Charlie Nitschelm

ME 646

Section 1 - Part 1: Solving the Thermistor Equation

Using the original thermistor equation:

$$R = R_0 e^{\beta(\frac{1}{T}-\frac{1}{T_0})}$$

And the table of values

T_1(K)	T_2(K)	$R_1(\Omega)$	$R_2(\Omega)$	T_0(K)	$\beta(K)$	$R_0(\Omega)$
273	373	27200	1020	298	3343	9736

Using the initial conditions above including T_1 and R_1, solve for R_0 by rearranging the thermistor equation to

$$R_0 = \frac{R_1}{e^{\beta(\frac{1}{T_1}-\frac{1}{T_0})}}$$

Once we have a solution for R_0, we can then use the second data set at boiling to make a second thermistor equation. R_0 can be substituted into this equation to produce

$$R_2 = \frac{R_1 e^{\beta(\frac{1}{T_2}-\frac{1}{T_0})}}{e^{\beta(\frac{1}{T_1}-\frac{1}{T_0})}}$$

Then to simplify by separating the exponential and dividing like terms:

$$\frac{R_2}{R_1} = \frac{e^{\beta(\frac{1}{T_2})}}{e^{\beta(\frac{1}{T_1})}}$$

$$\ln(\frac{R_2}{R_1}) = \ln e^{\beta(\frac{1}{T_2})} - \ln e^{\beta(\frac{1}{T_1})}$$

$$\ln(\frac{R_2}{R_1}) = \beta(\frac{1}{T_2} - \frac{1}{T_1})$$

Moreover, find an equation for β,

$$\beta = \frac{\ln(\frac{R_2}{R_1})}{(\frac{1}{T_2} - \frac{1}{T_1})}$$

And with β, an equation for R_0 can be solved as

$$R_0 = \frac{R_1}{e^{\beta(\frac{1}{T}-\frac{1}{T_0})}}$$

Section 1 - Part 2: Ice Bath Statistics

The temperature of the ice bath during the test was approximately 273.15K. Below is a table that details the voltage measurements obtained in the ice bath 10 separate times.

Recorded Ice Bath Data in mV:

34.7	38.3	36.2	31.4	36.6	37.2	33.7	31.8	33.9	35.5

The actual temperatures measured by the thermocouple during the test can be approximated by a linear approximation, meaning a line of best fit can take a linear form. This form, calibrated from data from multiple water temperature baths, can be applied to convert the voltage measurements to temperature measurements.

The calculated temperatures of the ice bath, in Celsius, are detailed below.

0.050°C	0.411°C	0.201°C	-0.308°C	0.214°C	0.274°C	-0.077°C	-0.268°C	-0.057°C	0.104°C

With a resolution of only $\pm$.1°C the maximum decimal places that could be accurately measured are two after the decimal.

The mean of the sample, $\bar{x}$, can be calculated by the equation:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$

Where n is the number of samples taken, which from above is equal to 10.

$$\bar{x} = 0.0463$$

The standard deviation of the data, σ, is calculated with the equation:

$$\sigma = \sqrt{\frac{\sum_{i=1}^{n}[x_i - \bar{x}]^2}{n-1}}$$

$$\sigma = 0.0191$$

$t_{v,P}$, which can be found within a table, is picked depending on the number of samples taken and the confidence level desired. This value can then be used to calculate the population mean interval where 95% of the population would lie. With N=10 and a desired 95% confidence, we find:

$$t_{v,P} = t_{8,95} = 2.306$$

The standard deviation of the mean can then be calculated using the equation below.

$$s_x = \frac{\sigma}{\sqrt{N}} = 0.0019$$

This quantity is then used for a final calculation that determines the bounds in which the population would lie between with 95% confidence.

$$x' = \bar{x} \pm t_{v,P} s_x = 0.0419\text{°C}, 0.0507\text{°C}$$

Section 2 – Part 5

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BIB = Bare Ice Boil
BBI = Bare Boil Ice
AIB = Aluminum Ice Boil
ABI = Aluminum Boil Ice
SIB = Steel Ice Boil
SBI = Steel Boil Ice
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Type of Constant and Bounds	BIB	BBI	AIB	ABI	SIB	SBI
Tau Constant – Gamma = 0:1 (s)	0.171	0.128	5.187	7.022	2.782	7.763
Tau Constant – Gamma = 0.2:0.7 (s)	0.129	0.125	5.956	6.597	3.142	6.126
S_{yx} **Constant – Gamma = 0:1 (K)**	1.678	2.178	2.356	1.151	1.239	3.609
S_{yx} **Constant – Gamma = 0.2:0.7 (K)**	0.561	2.177	1.371	1.367	0.744	2.503