

task_70jjg4yzznocarsq_with_calculation

Student Group

First Name	Surname	Matrikel Nr.

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resistivity, power, heat, exam WS2022

Exercise 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 $10 \text{ k}\Omega$ at $+25^\circ\text{C}$.

Its temperature coefficients are: $\alpha = 0.01 \frac{1}{\text{K}}$ and $\beta = 71 \cdot 10^{-6} \frac{1}{\text{K}^2}$

The temperature inside the refrigeration system can reach down to -40°C .

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

Solution

$$\begin{aligned} R &= R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2) \quad | \\ \text{with } T &= T_{\text{end}} - T_{\text{start}} \\ R &= 10 \text{ k}\Omega \cdot (1 + 0.01 \frac{1}{\text{K}} \cdot (-40^\circ\text{C} - 25^\circ\text{C}) + 71 \cdot 10^{-6} \frac{1}{\text{K}^2} \cdot (-40^\circ\text{C} - 25^\circ\text{C})^2) \end{aligned}$$

Final result

$$R = 6.5 \text{ k}\Omega$$

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 your answer.

Solution

The power of the resistor $P = U \cdot I = R \cdot I^2 = \frac{U^2}{R}$ 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.

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