**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**

**44.11 Water enters a $100ton$ cooling tower at $130°F$ and leaves at $105°F$. Air enters at $88°F$ and 60% RH and leaves at $104°F$ and 80% RH. What quantity of make up water is required? Assume no losses.**

A. $0.25gpm$

B. $0.5gpm$

C. $1gpm$

D. $2gpm$

The cooling tower entering and leaving water temperatures are extra information and not needed to solve the problem. The rate of heat transfer *to* the air is equivalent to the rate of heat transfer *from* the condenser water:

$$\dot{Q}_{cw} = \dot{Q}_{air} = 100tons\left(12,000\frac{Btu}{hr \cdot ton}\right) = 1,200,000\frac{Btu}{hr}$$

Set this quantity equal to a $m\Delta h$ expression, where entering air is State 1 and the leaving air is State 2. Both states are fully defined and enthalpy values as well as humidity ratios may be obtained using the Psychrometric Chart and High Temperature Psychrometric Chart, where required.

$$\dot{Q}_{air} = \dot{m}_{air}\Delta h$$

For the entering air, State 1:

$$T_1 = 88°F$$

$$\phi_1 = 60\%$$

$$h_1 = 40.03\frac{Btu}{lb}$$

$$\omega_1 = .01719\frac{lb_w}{lb_{da}}$$

For the leaving air, State 2:

$$T_2 = 104°F$$

$$\phi_2 = 80\%$$

$$h_2 = 67.76\frac{Btu}{lb}$$

$$\omega_2 = .03866\frac{lb_w}{lb_{da}}$$