46.66 **Water flows at $4fps$ through a $200ft$ pipe with inside diameter of $1.45in$. The Moody friction factor is 0.028. What is the pressure drop?**

A. $1.2psi$

B. $5.0psi$

C. $11.5psi$

D. $59.8psi$

Use the Darcy equation for Head Loss Due to Flow to calculate the head loss based on the given information.

$$h_f = \frac{fLv^2}{2Dg} = \frac{(0.028)(200ft)\left(4\frac{ft}{s}\right)^2}{2\left(\frac{1.45}{12}ft\right)\left(32.2\frac{ft}{s^2}\right)} = 11.51ft$$

Convert the head loss in ft to a pressure drop in psi. These terms are often used interchangably. Converting between pressure units and length units is trivial provided the fluid is water.

$$\Delta p = 11.51ft\left(\frac{1psi}{2.31ft}\right) = 4.98psi$$

Answer B

46.67 **An energy recovery device is used to pre-cool $5000cfm$ of outside air at $95°F$ db / $75°F$ wb. An equivalent volume of return air enters the device at $76°F$ and 50% relative humidity. After passing through the device the exhaust air is discharged outside at $84°F$ db / $70°F$ wb. What is the reduction in cooling demand provided by the energy recovery wheel?**

A. $4tons$

B. $8tons$

C. $10tons$

D. $18tons$

Sketch the energy recovery device, considering the outside air as State 1, the supply air as State 2, the exhaust air as State 3, and the return air as State 4. Since the problem statement makes no reference to any losses or effectiveness, assume 100% of the heat absorbed by the exhaust stream from $4 \rightarrow 3$ is removed from the supply stream $1 \rightarrow 2$. For an energy recovery device, both sensible and latent heat are transferred, so it is appropriate to quantify the total heat gained by the exhaust path using the change in enthalpy which accounts for both sensible and latent energy. State 3 and State 4 are both fully defined, so use the Psychrometric Chart to obtain the enthalpies, h_3 and h_4.

$$T_{3,db} = 84°F$$

$$T_{3,wb} = 70°F$$

$$h_3 = 33.96\frac{Btu}{lb}$$

$$T_4 = 76°F$$

$$\phi_4 = 50\%$$

$$h_4 = 28.74\frac{Btu}{lb}$$

Use the total heating rule of thumb to calculate the total heat added to the exhaust stream, and thus removed from the supply stream. Convert to refrigeration *tons*.

$$\dot{Q}_t = 4.5cfm\Delta h = 4.5\,(5000)\,(33.96 - 28.74) = 117,450\frac{Btu}{hr}$$

$$\dot{Q}_t = \frac{117,450\frac{Btu}{hr}}{12,000\frac{Btu}{hr \cdot ton}} = 9.8tons$$

Answer C

46.68 A 75% effective enthalpy wheel supplies $2000cfm$ of tempered air by recovering energy from a return air stream at $74°F$ and 50% relative humidity. The entering outside air is $96°F$ db / $76°F$ wb. What is the dry bulb temperature of the tempered air?

A. $76°F$

B. $79°F$

C. $82°F$

D. $85°F$

An enthalpy wheel is an example of an Energy-Recovery Ventilator (ERV). Therefore, both sensible and latent energy are transferred through the device. However, the question is concerned only with the *dry bulb temperature* of the tempered air, therefore it is not necessary to consider the enthalpy values in this case. (To be clear, it wouldn't be incorrect or inappropriate to explore the enthalpies as both sensible and latent heat are being conveyed when using an enthalpy wheel; it simply is not necessary in this case.) The effectiveness of the enthalpy wheel applies to both the sensible and latent heat being transfered in an equal manner. In other words, 75% of the possible sensible heat is being transferred, and 75% of the possible latent heat is being transferred.