Q. 03

Aheating element using nichrome connected to a 230 V supply draws an initial current of 3.2 A which settles after a few seconds toa steady value of 2.8 A. What is the steady temperature of the heating element if the room temperature is 27.0 °C? Temperature coefficient of resistance of nichrome averaged over the temperature range involved is $1.70 \times 10^{-4}\,°C^{-1}$.

Answer

Supply voltage, V = 230 V

Initial current drawn, I_1 = 3.2 A

Initial resistance = R_1, which is given by the relation,

$$R_1 = \frac{V}{I}$$

$$= \frac{230}{3.2} = 71.87\ \Omega$$

Steady state value of the current, I_2 = 2.8 A

Resistance at the steady state = R_2, which is given as

$$R_2 = \frac{230}{2.8} = 82.14\ \Omega$$

Temperature co-efficient of nichrome, $\alpha = 1.70 \times 10^{-4}\,°C^{-1}$

Initial temperature of nichrome, T_1= 27.0°C

Study state temperature reached by nichrome = T_2

T_2 can be obtained by the relation for α,

$$\alpha = \frac{R_2 - R_1}{R_1(T_2 - T_1)}$$

$$T_2 - 27\ °C = \frac{82.14 - 71.87}{71.87 \times 1.7 \times 10^{-4}} = 840.5$$

$$T_2 = 840.5 + 27 = 867.5\ °C$$

Therefore, the steady temperature of the heating element is 867.5°C