46.32 $5000cfm$ **of air at** $75°F$ **db /** $68°F$ **wb enters a spray chamber using** $90°F$ **water. The bypass factor for the spray chamber is 0.15. What is the dry bulb temperature of the leaving air?**

A. $69°F$

B. $74°F$

C. $77°F$

D. $88°F$

The spray chamber is heating the air, so the wet bulb temperature of the entering air has no bearing on the problem. If the process was 100% efficient, the air would leave at the same temperature as the water, $90°F$. However, due to the bypass factor, the efficiency of the heating process is only 85%.

$$\eta = 1 - BF = 1 - 0.15 = 0.85$$

Perform a mixing calculation using 85% of the airflow having been heated to $90°F$, and the balance having been unaffected because it bypassed the spray.

$$T_2 = (0.85)(90°F) + (0.15)(75°F) = 87.75°F$$

Alternatively, set up the efficieny as the ratio of the change in dry bulb temperature actually observed compared to the maximum possible delta T if there was no bypass, i.e. 100% efficiency.

$$\eta = \frac{T_2 - T_1}{T_{spray} - T_1}$$

$$0.85 = \frac{T_2 - 75°F}{90°F - 75°F}$$

$$T_2 = 87.75°F$$

Answer D

46.33 A pizza oven has a flame temperature of $1000°F$ and the internal walls are $700°F$. Assuming all surfaces are considered to be black, what is the rate of heat transfer per square foot due to radiation?

A. $1300 \frac{Btu}{hr \cdot ft^2}$

B. $4700 \frac{Btu}{hr \cdot ft^2}$

C. $8800 \frac{Btu}{hr \cdot ft^2}$

D. $13,000 \frac{Btu}{hr \cdot ft^2}$

The energy exchange due to Radiation is given by the equation below.

$$\dot{Q}_r = \varepsilon \sigma A \left(T_1^4 - T_2^4\right)$$

Since all surfaces are considered to be black, the emissivity is assumed to be 1.

$$\varepsilon = 1$$

The question asks for the heat transfer per square foot, so divide both sides by area.

$$\frac{\dot{Q}_r}{A} = \dot{q}_r = \sigma \left(T_1^4 - T_2^4\right)$$

σ is the Stefan-Boltzmann Constant. In order for the units to work out, absolute temperatures must be used i.e. Rankine. Solve for $\dot{q}_r$.

$$\dot{q}_r = \left(0.1713 \times 10^{-8} \frac{Btu}{hr \cdot ft^2 \cdot {}^\circ R^4}\right) \left[(1460°R)^4 - (1160°R)^4\right] = 4682 \frac{Btu}{hr \cdot ft^2}$$

Answer B