

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 nichrome wire with a temperature coefficient of resistance of $\alpha = 0.004 \text{ } ^\circ\text{C}^{-1}$ is used in an electric boiler. The power dissipation (= heat flow) of $P = 40 \text{ W}$ is necessary. Calculate the current I needed to operate it 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: $R = 10^{-3} \text{ } \Omega$
∴ Calculate the resistance R of the heating element.

Solution

$$\begin{aligned} P &= U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} = \sqrt{\frac{40 \text{ W}}{0.3 \text{ } \Omega}} \end{aligned}$$

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

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Last update: 2023/04/02 00:44

