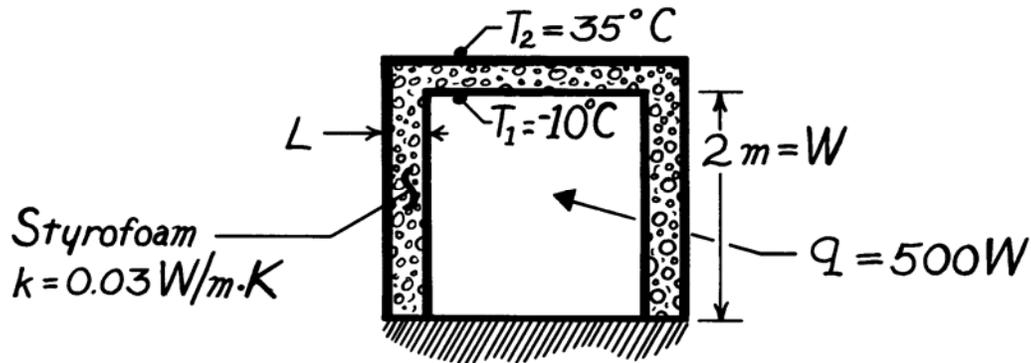


PROBLEM 1.10

KNOWN: Dimensions of freezer compartment. Inner and outer surface temperatures.

FIND: Thickness of styrofoam insulation needed to maintain heat load below prescribed value.

SCHEMATIC:



ASSUMPTIONS: (1) Perfectly insulated bottom, (2) One-dimensional conduction through 5 walls of area $A = 4m^2$, (3) Steady-state conditions, (4) Constant properties.

ANALYSIS: Using Fourier's law, Eq. 1.2, the heat rate is

$$q = q'' \cdot A = k \frac{\Delta T}{L} A_{\text{total}}$$

Solving for L and recognizing that $A_{\text{total}} = 5 \times W^2$, find

$$L = \frac{5 k \Delta T W^2}{q}$$

$$L = \frac{5 \times 0.03 \text{ W/m} \cdot \text{K} [35 - (-10)]^\circ \text{C} (4\text{m}^2)}{500 \text{ W}}$$

$$L = 0.054\text{m} = 54\text{mm.}$$

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COMMENTS: The corners will cause local departures from one-dimensional conduction and a slightly larger heat loss.