Given:

A hair dryer is designed to output 2000 W of heat by using 90 V source.

$$Q'_{out} := 2000W \quad V_s := 90V$$

Required:

If the heating coil is composed of nichrome (nickel-iron-chromium alloy) with a resistivity of 1.10×10^{-6} Ωm and a diameter of 0.4 mm, how long must the nichrome wire be?

Solution:

The resistivity and diameter of the wire are defined as

$$\rho := 1.10 \cdot 10^{-6} \cdot \Omega \cdot m \quad d := 0.4mm$$

The required overall resistance is

$$Q' = \frac{V^2}{R} \qquad \text{or} \qquad R := \frac{V_s^{\,2}}{Q'_{out}} = 4.05\,\Omega$$

The required for this overall resistance is then

$$R = \frac{\rho \cdot L}{A} \qquad \text{or} \qquad \boxed{L := \frac{R \cdot \left(\frac{\pi}{4} \cdot d^2\right)}{\rho} = 0.463 \cdot m}$$