task_70jjg4yzznocarsq_with_calculation

Student Group

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temperature dependent resistance, power, heat, exam ee1 WS2022

Exercise 1.1 : Temperature-dependent Resistance
(written test, approx. 6% of a 60-minute written test, WS2022)

A thermistor is used as a temperature sensor in a refrigeration system. The thermistor has a resistance of $10 k\Omega$ at $+25 °C$.
Its temperature coefficients are: $\alpha=0.01 {{1}\over{K}}$ and $\beta=71 \cdot 10^{-6}{{1}\over{K^2}}$
The temperature inside the refrigeration system can reach down to $-40 °C$.

1. Calculate the resistance of the thermistor at $-40 °C$.

Solution

> \begin{align*} R &= R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) && | \text{with } \Delta T = T_{end} - T_{start}\\ R &= 10 k\Omega \cdot \left(1 + 0.01 {{1}\over{K}} \cdot (-40°C - 25°C) + 71 \cdot 10^{-6}{{1}\over{K^2}} \cdot (-40°C - 25°C)^2 \right) \\ \end{align*}

Final result

> \begin{align*} R &= 6.5 k\Omega \\ \end{align*}

2. Additionally, explain which effect a resistive temperature sensor can have on the refrigeration system.

Solution

> Resistors transfer electrical energy out of the circuit and generate heat. Therefore, a resistive sensor might heat up the refrigeration system.

3. Regarding question 2.: Given a constant sensor voltage, would a sensor with tenfold the resistance be better or worse? Give an explanation for you answer.

Solution

The power of the resistor $P = U \cdot I = R \cdot I^2 = {{U^2}\over{R}}$ is equivalent with the heat flow.
Therefore, with constant U and increasing R the power decreases. Ten times more resistance decreases the heat flow to one tenth.