

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 $1.80 \times 10^{-5} \text{ } ^\circ\text{C}^{-1}$ is used. Electric power dissipation (= heat flow) of $P=40 \text{ W}$ is necessary.

Determine the current I needed to operate it for heating elements.

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

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

Solution: $\begin{aligned} R &= \rho \cdot \frac{L}{A} \end{aligned}$

1. Calculate the resistance R of the heating element.

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

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

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