

44.18 A $10\text{ft} \times 10\text{ft}$ exterior wall is made of 4in brick ($\rho = 120\frac{\text{lb}}{\text{ft}^3}$), 3.5in mineral fiber insulation, and $\frac{5}{8}\text{in}$ gypsum board. There is a single $3\text{ft} \times 6\text{ft}$ operable window comprised of double glazing with $\frac{1}{2}\text{in}$ air space and emissivity of 0.6. The window frame is made of insulated fiberglass. The temperature differential between inside and outside is 20°F . What is the average heat flux through the wall?

- A. $0.9\frac{\text{Bu}}{\text{hr}\cdot\text{ft}^2}$
- B. $1.4\frac{\text{Bu}}{\text{hr}\cdot\text{ft}^2}$
- C. $2.7\frac{\text{Bu}}{\text{hr}\cdot\text{ft}^2}$
- D. $8.6\frac{\text{Bu}}{\text{hr}\cdot\text{ft}^2}$

Find the total resistance of the composite wall. Look up [Thermal Resistance of Building Materials](#).

For [brick](#) with a density of $120\frac{\text{lb}}{\text{ft}^3}$, take the average resistance per inch from the range given and multiply by the thickness:

$$R_{\text{brick}} = \left(0.165\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}\cdot\text{in}}\right)(4\text{in}) = .66\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}}$$

For the [mineral fiber](#) insulation, the resistance is listed for the nominal thickness of 3.5in :

$$R_{\text{insulation}} = 13\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}}$$

For the [gypsum](#) board, the resistance is listed for the thickness of $\frac{5}{8}\text{in}$:

$$R_{\text{gypsum}} = .56\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}}$$

Calculate the total resistance for the composite wall, then determine the overall heat transfer coefficient:

$$R_{\text{wall}} = R_{\text{brick}} + R_{\text{insulation}} + R_{\text{gypsum}}$$

$$R_{\text{wall}} = .66\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}} + 13\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}} + .56\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}} = 14.22\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}}$$

$$U_{\text{wall}} = \frac{1}{R_{\text{wall}}} = \frac{1}{14.22\frac{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}{\text{Btu}}} = .07\frac{\text{Btu}}{\text{hr}\cdot\text{ft}^2\cdot^\circ\text{F}}$$

Find the heat transfer coefficient for the window. Look up [U-Factors for Fenestration](#) and use the frame type (insulated fiberglass), glazing type (double glazing with $e = 0.60$), thickness of the air space ($\frac{1}{2}\text{in}$), and operability to obtain the U Factor:

$$U_{window} = .43 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$$

Determine the total overall coefficient of heat transfer for the wall *inclusive* of the window by taking a weighted average of the U factors by area.

$$A_{window} = (3ft)(6ft) = 18ft^2$$

$$A_{wall} = (10ft)(10ft) - 18ft^2 = 82ft^2$$

$$U_{total} = \frac{\left(.07 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}\right) (82ft^2) + \left(.43 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}\right) (18ft^2)}{82ft^2 + 18ft^2} = .135 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$$

Find the heat flux by dividing the overall heat transfer formula by area:

$$\dot{Q} = UA\Delta T$$

$$\dot{q} = \frac{\dot{Q}}{A} = U\Delta T$$

$$\dot{q} = \left(.135 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}\right) (20^\circ F) = 2.7 \frac{Btu}{hr \cdot ft^2}$$

Answer C

44.19 An R-1234yf chiller operates between 50psia on the low pressure side and 150psia on the high pressure side with no subcooling and no superheat. What is the quality of refrigerant entering the evaporator?

- A. 0
- B. 0.12
- C. 0.22
- D. 0.32

Look up [Pressure Versus Enthalpy Curves for Refrigerant 1234yf](#) in the Reference Handbook and draw the refrigeration cycle on the diagram, either using on-screen drawing tools or scratch paper. Carefully locate State 3, the condition leaving the condenser prior to expansion, on the left side of the saturation curve. Assume the expansion is isenthalpic, therefore the enthalpy of State 4, after the expansion and before entering the evaporator, is known to be equal to the enthalpy at State 3.

For State 3:

$$P_3 = 150psia$$