Coefficient of linear expansion time

Science, Physics

Cofficient Of Linear Expansionaim

1. To determine by practical means within a laboratory environment, a value for the coefficient of linear expansion of a given material and compare the result with an accepted published value.
2. The following apparatus were used to conduct the experiment. a. PASCO steam generatorb. Flexi tube attached to a steam generator. c. Multimeter with thermocouple attached. d. Aluminium expansion tube. e. Thermal expansion equipment with digital testing indicator attached. f. Dip tray. g. 1-meter rule (millimetre intervals)h. Digital thermometer.
3. A picture of the apparatus, when assembled, can be seen at Annex A to this report.

Theory

1. When heat is applied or removed form most of the substances particles within the substances will move to add more spaces or contract, resulting expansion or contraction of the substance. The effects of expansion and contraction each depend on the change of temperature and type of substance used.
2. In solid, a length of material will expand or contract proportionally to the change in temperature that it undergoes, ie. : a. L is change in material length. b. Lo is the initial length of a material. c. t is change in temperature
3. The constant of proportionality is called the coefficient of linear expansion of the material which is represented by α (Greek alpha). a. is coefficient of linear expansion. b. is temperature hot. c. is temperature cold.

4. The coefficient of Aluminium is widely published as 23 x 10-6 per o C.

Procedure

1. The following procedure were conducted to determine the coefficient of linear expansion of a given material aluminium.
2. The apparatus was assembled as shown at Annex A at room temperature of 24 oC ensuring the bracket is placed to push onto the spring arm of the digital testing indicator.
3. The initial measurement of aluminium extension rod was taken using the 1-meter rule which was 701 mm. It was measured form the inner edge of bracket near the gauge to the middle of the mounting bracket which is the fixed point.
4. The built in digital testing indicator was set to zero before pouring hot water to the steam generator.
5. The steam generator was filled with hot water and the lid with flexi tube attached was placed on top. The steam generator was turned on to let the vapour pass through to the aluminium rod.
6. As the steam enters the tube watch the digital testing indicator and multimeter to record the change.
7. Once the vapour at the other end was constant, the measurement of temperature rise was taken via thermocouple attached to a multimeter. Heat energy through conduction did raised the temperature of the aluminium rod.
8. With the thermocouple fixed on the outer surface of the aluminium tube, temperature was recorded which was 96 oC. The inside

temperature of the aluminium was 100 oC because vapour was passing through the tube. The average temperature hot was 98 oC.

9. The change in length was recorded to be 1. 2 mm as seen on the digital testing indicator.
10. The same procedure was repeated again after cooling the rod back to room temperature at 24 oC.

Conclusion

1. The material which is heated or cooled will expand or contract. From the graph, we can see the relationship between temperature rise and expansion of tube is directly proportional. The gradient of that line is a constant value connecting the variables value of extension and temperature of the aluminium rod.
2. The percentage error when taking the average temperature of 98 oC (100 oC inside tube and 96 oC recorded by multimeter) is 0. 56%. However, when the temperature reading taken at 96 oC percentage error was 3. 35 %. That means if we can take the accurate temperature considering all the factor the result could have changed potentially more accurate.
3. The only way to record the temperature and extension was at its highest temperature. So if we could have stop the rise in temperature in stages we could achieve more recorded data to find more accurate result.
4. The thermometer could have been calibrated to ensure accurate temperature reading. Two thermocouple could haven used to compare and get accurate reading.

5. The aluminium length of 701mm could have affected the final reading, so rather than using a 1m rule, we could use other measuring device which would have given more accurate length resulting the experiment more accurate.
6. The digital testing indicator could have been digital to negate human error.
7. The clamps and expansion device could have been affected during the heat transfer.
8. This experiment has determined the coefficient of linear expansion to be 23. 13 x 10-6 /oC. The percentage error was 0. 56 % when comparing with widely published value of 23 x 10-6 /oC. Therefore, this experiment is considered to be successful in its aim.