The Resistance Temperature Detector (RTD) Characteristics

Objectives:

1. To know what is an RTD.
2. To know how to convert the RTD resistance reading to temperature.
3. To understand the characteristics of the RTD.

Introduction:

RTDs or Resistance Temperature Detectors, are electrical resistors that change resistance as temperature changes, with all common types of RTD, the resistance increases as temperature increases, this is referred to as Positive Temperature coefficient PTC.

RTD's are manufactured using several different materials as the sensing element. The most common by far is the Platinum RTD. Platinum is used for several different reasons including high temperature rating, very stable, and very repeatable. Other materials used to make RTD's are nickel, copper, and nickel-iron. These materials are becoming less common now, because the cost of platinum RTD's is coming down.

RTDs are constructed using one of two different manufacturing configurations. Wire-wound RTDs are created by winding a thin wire into a coil. A more common configuration is the thin-film element, which consists of a very thin layer of metal laid out on a plastic or ceramic substrate. Thin-film elements are cheaper and more widely available because they can achieve higher nominal resistances with less platinum. To protect the RTD, a metal sheath encloses the RTD element and the lead wires connected to it.

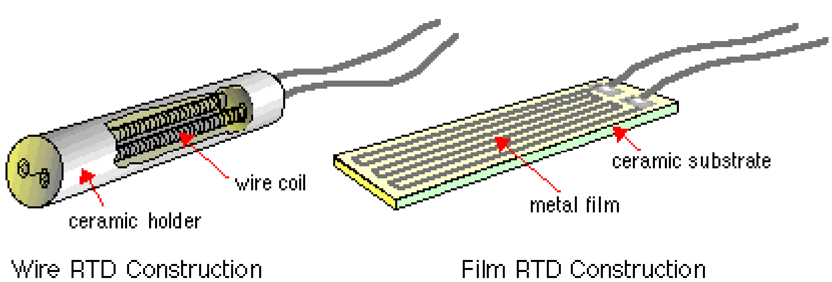

Figure (1): RTD Constructions

They are popular because of their stability; RTDs exhibit the most linear signal with respect to temperature of any electronic temperature sensor. However, they are generally more expensive than alternatives because of the careful construction and use of platinum. RTDs are also characterized by a slow response time and low sensitivity, and, because they require current excitation, they can be prone to self-heating.

Theory:

RTDs are commonly categorized by their nominal resistance at 0 °C. Typical nominal resistance values for platinum thin-film RTDs include 100 and 1000 Ω. In TMT a **PT100 RTD** is used.

In order to measure temperature with the RTD, you only need to measure the resistance of the RTD, and then substitute the resistance value in the following equation

$$T = \frac{R_o - R}{-0.5(R_o A + \sqrt{R_o^2 A^2 - 4R_o B(R_o - R)})}$$

Where :

T : Calculated temperature in (^oC).
R_o : RTD nominal resistance at 0 ^oC, R_o=100 Ω.
R : Measured resistance (Ω).
A = 3.90802×10^{-3}
B = -5.80195×10^{-7}

The above equation will give you the temperature in ^oC. The value of R_o, A & B differs from one type of RTD to another.

Experiment Procedure:

