

task_rj0r6j4apumukrj6_with_calculation

Student Group

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Exercise E1.1 Resistance of a Wire by Resistivity (written test, approx. 6 % of a 60-minute written test, WS2022)

A heating element made of nichrome wire with a temperature coefficient of resistance of $\alpha = 0.004 \text{ } ^\circ\text{C}^{-1}$ is used. Electric power dissipation (= heat flow) of $P = 40 \text{ W}$ is necessary.

Determine the current I and the operating voltage U for heating elements.

The Nichrome wire has a resistivity of $\rho = 1.10 \cdot 10^{-6} \text{ } \Omega \cdot \text{m}$.

The heating element is 3 m long and has a diameter of 3.57 mm .

Solution: $\begin{aligned} R &= \rho \cdot \frac{L}{A} = 1.10 \cdot 10^{-6} \cdot \frac{3}{\pi \cdot (3.57 \cdot 10^{-3})^2} \end{aligned}$

1. Calculate the resistance R of the heating element.

$\begin{aligned} P &= U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} = \sqrt{\frac{40 \text{ W}}{0.33 \text{ } \Omega}} \end{aligned}$

$\begin{aligned} R &= \rho \cdot \frac{L}{A} \quad \text{with } A = r^2 \cdot \pi = \frac{1}{4} d^2 \cdot \pi \\ R &= \rho \cdot \frac{L}{\frac{1}{4} d^2 \cdot \pi} = \rho \cdot \frac{4 \cdot L}{d^2 \cdot \pi} = 1.10 \cdot 10^{-6} \cdot \frac{4 \cdot 3}{(3.57 \cdot 10^{-3})^2 \cdot \pi} \end{aligned}$

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