Embry-Riddle
Aeronautical University

Thermal Expansion

Cameron Stark, Zachary Chaung, Cristian Abades, Barbara De Feigueiredo

PS-253 Section 12

Introduction

Every material has the property to expand or contract dependding on the tempertaure it's exposed to. This varies from even basic materials (elements), to all alloys.

This is important becuase it represents a change in a system that could be good, like a Thermal Expansion valve in an air conditioning unit allows the system to cool regularly, or it could be bad in the case of optics where the curvature of the lens which could effect the use of the optic.

This is experiment is specifically concerned with the expansion quealities of the three rods of the unknown materials due to the influence of heat, and from there supposed to identify the material based off of the measured Coefficient of Thermal Expansion

Theory & Methods

We can determine this property of how an object or material changes size due to heat, called Coefficient of Thermal Expansion, by measuring the fractional change in size per change in temperature.

The experiment will investigate and analyze the expansion of the rods using a simple linear model. [4]

The tools to be used are a Machinist's Dialindicator, capstone modules to measure temperature, a burner to heat the liquid and an aparatus to make sure only the hot steam make it into the metal rod apparatus

The pasco capstone will electronically measure the tempertaure, from initial Ti to final Tf

Experiment Setup

- Safety Precautions to prevent burns from the burner and metal housing
- Record initial length of the rod
- Insert desired rod for the run into the appartus [figure 1] and record intital temperature
- Turn on boiler and wait for temperature to peak and hold for 15 seconds
- Record the final length of the rod

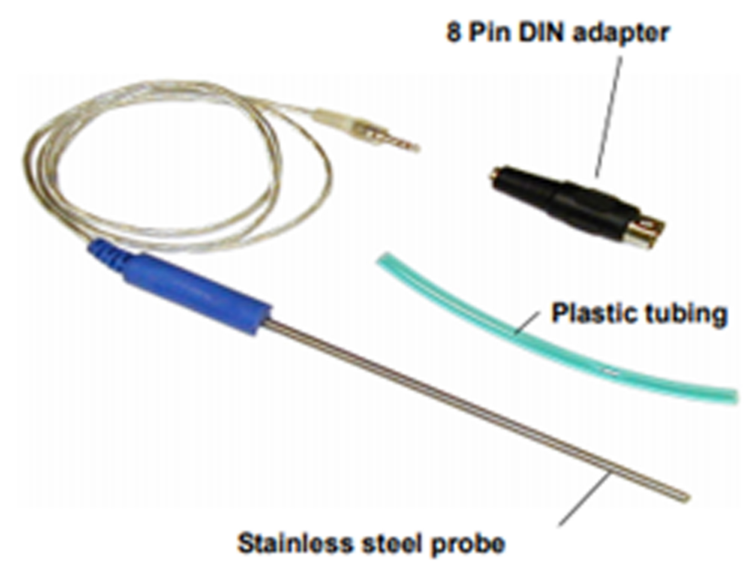

Figure 1. Pasco Temperature Probe CI-6605A

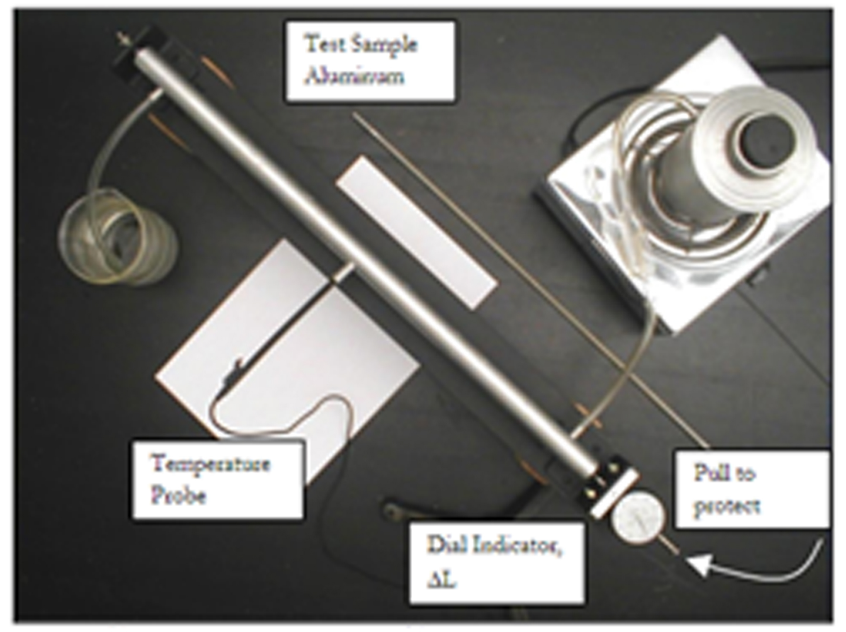

Figure 2. Thermal Expansion Apparatus. Lab Manual Embry-Riddle Aeronautical Engineering [4]

Results

The results show that the expansion coefficients of the silver colored metal, reddish brownish metal and the golden colored metal, were 3.13x10^-4 m/m*k, 3.004x10^-4 and 3.196x10^-4.

These coefficients are very far off from the ones provided in the List of Thermal Expansion Coefficients (CTE) for Natural and Engineered Materials.

The reference expansion coefficients for the materials were zinc = 29.7x10^-6, copper = 16.6x10^-6, brass = 18.7x10^-6 (MSE Supplies, n.d).

The percent difference between the two values were found to be zinc being 954%, copper at 1710%, and for brass 1610%. From these it can be concluded that the experiment was not successful

$$\propto_{Silver} = 3.13\ x\ 10^{-4}\ \frac{m}{m*K}$$

$$\propto_{Copper} = 3.004\ x\ 10^{-4}\ \frac{m}{m*K}$$

$$\propto_{Brass} = 3.196\ x\ 10^{-4}\ \frac{m}{m*K}$$

$$\%\ Uncertainty\ in\ L_{Silver} = 0.838\%$$

$$\%\ Uncertainty\ in\ L_{Copper} = 0.838\%$$

$$\%\ Uncertainty\ in\ L_{Brass} = 0.838\%$$

$$\%\ Uncertainty\ in\ \Delta L_{Silver} = 36.1\%$$

$$\%\ Uncertainty\ in\ \Delta L_{Copper} = 36.4\%$$

$$\%\ Uncertainty\ in\ \Delta L_{Brass} = 36.0\%$$

References

1. Schumacher, Donald, Prof. "Thermal Expansion" Physics Lab Packet. ERAU, Daytona Beach, FL. 30 September 2016. Reading.

2. MSE Supplies. (n.d.) List of Thermal ExpansionCoefficients (CTE) for Natural and Engineered Materials.Retrieved from web

3 Slotnik, B. (2017, January 11). Advatages of a Thermal Exapnsion Valve in Enclosure Cooling. Retrieved from web

4. Elert, G. (n.d.). Thermal Expansion. The Physics Hypertextbook. Retrieved from web

5. Pasco Stainless Steel Temperature Sensor CI-6605A Instruction Sheet Retrieved from web

6. Lab Manual PS253 - Physics Laboratory For Engineers - Thermal Expansion. Embry-Riddle Aeronautical University