47.75 A room is maintained at $74°F$ and 50% relative humidity by supplying $8000cfm$ of $60°F$ supply air. The room has a sensible heat load of $150,000\frac{Btu}{hr}$ and a sensible heat ratio of 0.75. $1000cfm$ of air is exhausted from the space and a corresponding volume of outside air at $92°F$ db / $74°F$ wb is introduced. What is the wet bulb temperature of the supply air?

A. $50°F$

B. $53°F$

C. $55°F$

D. $58°F$

Sketch the system and label with given information. Apply the Sensible Heat Ratio to determine the total heat load in the room.

$$SHR = \frac{\dot{Q}_s}{\dot{Q}_t}$$

$$\dot{Q}_t = \frac{\dot{Q}_s}{SHR} = \frac{150,000\frac{Btu}{hr}}{0.75} = 200,000\frac{Btu}{hr}$$

Determine the enthalpy of the room/return condition using the Psychrometric Chart.

$$T_{room} = 74°F\,db\,/\,50\%\,RH$$

$$h_{room} = 27.56\frac{Btu}{lb}$$

Draw a system boundary around the room and the supply/return air only. Ignore the exhaust air, outside air, and mixing prior to the cooling coil. Use the total cooling rule of thumb for air to determine the enthalpy of the supply air, which depends on the total heat load in the room as previously calculated, the enthalpy of the room/return condition, and the supply airflow.

$$\dot{Q}_t = 4.5cfm\Delta h = 4.5cfm\left(h_{room} - h_{supply}\right)$$

$$h_{supply} = h_{room} - \frac{\dot{Q}_t}{4.5cfm} = 27.56 - \frac{200,000}{(4.5)\,(8000)} = 22\frac{Btu}{lb}$$

Use the Psychrometric Chart again to determine the supply wet-bulb temperature corresponding to the enthalpy.

$$T_{supply,wb} = f\left(h_{supply}\right) \approx 53°F$$

Answer B

47.76 An expansion tank consists of an air bladder which is filled to a pressure of $10psig$ which sits atop a column of water $4ft$ high. The tank has a single opening at the bottom of the tank. What is the pressure at the opening?

A. $12psia$

B. $26psia$

C. $29psia$

D. $34psia$

Consider the static pressure due to the air bladder and the height of the water column which exerts additional hydrostatic pressure on the point of interest. Neglect velocity pressure.

$$P = P_s + \gamma z$$

Since the answer choices are in *absolute* pressure, convert the bladder pressure from $psig$ to $psia$.

$$P_s = 10psig + 14.7psi = 24.7psia$$

For the water column, divide by the coversion factor rule of thumb for water, $2.31\frac{ft}{psi}$.

$$\frac{4ft}{2.31\frac{ft}{psi}} = 1.73psi$$

Solve for the total pressure.

$$P = 24.7psia + 1.73psi = 26.43psia$$

Answer B

47.77 How much air is required to burn $25lb$ of methane with 30% excess air?

A. $260lb$

B. $340lb$

C. $430lb$

D. $560lb$

Use the Combustion Reactions of Common Fuel Constituents table and consider the reaction and Stoichiometric Oxygen and Air Requirements for methane. Optionally, re-write the reaction including nitrogen on both sides to validate the stoichiometric air requirements provided in the table. Calculate the air-to-fuel ratio on a molar/volume basis as well as on a mass basis. Use the Periodic Table for atomic weights as needed. Alternatively, use the values provided directly in the table.