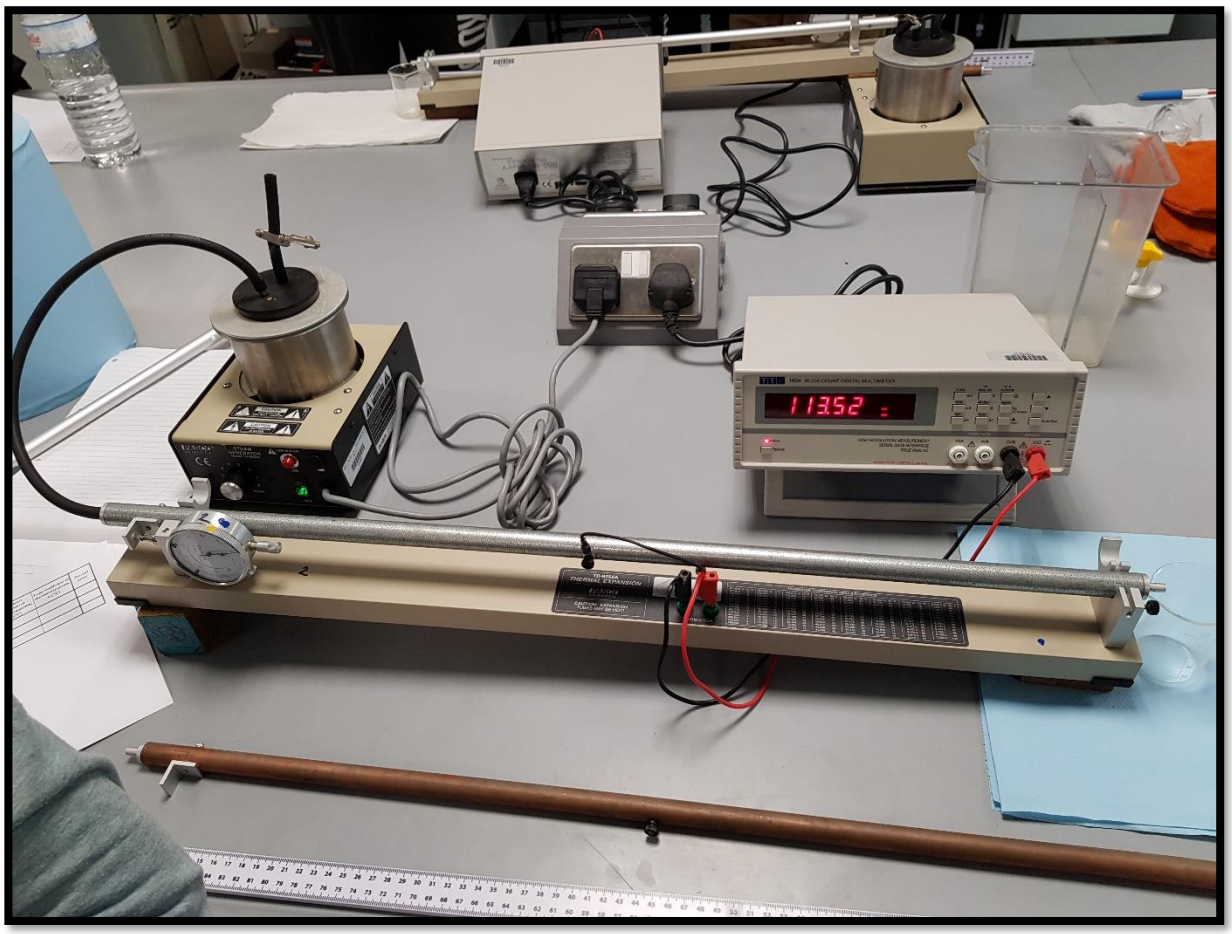


Linear expansion

$$\frac{\Delta L}{L_0} = \alpha \Delta T$$

Apparatus

In this experiment, the materials that are required for this experiment are listed below



- Aluminium, Copper, Steel Rods
- Metre ruler
- Digital Ohmmeter
- Tissue papers
- Jar
- Water bucket
- Thermometer
- Rubber tube
- Gauge
- Thermal expansion apparatus
- Steam generator

Procedure

At the beginning of this procedure, we are going to take a metal rod and we are going to measure the initial length of the rod from the clip to clip with a long ruler. The clips of the rod are placed into the thermal expansion apparatus until it fits then the screw can rotate counterclockwise to secure the rod in place.

The rubber tubing connects the rod to the steam generator. The liquid comes out from the other side of the rod, so the jar is placed under the end of the bar to collect the water and pour water into a bucket. The tissue is placed under the jar to avoid splitting water on the table.

The wire from the thermistor connect it to the metal rod and the ohms meter is connected to the thermistor with two wires. Taking the initial resistance reading from ohms metre and using the table on the thermistor or apparatus to convert the reading to a temperature. Then pour water into the steam generator and turn on the generator.

