35.29 A cooling tower has a range of $15°F$ and a volume flow rate of $50gpm$. Air enters at $88°F$ dry bulb and $75°F$ wet bulb and exits at $92°F$ and 75% relative humidity. Assuming no losses, what is the required volume flow rate of air?

A. $3,300cfm$

B. $7,700cfm$

C. $8,200cfm$

D. $10,900cfm$

The heat rejected by the condenser water is absorbed into the air. Use the sensible heat rule of thumb for water to determine the quantity of heat removed from the condenser water.

$$\dot{Q}_{cw} = \dot{Q}_{air}$$

$$\dot{Q}_{cw} = 500GPM\Delta T = (500)(50)(15) = 375,000\frac{Btu}{hr}$$

$$\dot{Q}_{air} = \dot{m}\Delta h = 375,000\frac{Btu}{hr}$$

Use the Psychrometric Chart to determine the enthalpy for the entering and leaving air as well as the specific volume for the entering air. Let State 1 represent the entering condition and State 2 represent the leaving condition.

$$T_{1,db} = 88°F$$

$$T_{1,wb} = 75°F$$

$$h_1 = 38.47\frac{Btu}{lb}$$

$$v_1 = 14.2\frac{ft^3}{lb_{da}}$$

$$T_2 = 92°F$$

$$\phi_2 = 75\%$$

$$h_2 = 49.23\frac{Btu}{lb}$$

Solve for the mass flow rate of air using the enthalpy values.

$$\dot{m} = \frac{\dot{Q}}{\Delta h} = \frac{\dot{Q}}{h_2 = h_1} = \frac{375,000\frac{Btu}{hr}}{49.23\frac{Btu}{lb} - 38.47\frac{Btu}{lb}} = 34,851\frac{lb}{hr}$$

Use the specific volume for State 1 to determine the volume flow rate in cfm.

$$\dot{V} = \dot{m}v_1 = \left(34,851\frac{lb}{hr}\right)\left(\frac{1hr}{60min}\right)\left(14.2\frac{ft^3}{lb}\right) = 8,248cfm$$

Answer C