47.59 A water-cooled chiller produces $500gpm$ of $45°F$ supply chilled water from $56°F$ return chilled water. The chiller has a coefficient of performance of 4.8. What is the load on the condenser?

A. $181tons$

B. $229tons$

C. $277tons$

D. $325tons$

Use the sensible cooling rule of thumb for water to determine the refrigeration effect, $\dot{Q}_{in}$.

$$\dot{Q}_{in} = 500gpm\Delta T_{CHW}$$

$$\dot{Q}_{in} = 500\,(500)\,(56-45) = 2,750,000\frac{Btu}{hr}$$

Use the Coefficient of Performance for a refrigeration cycle to determine the work done by the compressor.

$$COP_R = \frac{\dot{Q}_{in}}{\dot{W}_{in}}$$

$$\dot{W}_{in} = \frac{\dot{Q}_{in}}{COP} = \frac{2,750,000\frac{Btu}{hr}}{4.8} = 572,917\frac{Btu}{hr}$$

The condenser load is the total heat rejected by the condenser which is the sum of the heat absorbed by the evaporator and the compressor input energy. Calculate $\dot{Q}_{out}$. Convert units from $\frac{Btu}{hr}$ to $tons$.

$$\dot{Q}_{out} = \dot{Q}_{in} + \dot{W}_{in}$$

$$\dot{Q}_{out} = 2,750,000\frac{Btu}{hr} + 572,917\frac{Btu}{hr} = 3,322,917\frac{Btu}{hr}$$

$$\dot{Q}_{out} = 3,322,917\frac{Btu}{hr}\left(\frac{1ton}{12,000\frac{Btu}{hr}}\right) = 277tons$$

Answer C

47.60 **A single phase $240V$ motor drives a pump that supplies $100\frac{lb_m}{min}$ of $80°F$ water and adds $400ft$ of pressure head. The pump is 70% efficient and the motor is 90% efficient. What is the current drawn by the motor?**

A. $3A$

B. $4A$

C. $5A$

D. $6A$

Use the Properties of Water table to look up the density of water at $80°F$. Use the density and the mass flow rate to find the volume flow rate. Convert units to gpm.

$$\rho = 62.2\frac{lb_m}{ft^3}$$

$$\dot{m} = \rho Q$$

$$Q = \frac{\dot{m}}{\rho} = \frac{100\frac{lb_m}{min}}{\left(62.4\frac{lb_m}{ft^3}\right)\left(\frac{1ft^3}{7.48gal}\right)} = 12gpm$$

Calculate the Water Horsepower delivered by the pump.

$$whp = \frac{Qh}{3960}$$

$$whp = \frac{(12)(400)}{3960} = 1.21hp$$

Use the pump and motor efficiencies to calculate the input power to the motor. Convert units to KW.

$$P_{[KW]} = \frac{whp}{\eta_m \eta_p} = \frac{(1.21hp)\left(0.7457\frac{KW}{hp}\right)}{(0.7)(0.9)} = 1.44KW$$

Select the equation in the table Power for Different Motor Phases for single-phase motors to determine the current. Assume the power factor is unity. Write and check all units.

$$P_{[KW]} = IV\,(pf)$$

$$I_{[amps]} = \frac{P_{[KW]}\left(\frac{1000W}{KW}\right)}{V\,(pf)} = \frac{(1.44KW)\left(\frac{1000W}{KW}\right)}{(240V)(1)} = 6A$$

Answer D