When the progress can be noticed during time passes around 10 minutes or so then turn off the steam generator and take the final resistance reading again to convert to the temperature.

Look at the final gauge reading shown in centimetres which must convert into millimetres and add that to the initial length of the metal rod. Which is going to be the final length of the rod.

Calculated coefficient of thermal expansion, Exact coefficient of thermal expansion and Percent error of three metals.

Result

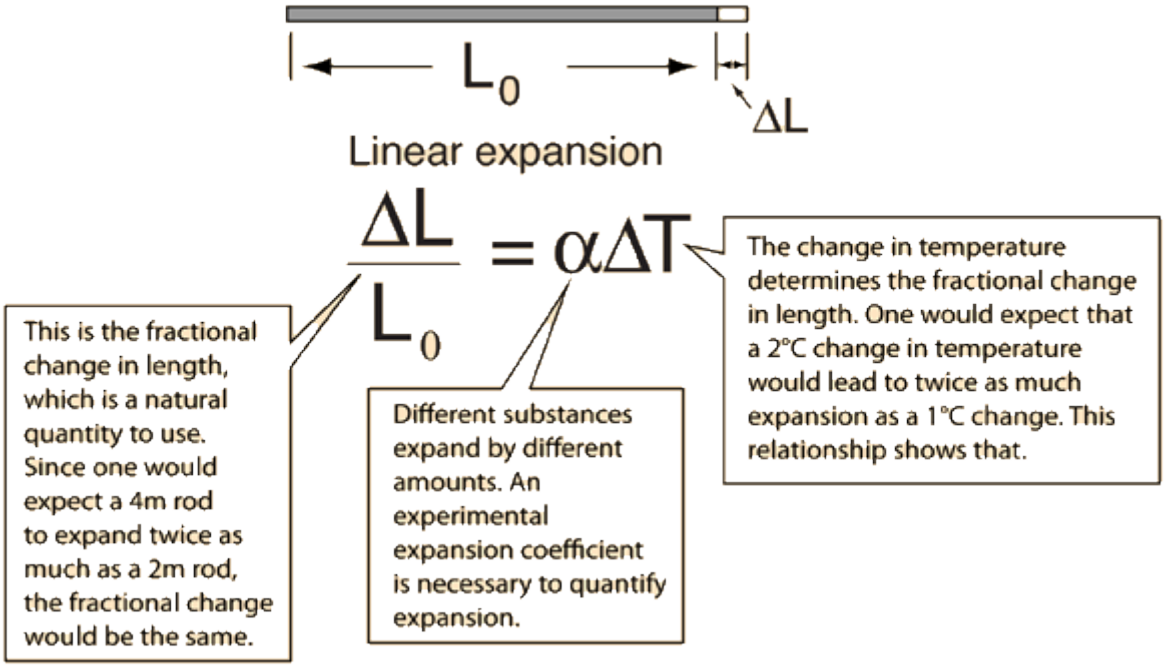
Material	Original length (m)	New length (m)	Expansion (m)	Resistance (starting) (Ω)	Temperature (starting) (°C)	Resistance (final) (Ω)	Temperature (final) (°C)	Calculated coefficient of thermal expansion, α (/°C)	Exact coefficient of thermal expansion, α (/°C)	Percent error
Aluminium	0.7	0.72	0.02	114.20	22.5	14.014	72.8	$.28 \times 10^{-6}$	24×10^{-6}	0.16
Copper	0.7	0.89	0.19	114.20	22.5	9.601	83.3	4.46×10^{-6}	17×10^{-6}	-0.7
Steel	0.7	0.80	0.1	114.20	22.5	12.850	76.6	2.64×10^{-6}	13×10^{-6}	-0.79

Discussion of result

The discussion that was taken place between the team members during the experiment. The main thing that was noticed was the gauge was not accurate much, which increase the Percent error however, the vibration of atoms causes metal expansion.

Conclusion

The objectives of the experiment were achieved because we were able to determine the coefficient of linear expansion of a metal tube by measuring the initial length using a meter stick, its initial and final temperature of the metal tube by interpolation, resistance using a digital multi-tester and the final length using a dial gauge. We were also able to achieve the second objective of this experiment by determining the factors that affect the change in length in thermal expansion. The factors are: change in temperature, the original length, and the coefficient of thermal expansion.



References

There are some of the websites that were used for practical uses and some theory parts of the experiment.

1. Thermal expansion of solids (Mark Davison, 1997)
   http://media.uws.ac.uk/~davison/labpage/expans/expans.html

2. Coefficient of Linear Expansion (pstcc. education)
   http://www.pstcc.edu/departments/natural_behavioral_sciences/Web%20Physics/Experiment%2008-1320.htm

3. Thermal expansion calculation (phy-astr. Gsu. Education)
   http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/thexp.html