convenience, use the known volume flow rates as the states are not fully defined and it will be implausible to determine the mass flow rates.

$$T_{MA} = \frac{(5000cfm)\,(25^{\circ}F) + (15,000cfm)\,(75^{\circ}F)}{20,000cfm} = 62.5^{\circ}F$$

Calculate the sensible heating of the air.

$$\dot{Q}_{s,air} = 1.08\,(20,000)\,(120 - 62.5) = 1,242,000\frac{Btu}{hr}$$

Equate the quantity of heat added to the air with the quantity of heat given up by the hot water flowing through the coil. The hot water undergoes an equal amount of sensible cooling. Use the sensible heating/cooling rule of thumb for water to solve for the volume flow rate of hot water. The temperature range is given.

$$\dot{Q}_{s,water} = \dot{Q}_{s,air}$$

$$500gpm\Delta T = 1,242,000\frac{Btu}{hr}$$

$$gpm = \frac{1,242,000}{(500)\,(135 - 105)} = 82.8gpm$$

Answer B

47.38 A radiator is designed for $100^{\circ}F$ entering air and $150^{\circ}F$ leaving air. The inlet water is expected to enter at $212^{\circ}F$ and leave at $195^{\circ}F$. The radiator may be treated as a counterflow heat exchanger with a heat transfer surface area of $10ft^2$ and an overall coeffieient of heat transfer of $11\frac{Btu}{hr\cdot ft^2\cdot {}^{\circ}F}$. What is the rate of heat transfer?

A. $5000\frac{Btu}{hr}$

B. $8100\frac{Btu}{hr}$

C. $8500\frac{Btu}{hr}$

D. $10,500\frac{Btu}{hr}$

Calculate the log mean temperature difference for the radiator modeled as a Counterflow heat exchanger. Draw the heat exchanger and label the temperatures.

$$Hot\,Fluid:\ 212^{\circ}F \longrightarrow 195^{\circ}F$$

$$Cold\,Fluid:\ 150^{\circ}F \longleftarrow 100^{\circ}F$$

Define one *physical* side of the heat exchanger as 'A' and the other side as 'B' and determine the respective temperature differences.

$$\Delta T_A = 212°F - 150°F = 62°F$$

$$\Delta T_B = 195°F - 100°F = 95°F$$

Use the formula below to calculate the log mean temperature difference.

$$LMTD_{counterflow} = \frac{\Delta T_A - \Delta T_B}{ln\left(\frac{\Delta T_A}{\Delta T_B}\right)}$$

$$LMTD_{counterflow} = \frac{62°F - 95°F}{ln\left(\frac{62°F}{95°F}\right)} = 77.3°F$$

Calculate the heat transfer for the heat exchanger:

$$\dot{Q} = UA\Delta T_{lm} = \left(11\frac{Btu}{hr \cdot ft^2 \cdot °F}\right)\left(10ft^2\right)(77.3°F) = 8506\frac{Btu}{hr}$$

Answer C

47.39 An $8ft$ long, $1in$ diameter solid aluminum alloy rod with coefficient of linear thermal expansion of $12.8 \times 10^{-6}\frac{1}{°F}$ is heated from $70°F$ to $230°F$. What is the change in cross-sectional area?

A. $-3.2 \times 10^{-3}in^2$

B. $-2.1 \times 10^{-3}in^2$

C. $+2.1 \times 10^{-3}in^2$

D. $+3.2 \times 10^{-3}in^2$

The change in cross-sectional area of the rod is dependent upon the change in diameter, which is linear with the change in temperature. To obtain the change in the diameter, multiple the original diameter by the linear coefficient of thermal expansion and the ΔT.

$$\Delta D = D_0 \alpha \Delta T$$

$$\Delta D = (1in)\left(12.8 \times 10^{-6}\frac{1}{°F}\right)(230°F - 70°F) = 0.00205in$$

Calculate the new diameter.

$$D_1 = D_0 + \Delta D = 1in + 0.00205in = 1.00205in$$

Calculate the new difference between the new and old cross-sectional areas.

$$A_1 - A_0 = \frac{\pi}{4}\left[D_1^2 - D_0^2\right]$$

$$A_1 - A_0 = \frac{\pi}{4}\left[(1.00205in)^2 - (1in)^2\right] = 3.2 \times 10^{-3}in^2$$

Answer D