47.31 A heated indoor swimming pool is maintained at $78°F$. Evaporation of pool water introduces moisture into the surrounding space at a rate of $4\frac{lb}{min}$. The room is maintained at $80°F$ and 60% relative humidity by exhausting a constant volume of room air and replacing it with outside air at $85°F$ db / $65°F$ wb. What volume flow rate of outside air is required to achieve the intended dehumidification?

A. $9800 cfm$

B. $11,600 cfm$

C. $12,300 cfm$

D. $18,100 cfm$

Sketch the pool room and label the outside air and room air. The primary driver for the required volume flow rate of outside air is the difference in humidity ratio between the inside and outside conditions, both of which are fully defined states. Use the Psychrometric Chart to obtain both humidity ratios. Also obtain the specific volume for the outside air condition.

$$T_r = 80°F$$

$$\phi_r = 60\%$$

$$\omega_r = 0.01321\frac{lb_w}{lb_{da}}$$

$$T_{OA,db} = 85°F$$

$$T_{OA,wb} = 65°F$$

$$\omega_{OA} = 0.00865\frac{lb_w}{lb_{da}}$$

$$v_{OA} = 13.97\frac{ft^3}{lb_{da}}$$

Using the equation under Moist-Air Cooling and Dehumidification, then substitute for the mass flow rate of air, $\dot{m}_a$, and rearrange for the volume flow rate of outside air, Q_{OA}. The mass flow rate of water, $\dot{m}_w$, is the evaporation rate of pool water into the room air, which is given. Substitute and solve.

$$\dot{m}_w = \dot{m}_a \Delta\omega$$

$$\dot{m}_a = \rho_{OA} Q_{OA} = \frac{Q_{OA}}{v_{OA}}$$

$$\dot{m}_w = \frac{Q_{OA}}{v_{OA}} \Delta\omega \rightarrow Q_{OA} = \frac{\dot{m}_w v_{OA}}{\Delta\omega}$$

$$Q_{OA} = \frac{\left(4\frac{lb_w}{min}\right)\left(13.97\frac{ft^3}{lb_{da}}\right)}{\left(0.01321\frac{lb_w}{lb_{da}} - 0.00865\frac{lb_w}{lb_{da}}\right)} = 12,254\frac{ft^3}{min}$$

Answer C

47.32 A refrigeration cycle provides $8tons$ of cooling with a COP of 4.2. What is the required compressor horsepower?

A. $9hp$

B. $12hp$

C. $31hp$

D. $38hp$

Recall from Thermodynamics the formula for Coefficient of Performance for a refrigeration cycle.

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

Rearrange for the compressor work, $\dot{W}_{in}$. Substitute, solve, and convert units to hp.

$$\dot{W}_{in} = \frac{\dot{Q}_L}{COP} = \frac{8tons}{4.2}\left(12,000\frac{Btu}{hr \cdot ton}\right)\left(\frac{1W}{3.412\frac{Btu}{hr}}\right)\left(\frac{1hp}{745.7W}\right) = 9hp$$

Answer A