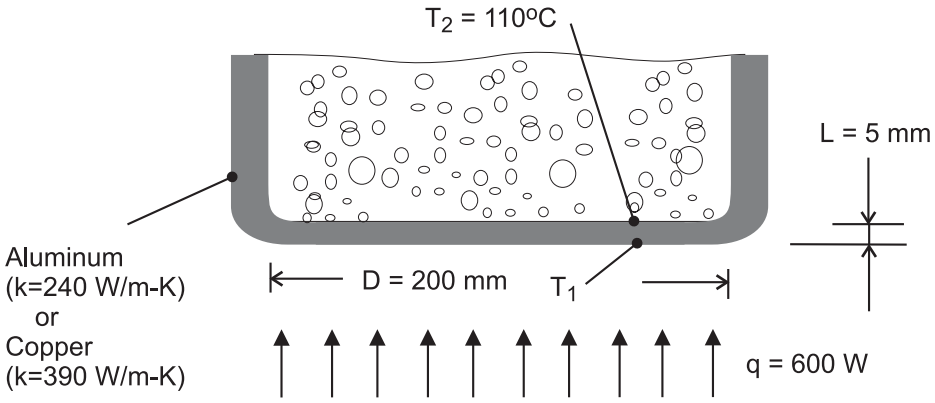
PROBLEM 1.15

KNOWN: Thickness, diameter and inner surface temperature of bottom of pan used to boil water. Rate of heat transfer to the pan.

FIND: Outer surface temperature of pan for an aluminum and a copper bottom.

SCHEMATIC:



ASSUMPTIONS: (1) One-dimensional, steady-state conduction through bottom of pan.

ANALYSIS: From Fourier's law, the rate of heat transfer by conduction through the bottom of the pan is

$$q = kA\frac{T_1 - T_2}{L}$$

Hence,

$$T_1 = T_2 + \frac{qL}{kA}$$

where $A = \pi D^2/4 = \pi(0.2\text{m})^2/4 = 0.0314\ \text{m}^2$.

Aluminum: $$T_1 = 110\ ^\circ\text{C} + \frac{600\text{W}(0.005\ \text{m})}{240\ \text{W/m}\cdot\text{K}\left(0.0314\ \text{m}^2\right)} = 110.40\ ^\circ\text{C} \quad <$$

Copper: $$T_1 = 110\ ^\circ\text{C} + \frac{600\text{W}(0.005\ \text{m})}{390\ \text{W/m}\cdot\text{K}\left(0.0314\ \text{m}^2\right)} = 110.24\ ^\circ\text{C} \quad <$$

COMMENTS: Although the temperature drop across the bottom is slightly larger for aluminum (due to its smaller thermal conductivity), it is sufficiently small to be negligible for both materials. To a good approximation, the bottom may be considered *isothermal* at $T \approx 110\ ^\circ\text{C}$, which is a desirable feature of pots and pans.