44.9 An outside air handler mixes $2000cfm$ of $90°F$ db / $80°F$ wb fresh air with recirculated return air at $76°F$ / 50% relative humidity. The unit supplies $10,000cfm$ of $58°F$ air to the space. What is the enthalpy of the mixed air entering the cooling coil?

A. $31\frac{Btu}{lb}$

B. $32\frac{Btu}{lb}$

C. $33\frac{Btu}{lb}$

D. $34\frac{Btu}{lb}$

It may be helpful to draw and label a typical outside air handling arrangement. The supply air temperature downstream of the cooling coil is extra information.

Since the volume flow rate of outside air is $2000cfm$ and a total of $10,000cfm$ is being supplied, the volume flow rate of recirculated air is given by:

$$Q_{recirculation} = 10,000cfm - 2000cfm = 8,000cfm.$$

To find the enthalpy of mixed air (prior to the coil), perform a mixing calculation using the outside air stream and return (recirculated) air stream, both of which are fully defined. Use the Psychrometric Chart to obtain the enthalpy values for both states:

$$T_{OA,db} = 90°F$$

$$T_{OA,wb} = 80°F$$

$$h_{OA} = 43.57\frac{Btu}{lb}$$

$$T_{RA} = 76°F$$

$$\phi_{RA} = 50\%$$

$$h_{RA} = 28.74\frac{Btu}{lb}$$

$$h_{MA} = \frac{(2000cfm)\left(43.57\frac{Btu}{lb}\right) + (8000cfm)\left(28.74\frac{Btu}{lb}\right)}{2000cfm + 8000cfm} = 31.7\frac{Btu}{lb}$$

Answer B

44.10 A hydronic piping system is re-designed to improve efficiency. The $250gpm$ pump is re-selected from $200ft$ TDH to $175ft$ TDH to suit the reduction in pressure loss throughout the system and capture savings. Both the old and new pump selections have an efficiency of 85% and are driven by a 94% efficient motor. The pump will run 9AM-5PM Monday through Friday year round. Electricity costs $0.18 per kWh. What are the annual savings?

A. $550

B. $950

C. $1250

D. $1650

Consider the original pump selection as Case 1 and the new pump selection as Case 2. Find the water horsepower, WHP, for both scenarios:

$$WHP = \frac{Q\Delta h}{3960}$$

$$WHP_1 = \frac{(250)(200)}{3960} = 12.63hp$$

$$WHP_2 = \frac{(250)(175)}{3960} = 11.05hp$$

Find the electrical power for each scenario by applying the pump and motor efficiency and converting units to KW:

$$P_1 = \frac{WHP_1}{\eta_p \eta_m} = \frac{12.63hp}{(.85)(.94)}\left(.7457\frac{KW}{hp}\right) = 11.8KW$$

$$P_2 = \frac{WHP_2}{\eta_p \eta_m} = \frac{11.05hp}{(.85)(.94)}\left(.7457\frac{KW}{hp}\right) = 10.34KW$$

Calculate the annual costs for each scenario by applying the annual run time and electricity rate:

$$Cost_1 = (11.8KW)\left(8\frac{hr}{day}\right)\left(5\frac{days}{wk}\right)\left(52\frac{wk}{yr}\right)\left(\frac{\$0.18}{kW \cdot hr}\right) = \$4,418/year$$

$$Cost_2 = (10.34KW)\left(8\frac{hr}{day}\right)\left(5\frac{days}{wk}\right)\left(52\frac{wk}{yr}\right)\left(\frac{\$0.18}{kW \cdot hr}\right) = \$3,871/year$$

Calculate the savings:

$$Savings = \$4,418/year - \$3,871/year = \$547/year$$

Answer A