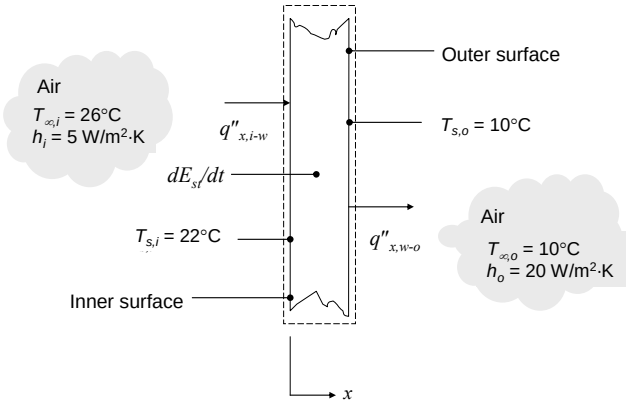
PROBLEM 1.20

KNOWN: Inner and outer surface temperatures of a wall. Inner and outer air temperatures and convection heat transfer coefficients.

FIND: Heat flux from inner air to wall. Heat flux from wall to outer air. Heat flux from wall to inner air. Whether wall is under steady-state conditions.

SCHEMATIC:



ASSUMPTIONS: (1) Negligible radiation, (2) No internal energy generation.

ANALYSIS: The heat fluxes can be calculated using Newton's law of cooling. Convection from the inner air to the wall occurs in the positive x-direction:

$$q''_{x,i-w} = h_i(T_{\infty,i} - T_{s,i}) = 5\ \text{W/m}^2\cdot\text{K} \times (26°\text{C} - 22°\text{C}) = 20\ \text{W/m}^2 \quad <$$

Convection from the wall to the outer air also occurs in the positive x-direction:

$$q''_{x,w-o} = h_o(T_{s,o} - T_{\infty,o}) = 20\ \text{W/m}^2\cdot\text{K} \times (10°\text{C} - 10°\text{C}) = 0\ \text{W/m}^2 \quad <$$

From the wall to the inner air:

$$q''_{w-i} = h_i(T_{s,i} - T_{\infty,i}) = 5\ \text{W/m}^2\cdot\text{K} \times (22°\text{C} - 26°\text{C}) = -20\ \text{W/m}^2 \quad <$$

Since $dE_{st}/dt = 0$, the wall is not at steady state. <

COMMENTS: The heat flux from the wall to the inner air is equal and opposite to the heat flux from the inner air to the wall.