Engineering Measurements

Chapter 8

Temperature measurements

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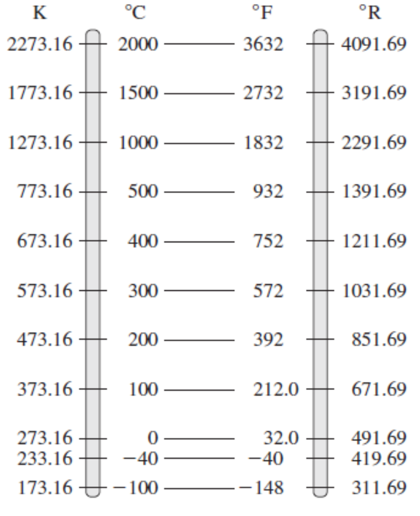
Temperature measurements

Temperature Scales



$$^{\circ}F = 32.0 + \tfrac{9}{5}{}^{\circ}C$$

$$^{\circ}R = \tfrac{9}{5}K$$

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Temperature Measurement by Electrical Effects

Electrical-Resistance Thermometer, or Resistance Temperature Detector (RTD)

- It consists of some type of resistive element
- The temperature is indicated through a measurement of the change in resistance of the element
- The linear temperature coefficient of resistance α *is defined by*

$$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)} \quad \text{or} \quad R = R_0[1 + \alpha(T - T_0)]$$

where R_2 *and* R_1 *are the resistances of the material at temperatures* T_2 *and* T_1

This relationship is usually applied over a narrow temperature range such that the variation of resistance with temperature approximates a linear relation. For wider temperature ranges, we use quadratic relation:

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Temperature measurements

Temperature Measurement by Electrical Effects

quadratic relation

$$R = R_0(1 + aT + bT^2)$$

Where

- *R = resistance at temperature T*
- R_0 *= resistance at reference temperature* T_0
- *a, b = experimentally determined constants*

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Temperature measurements

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Thermistors

is a semiconductor device that has a negative temperature coefficient of resistance

$$R = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

where R_0 *is the resistance at the reference temperature* T_0 *and* β *is an experimentally* determined constant. The numerical value of *β varies between 3500 and 4600 K,* depending on the thermistor material and temperature

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Temperature measurements

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SENSITIVITY.

RTD

$$R = R_0[1 + \alpha(T - T_0)]$$

$$S = \frac{dR}{dT} = \alpha R_0$$

Thermistor

$$R = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]$$

$$S = \frac{dR}{dT} = R_0 \exp\left[\beta\left(\frac{1}{T} - \frac{1}{T_0}\right)\right]\left(\frac{-\beta}{T^2}\right)$$

E n g i n e e r i n g m e a s u r e m e n t s

Temperature measurements

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Thermocouples

When two dissimilar metals are joined together as in Fig., an emf will exist between the two points *A and B, which is primarily a function of the junction* temperature