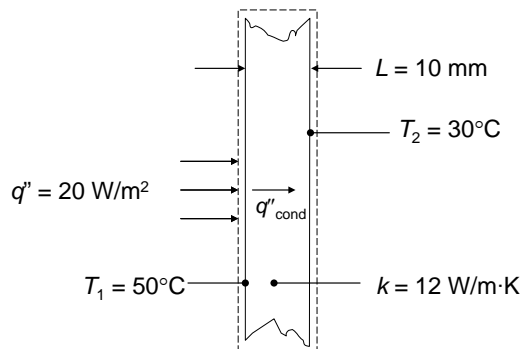


PROBLEM 1.3

KNOWN: Thickness and thermal conductivity of a wall. Heat flux applied to one face and temperatures of both surfaces.

FIND: Whether steady-state conditions exist.

SCHEMATIC:



ASSUMPTIONS: (1) One-dimensional conduction, (2) Constant properties, (3) No internal energy generation.

ANALYSIS: Under steady-state conditions an energy balance on the control volume shown is

$$q''_{\text{in}} = q''_{\text{out}} = q''_{\text{cond}} = k(T_1 - T_2)/L = 12 \text{ W/m}\cdot\text{K}(50^\circ\text{C} - 30^\circ\text{C})/0.01 \text{ m} = 24,000 \text{ W/m}^2$$

Since the heat flux in at the left face is only 20 W/m^2 , the conditions are not steady state. <

COMMENTS: If the same heat flux is maintained until steady-state conditions are reached, the steady-state temperature difference across the wall will be

$$\Delta T = q''L/k = 20 \text{ W/m}^2 \times 0.01 \text{ m} / 12 \text{ W/m}\cdot\text{K} = 0.0167 \text{ K}$$

which is much smaller than the specified temperature difference of 20°C .