

Sketch the enthalpy wheel and label with all given information. Equate the effectiveness to the ratio of the actual delta T achieved between the outside air and the tempered air as compared to the maximum delta T possible, which would be the difference between the outside air and the return air. It is recommended to arrive at this relation through reasoning since the HRV/ERV formulas in the Reference Handbook are unnecessarily convoluted.

$$\varepsilon = \frac{T_{OA} - T_{TA}}{T_{OA} - T_{RA}}$$

$$0.75 = \frac{96^\circ F - T_{TA}}{96^\circ F - 74^\circ F}$$

$$T_{TA} = 79.5^\circ F$$

Answer B

46.69 10,000cfm of air at 90°F db / 54°F wb enters an evaporative cooler using a 50°F water spray to produce 60°F leaving air. What is the saturation efficiency?

- A. 62%
- B. 67%
- C. 75%
- D. 83%

Sketch the evaporative cooler and label the entering and leaving air conditions. Consider the entering condition as State 1 and the leaving condition as State 2. Use the formula for **Saturation Efficiency**. The numerator is the actual ΔT observed, and the denominator is the maximum possible ΔT achievable if the leaving air was reduced to the wet bulb temperature of the entering air. This would imply 100% saturation efficiency. The volume flow rate of the air and the spray temperature are excess information.

$$\varepsilon_e = \frac{T_1 - T_2}{T_1 - T_{1,wb}} = \frac{90^\circ F - 60^\circ F}{90^\circ F - 54^\circ F} = 0.833 = 83.3\%$$

Answer D

46.70 Steam enters a 75% efficient turbine at a pressure of 800psia and a temperature of 700°F and exits at atmospheric pressure. What is the specific work produced by the turbine?

- A. $250\frac{\text{Btu}}{\text{lb}}$
- B. $330\frac{\text{Btu}}{\text{lb}}$
- C. $1010\frac{\text{Btu}}{\text{lb}}$
- D. $1190\frac{\text{Btu}}{\text{lb}}$

Consider the entering steam as State 1 and the exiting steam as State 2. Use the properties of **Superheated Steam** tables to obtain the enthalpy and entropy at State 1.

$$P_1 = 800\text{psia}$$

$$T_1 = 700^\circ\text{F}$$

$$h_1 = 1338.4\frac{\text{Btu}}{\text{lb}}$$

$$s_1 = 1.548\frac{\text{Btu}}{\text{lb}\cdot\text{R}}$$

Find the *ideal* entropy and enthalpy at State 2 by imagining the turbine was isentropic i.e. 100% efficient. Use the properties of **Saturated Water and Steam** table to look up entropy values to determine the ideal quality for State 2, and use the quality to find the ideal enthalpy at State 2.

$$s_2 = s_1 = 1.548\frac{\text{Btu}}{\text{lb}\cdot\text{R}}$$

$$P_2 = 14.7\text{psia}$$

$$s_f = 0.3122\frac{\text{Btu}}{\text{lb}\cdot\text{R}}$$

$$s_{fg} = 1.4443\frac{\text{Btu}}{\text{lb}\cdot\text{R}}$$

$$h_f = 180.18\frac{\text{Btu}}{\text{lb}}$$

$$h_{fg} = 970.07\frac{\text{Btu}}{\text{lb}}$$

$$\chi_2 = \frac{s_2 - s_f}{s_{fg}} = \frac{1.548\frac{\text{Btu}}{\text{lb}\cdot\text{R}} - 0.3122\frac{\text{Btu}}{\text{lb}\cdot\text{R}}}{1.4443\frac{\text{Btu}}{\text{lb}\cdot\text{R}}} = 0.856$$