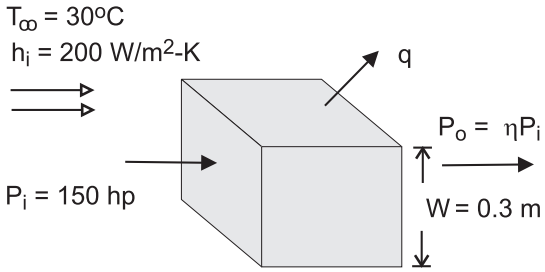
PROBLEM 1.23

KNOWN: Width, input power and efficiency of a transmission. Temperature and convection coefficient associated with air flow over the casing.

FIND: Surface temperature of casing.

SCHEMATIC:



ASSUMPTIONS: (1) Steady state, (2) Uniform convection coefficient and surface temperature, (3) Negligible radiation.

ANALYSIS: From Newton's law of cooling,

$$q = hA_s\left(T_s - T_\infty\right) = 6hW^2\left(T_s - T_\infty\right)$$

where the output power is $\eta\, P_i$ and the heat rate is

$$q = P_i - P_o = P_i\left(1-\eta\right) = 150\,\text{hp}\times 746\,\text{W/hp}\times 0.07 = 7833\,\text{W}$$

Hence,

$$T_s = T_\infty + \frac{q}{6\ hW^2} = 30°\text{C} + \frac{7833\ \text{W}}{6\times 200\ \text{W/m}^2\cdot\text{K}\times\left(0.3\,\text{m}\right)^2} = 102.5°\text{C} \quad <$$

COMMENTS: There will, in fact, be considerable variability of the local convection coefficient over the transmission case and the prescribed value represents an average over the surface.