

task_rj0r6j4apumukrj6_with_calculation

Student Group

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resistivity, power, exam ee1 WS2022

Exercise E1 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 $1.80 \cdot 10^{-4} \text{ K}^{-1}$ 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 $1.10 \cdot 10^{-6} \text{ } \Omega \text{ m}$.

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

Solution:
$$R = \rho \cdot \frac{l}{A} = 1.10 \cdot 10^{-6} \cdot \frac{3}{\pi \cdot (3.57 \cdot 10^{-3})^2} = 2.73 \cdot 10^{-3} \text{ } \Omega$$

1. Calculate the resistance R of the heating element.

Solution:
$$P = U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} = \sqrt{\frac{40 \text{ W}}{2.73 \cdot 10^{-3} \text{ } \Omega}} = 120.3 \text{ A}$$

$$R = \rho \cdot \frac{l}{A} \quad \text{with } A = r^2 \cdot \pi = \frac{1}{4} d^2 \cdot \pi \quad R = \rho \cdot \frac{4 \cdot l}{d^2 \cdot \pi} \quad R = 1.10 \cdot 10^{-6} \text{ } \Omega \text{ m} \cdot \frac{4 \cdot 3 \text{ m}}{(3.57 \cdot 10^{-3} \text{ m})^2 \cdot \pi} = 2.73 \cdot 10^{-3} \text{ } \Omega$$

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