

46.37 A composite wall is composed of $\frac{3}{4}$ in of stucco, 8 in normal weight concrete blocks, and $\frac{1}{2}$ in gypsum board. The inside and outside surface conductances are $6 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$ and $1.5 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$, respectively. What is the U-factor for the wall?

- A. $0.11 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$
- B. $0.41 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$
- C. $0.62 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$
- D. $2.4 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$

Sketch the **Composite Plane Wall** and label with given information. There are five sources of resistance, the two surface conductances and the three layers of building materials. The U-factor, or overall coefficient of heat transfer, is the inverse of the total resistance.

$$U = \frac{1}{R_{total}}$$

Write an expression for R_{total} for this specific situation.

$$R_{total} = \frac{1}{h_i} + R_{stucco} + R_{concrete} + R_{gypsum} + \frac{1}{h_o}$$

Use the table **Thermal Resistance of Building Materials** to look up the resistance values for each of the materials. In some cases the resistance may be provided per unit thickness and in others it may be given for a particular, typical thickness. Be sure to account for such nuances by ensuring correct units before taking the sum. For concrete, use the average value from the range provided for 8 in blocks.

$$R_{stucco} = \left(0.15 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu \cdot in} \right) (0.75 in) = 0.1125 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu}$$

$$R_{concrete} = 1.04 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu}$$

$$R_{gypsum} = 0.45 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu}$$

Calculate R_{total} .

$$R_{total} = \frac{1}{6 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}} + 0.1125 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu} + 1.04 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu} + 0.45 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu} + \frac{1}{1.5 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}}$$

$$R_{total} = 2.436 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu}$$

Calculate the U-factor.

$$U = \frac{1}{R_{total}} = \frac{1}{2.436 \frac{hr \cdot ft^2 \cdot ^\circ F}{Btu}} = 0.41 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$$

Answer B

46.38 A fluid with a kinematic viscosity of 3centistokes and a specific gravity of 0.88 flows through a nominal 3in pipe at 4fps . What is the Reynolds number?

- A. 32,000
- B. 104,000
- C. 380,000
- D. 3,700,000

Reynolds Number is a function of velocity, diameter, and kinematic viscosity. Specific gravity has no bearing on Reynolds number.

$$Re = \frac{vD}{\nu}$$

The kinematic viscosity has been given in cSt which is best converted to $\frac{ft^2}{s}$ since the problem is otherwise specified in US Customary units. Use the table **Measurement Relationships** to find the relevant conversion factors from cSt to $\frac{m^2}{s}$ and from $meters$ to ft . Substitute directly into the Reynolds number formula and solve. Use the table **Schedule 40 Steel Pipe** to look up the internal diameter of a nominal 3in pipe.

$$Re = \frac{\left(4\frac{ft}{s}\right)\left(\frac{3.068}{12}ft\right)}{\left(3cSt\right)\left(\frac{1\times 10^{-6}m^2}{1cSt}\right)\left(\frac{3.281ft}{1m}\right)^2} = 31,666$$

Answer A