MOHAWK-MCMASTER UNIVERSITY
FACULTY OF ENGINEERING

Lab #: 6
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COURSE NAME:
PROTECH 2IC3: Instrumentation and Control

TITLE: Hydrostatic Level Measurement

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LAB REPORT DEFINITIONS			**COMMENTS**
INTRODUCTION, EQUIP AND OBJECTIVE	1		
PROCEDURE	1		
GRAPHS AND DIAGRAMS	2		
TABLES AND RESULTS	3		
CALCULATIONS	1		
CONCLUSION	2		
Mark (out of 10)	10		

Table of Contents

Introduction:

A Thermocouple is a device made of two different metals, when heat is applied a small voltage is produced. The magnitude of the voltage is dependent on the temperature difference between the two metals. During this lab we calculated calibration points and millivoltages for a Type K thermocouple. We then calibrated the thermocouple and compare them to known standard and calculated the %Error.

Equipment:

- Thermocouple mV/I transmitter E&H TMT122
- Hart communication device
- Ametek Calibration Instruments, AMC910
- Thermocouple leads (compatible with the transmitter)
- Supply of connecting wires.

Procedure:

1- Connect the Thermocouple Temperature transmitter as shown in Figure 1A
2- Prepare a calibration line (100°C -1100°C) from 0% to 100%. Record in Table 2
3- Start Endress & Hauser device care and configure the temperature transmitter from 100- 1100°C and type K sensor input
4- Using the recorded mV values one at a time and record the output
5- Get two unknown temperatures from instructor and calculate the error and confirm the values using table 1
6- Disassemble and clean work area

Graphs and Diagrams:

Temperature (°C) vs Output (mA)

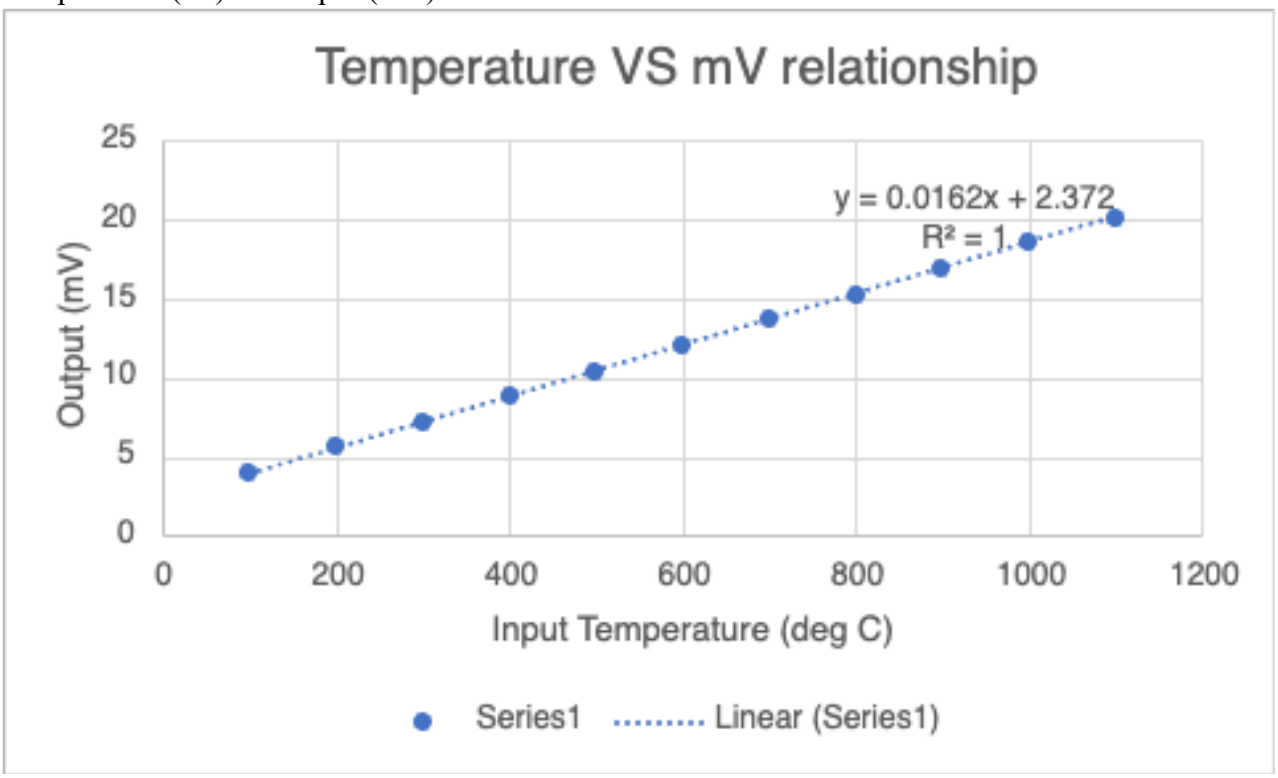
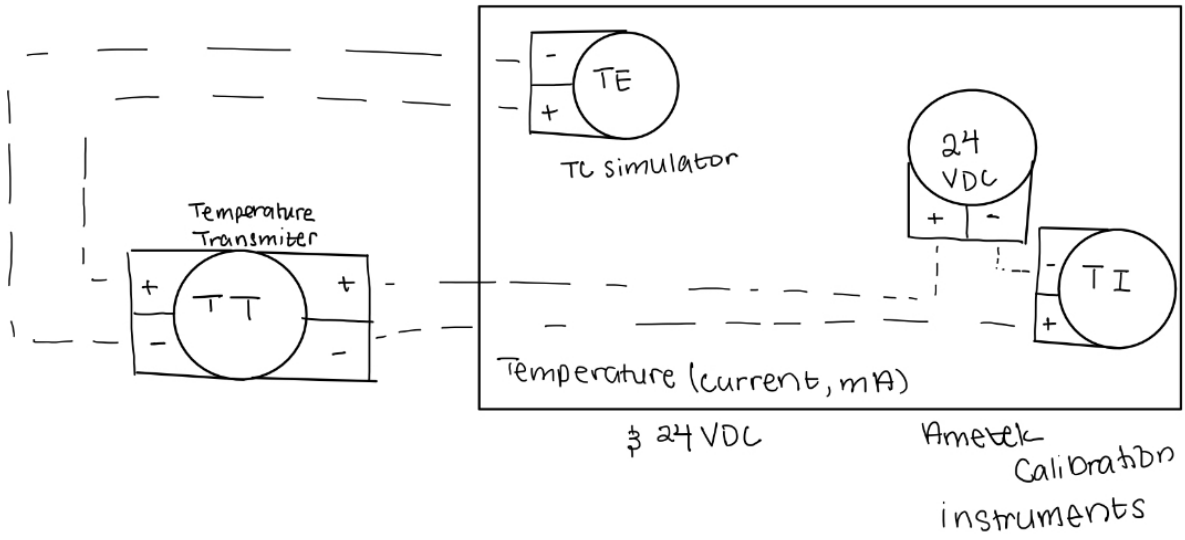


