task_70jjg4yzznocarsq_with_calculation

Student Group

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Exercise E1.1 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 $10 ~\rm{k}\Omega$ at $+25 ~°\rm{C}$.
Its temperature coefficients are: $\alpha=0.01 ~{{1}\over{\rm{K}}}$ and $\beta=71 \cdot 10^{-6}~{{1}\over{\rm{K}^2}}$
The temperature inside the refrigeration system can reach down to $-40 ~°\rm{C}$.

1. Calculate the resistance of the thermistor at $-40 ~°\rm{C}$.

Solution

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

Result

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

2. Additionally, explain what effect a tenfold resistance would have on the refrigeration system. Give an explanation for your answer.

Result

The resistor transfers electrical energy out of the circuit and generates heat. This is equivalent to the heat flow.
The power of the resistor $P = U \cdot I = R \cdot I^2 = {{U^2}\over{R}}$. Therefore, a tenfold resistor might heat up the refrigeration system.
Therefore, with constant U and increasing R the power decreases. Ten times more resistance decreases the heat flow to one-tenth.