

task_rj0r6j4apumukrj6_with_calculation

Student Group

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

2. The heating element made of solid nichrome wire with a temperature coefficient of $1.80 \times 10^{-3} \text{ K}^{-1}$ is used in an electric boiler. A power dissipation (= heat flow) of $P = 40 \text{ W}$ is necessary.
 a) Calculate the current I needed for heating elements.
 The Nichrome wire has a resistivity of $1.10 \times 10^{-6} \text{ } \Omega \text{ m}$.
 The heating element is 3 m long and has a diameter of 3.57 mm .
 b) Calculate the resistance R of the heating element.

Solution

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

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

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