1. Refer to running procedure in Thermocouple Experiment.
2. Choose Experiment 2: "**RTD Characteristics**".

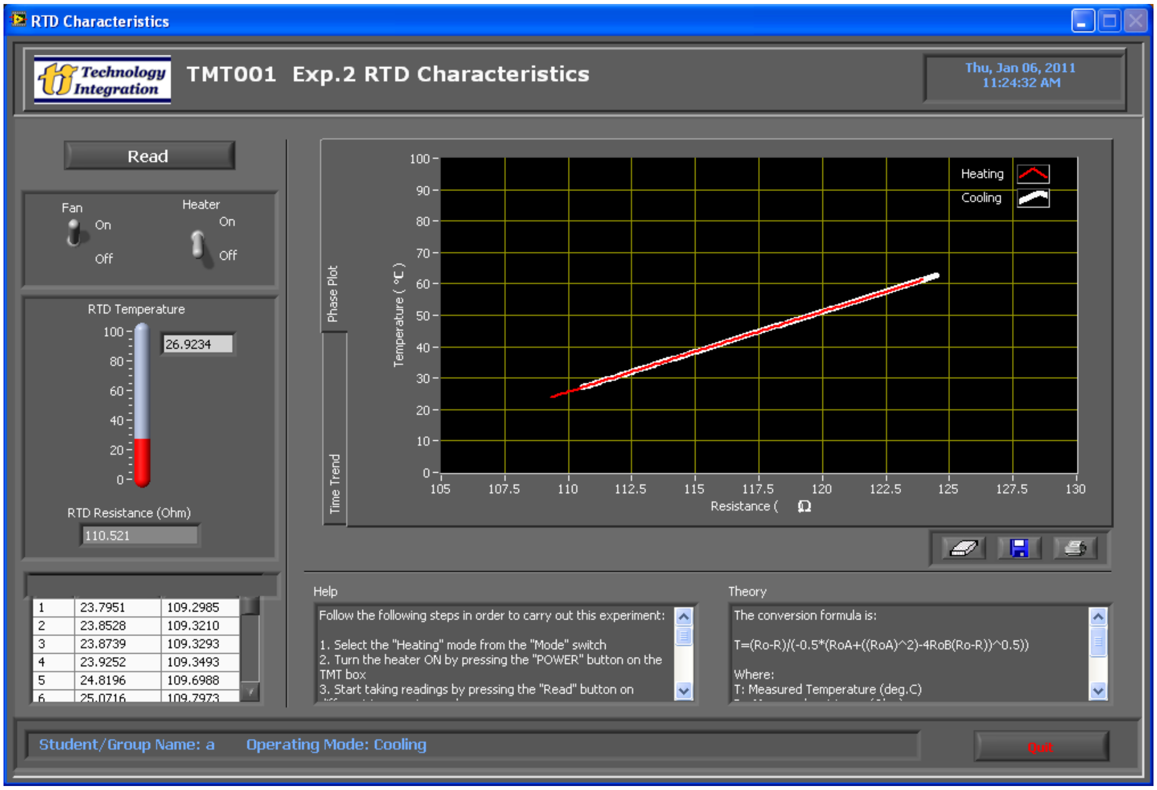

Figure (2): RTD Characteristics Experiment.

3. Study the front panel carefully and observe the buttons on the screen.

4. Turn the **Heater** ON by pressing ON the **Heater Switch** on the screen (Heating Mode).

5. Start taking readings by pressing **[Read]** button over different temperature values.

6. The acquired readings appear on the Temperature-Resistance graph as **red** points.

7. Compare the read temperature with the temperature of the **glass thermometer**. Is it the same temperature? Why?

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8. Turn the **Heater** OFF by pressing OFF the **Heater Switch** on the screen.

9. Turn the **Fan** ON by pressing ON the **Fan Switch** on the screen (Cooling Mode).

10. Start taking readings by pressing **[Read]** button on different temperature values.

11. The acquired reading appears on the Temperature-Resistance graph as **white** points.

12. Is the cooling curve the same as the heating curve? Why?
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13. Notice the Temperature vs. Resistance curve and answer the following questions:

14. 1 Is the curve linear?
    a) Yes
    b) No

14. 2 Does the RTD equation in the "**Theory**" window describe the curve on the Temperature-Resistance graph? If your answer is "No", what is the difference and why?
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15. Choose one of the readings taken before from the **Readings Table** and write down its Resistance (Ω) and Temperature (^{o}C) readings:

    15. 1 Current Resistance (Ω) ………………………..
    15. 2 Current temperature (^{o}C)…………………....
    15. 3 Apply the current resistance in the RTD equation
    15. 4 Write down the Calculated temperature (^{o}C)………………....
    15.5 Compare the calculated temperature with the current temperature.

Conclusions

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