46.65 During initial operating conditions, the cooling coil in a computer room air conditioning unit cools $90°F$ entering air to $65°F$. The unit uses $56°F$ supply chilled water to drive the coil temperature to an apparatus dew point of $60°F$. The coil is designed for a maximum air side delta T of $25°F$. After an increase in heat load, the same unit is met with $95°F$ return air. In order to stay safely within the coil's temperature limits, operators raise the chilled water supply temperature to $63°F$ such that the apparatus dew point becomes $67°F$. What is the expected discharge air temperature based on the new operating conditions?

A. $68.3°F$

B. $70.0°F$

C. $71.7°F$

D. $72.5°F$

Consider the original operating conditions as Case A and the final operating conditions as Case B. Calculate the coil efficiency for Case A. Coil efficiency is the ratio of the actual ΔTaccross the coil as compared to the maximum possible ΔT which occurs when the discharge air has been cooled to the apparatus dew point (ADP).

$$\eta_A = \frac{T_{return,A} - T_{discharge,A}}{T_{return,A} - ADP_A} = \frac{90°F - 65°F}{90°F - 60°F} = 0.833$$

Assume the coil efficiency remains constant for the new set of operating conditions.

$$\eta_B = \eta_A = 0.833$$

Use the new return temperature and new ADP for Case B to determine the new discharge temperature, $T_{discharge,B}$, after the change.

$$\eta_B = \frac{T_{return,B} - T_{discharge,B}}{T_{return,B} - ADP_B} = \frac{95°F - T_{discharge,B}}{95°F - 67°F} = 0.833$$

$$T_{discharge,B} = 71.7°F$$

While it is not required for the solution, it is noteworthy that the reduction in ΔT on the air side will require an increase in cfm to satisfy the same cooling demand, and since the problem states that the heat load has been *increased*, this compounds the need for additional airflow!

Answer C

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.