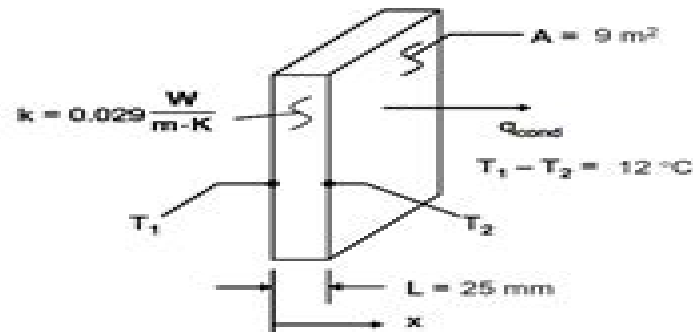


PROBLEM 1.2

KNOWN: Thermal conductivity, thickness and temperature difference across a sheet of rigid extruded insulation.

FIND: (a) The heat flux through a $3 \text{ m} \times 3 \text{ m}$ sheet of the insulation, (b) the heat rate through the sheet, and (c) the thermal conduction resistance of the sheet.

SCHEMATIC:



ASSUMPTIONS: (1) One-dimensional conduction in the x -direction, (2) Steady-state conditions, (3) Constant properties.

ANALYSIS: (a) From Equation 1.2 the heat flux is

$$q_x'' = -k \frac{dT}{dx} = k \frac{T_1 - T_2}{L} = 0.029 \frac{\text{W}}{\text{m} \cdot \text{K}} \times \frac{12 \text{ K}}{0.025 \text{ m}} = 13.9 \frac{\text{W}}{\text{m}^2} \quad <$$

(b) The heat rate is

$$q_x = q_x'' \cdot A = 13.9 \frac{\text{W}}{\text{m}^2} \times 9 \text{ m}^2 = 125 \text{ W} \quad <$$

(c) From Eq. 1.11, the thermal resistance is

$$R_{\text{cond}} = \Delta T / q_x = 12 \text{ K} / 125 \text{ W} = 0.096 \text{ K/W} \quad <$$

COMMENTS: (1) Be sure to keep in mind the important distinction between the heat flux (W/m^2) and the heat rate (W). (2) The direction of heat flow is from hot to cold. (3) Note that a temperature *difference* may be expressed in kelvins or degrees Celsius. (4) The conduction thermal resistance for a plane wall could equivalently be calculated from $R_{\text{cond}} = L/kA$.

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