Figure 1B:



Tables and Results:

Table 1: Thermocouple calibration Line ("Hill") Data

Thermocouple Type: K type

Table 1: Thermocouple calibration Line ("Hill") Data
100% 1100°C – 44.618 mV
90% 1000°C – 40.786 mV
80% 900°C – 36.767 mV
70% 800°C – 32.642 mV
60% 700°C – 28.459 mV
50% 600°C – 24.239 mV
40% 500°C – 19.936 mV
30% 400°C – 15.645 mV
20% 300°C – 11.412 mV
10% 200°C – 7.299 mV
0% 100°C – 3.217 mV
Ref. 22°C – 0.879 mV

Table 2: Thermocouple Calibration

Transmitter Make: Hart Communication Device

Table 2: Thermocouple Calibration			
% Of Range	INPUT	OUTPUT	
	Corrected mV	Actual mA	Ideal mA
0% (100°C)	3.217	3.99	4.00
10%	7.299	5.61	5.60
20%	11.412	7.22	7.20
30%	15.645	8.84	8.80
40%	19.936	10.45	10.40
50%	24.239	12.07	12.00
60%	28.459	13.67	13.60
70%	32.642	15.29	15.20
80%	36.767	16.92	16.80
90%	40.786	18.55	18.40
100% (1100°C)	44.618	20.15	20.00

$$\%Errors = \frac{Deviation\ [°C]}{Span\ [°C]} x100$$

$$Deviation[°C] = maximum\ Deviation\ [°C]$$

$$\%Errors = 0.9375\%$$

Table 3: Unknown Test Reading

Table 3 – "Unknown"	Temperature #1	Temperature #2
Output Meter Reading (mA)	7.9751	15.9730
Calculated Temperature	348.4	848.3
True Temperature (given by transmitter)	350°C	850°C
Error (% of Reading)	0.46%	0.20%
Error (% of Span)	0.16%	0.17%

Sample Calculations:

$$\%Errors = \frac{Deviation\ [°C]}{Span\ [°C]} x100$$
$$\%Errors = \frac{20.15 - 20.00}{20 - 4} x100$$
$$\%Errors = 0.9375\%$$

$$Output\ Reading\ (in\ \%\ of\ Span) = (Meter\ reading - 4\ mA) \div 16\ mA\ x100$$
$$Output\ Reading\ (in\ \%\ of\ Span) = (7.9751\ mA - 4\ mA) \div 16\ mA\ x100$$
$$Output\ Reading\ (in\ \%\ of\ Span) = 24.84$$

$$Calculated\ Temperature = \%\ of\ Span\ x\ (Temperature\ Span) + LRV\ of\ Temp\ Range$$
$$Calculated\ Temperature = 0.2484\ x\ (1000) + 100$$
$$Calculated\ Temperature = 348.4$$

Deviation (Error) = Measured Value - True Value
Deviation (Error) = 348.4 – 350
Deviation (Error) = 1.6

$$Error\ (in\ \%\ of\ Reading) = Deviation \div True\ Tempereature\ x\ 100$$
$$Error\ (in\ \%\ of\ Reading) = 1.6 \div 350\ x\ 100$$
$$Error\ (in\ \%\ of\ Reading) = 0.46\%$$

$$Error\ (in\ \%\ of\ Span\ ) = Deviation\ \div Temperature\ Span\ x\ 100$$
$$Error\ (in\ \%\ of\ Span\ ) = 1.6\ \div 1000\ x\ 100$$
$$Error\ (in\ \%\ of\ Span\ ) = 0.16\%$$

Conclusion:

After completing this lab, we noticed our numbers are very close to the expected value. Our %Error is only 0.9375% which can be because we can not calculate mV more accurately, for example our TC temperature reading for our reference point was 21.71 °C but the closest value we were able to calculate was for 22°C.