$$\dot{m} = \frac{\dot{V}}{v}$$

Substitute and solve:

$$\dot{m}_w = \frac{\dot{V}}{v}(\omega_2 - \omega_1)$$

$$\dot{m}_w = \frac{\left(2000\frac{ft^3}{min}\right)}{\left(11.85\frac{ft^3}{lb}\right)}\left(.00893\frac{lb_w}{lb_{da}} - .00065\frac{lb_w}{lb_{da}}\right) = 1.4\frac{lb}{min}$$

Multiply by time and divide by density to find the volume of water added in 24 hours. Note if the humidity ratio of state 1 is taken as zero, the result will be overstated by 7%, still leading to the correct answer choice.

$$1.4\frac{lb}{min}\left(60\frac{min}{hr}\right)(24hr)\left(\frac{1ft^3}{62.4lb}\right)\left(\frac{7.48gal}{ft^3}\right) = 242\,gal$$

Answer D

43.5 A warehouse located in a damp climate uses two-pipe heating fan coil units to maintain a maximum relative humidity of 60%. With the fan coil units disabled and all heating control valves closed, the room reaches $62°F$ and 80% RH. There are (12) $\times$ $200cfm$ fan coil units. What is the required heating capacity per unit?

A. $1800\frac{Btu}{hr}$

B. $2300\frac{Btu}{hr}$

C. $22,000\frac{Btu}{hr}$

D. $28,000\frac{Btu}{hr}$

The fan coil units provide heating only; therefore, they cannot remove any moisture from the air, as that would require a cooling process to drive dehumidification. To maintain a maximum relative humidity, the air must be heated. This may initially seem counter-intuitive, but recall that warmer air has a greater *capacity* for holding moisture. Sufficient heating (without any change to the humidity ratio) will drive the relative humidity down.

Drawing this on the psychrometric chart, the process line is horizontal to the right for purely sensible heating. State 1 is fully defined. Obtain the dew point temperature (alternatively the humidity ratio may also be used, as both parameters will keep the process line horizontal when held constant).

$$T_{db,1} = 62°F$$

$$\phi_1 = 80\%$$

$$T_{dp,1} = 55.8°F$$

For state 2, since the process line is horizontal, the dew point temperature is the same. Taken together, the dew point and the relative humidity fully define state 2. Obtain the dry bulb temperature at state 2 (after heating).

$$T_{dp,2} = T_{dp,1} = 55.8°F$$

$$\phi_2 = 60\%$$

$$T_{db,2} = 70.4°F$$

Use the sensible heating rule of thumb to calculate the required heating capacity to increase the dry bulb temperature from state 1 to state 2. Note it is not necessary to multiply by the number of fan coil units as the problem asks for the capacity per unit.

$$\dot{Q}_s = 1.08cfm\Delta T$$

$$\dot{Q}_s = 1.08\,(200)\,(70.4 - 62) = 1814\frac{Btu}{hr}$$

Answer A

43.6 A $5000ft^2$ laboratory has 200 occupants in the summer. In addition to the required fresh air, additional outside air at $90°F$ db, $75°F$ wb infiltrates into the building at 1 air change per hour. The building volume is $75,000ft^3$ and the inside design conditions are $72°F$ and 50% RH. What is the total cooling delivered by the ventilation system?

A. $7tons$

B. $8tons$

C. $19tons$

D. $21tons$

The cooling capacity of the ventilation system must be sized for both the minimum fresh air provision and the infiltration.

Look up ventilation rates in the Reference Handbook and find a table with different occupancy categories. Note the minimum ventilation requirements for a laboratory per person and per square foot are:

$$R_p = 10\frac{cfm}{person}$$