31.26 **$3\frac{lb}{min}$ of $500°F$ saturated steam enters an open feedwater heater in addition to $1gpm$ of $60°F$ water at $14.7psia$. What is the enthalpy of the exit stream after mixing?**

A. $230\frac{Btu}{lb}$

B. $340\frac{Btu}{lb}$

C. $450\frac{Btu}{lb}$

D. $560\frac{Btu}{lb}$

Consider the saturated steam as State 1, the $60°F$ water as State 2, and the exit stream as State 3.

Use the Properties of Saturated Water table to obtain the enthalpy for State 1.

$$\dot{m}_1 = 3\frac{lb}{min}$$

$$T_1 = 500°F\,(saturated)$$

$$h_1 = 1202.32\frac{Btu}{lb}$$

For State 2, calculate the mass flow rate of water. Convert units to align with the mass flow rate in State 1, $\frac{lb}{min}$.

$$\dot{m}_2 = \rho Q = \left(62.4\frac{lb}{ft^3}\right)\left(1\frac{gal}{min}\right)\left(\frac{1ft^3}{7.48gal}\right) = 8.34\frac{lb}{min}$$

Notice that for State 2, working with the Properties of Saturated Water and Steam table, the temperature is lower than the saturation temperature at atmospheric pressure; therefore, the water is a compressed liquid. To find the enthalpy, h_2, use the specific heat capacity, temperature differential, and enthalpy at saturation.

$$\Delta h = c_p \Delta T$$

$$h_{sat} - h_2 = c_p\,(T_{sat} - T_2)$$

$$h_2 = h_{sat} - c_p\,(T_{sat} - T_2) = 180.2\frac{Btu}{lb} - \left(1\frac{Btu}{lb°F}\right)(212°F - 60°F) = 28.2\frac{Btu}{lb}$$

Write the energy balance and solve for h_3.

$$\dot{m}_1 h_1 + \dot{m}_2 h_2 = \dot{m}_3 h_3$$

$$h_3 = \frac{\dot{m}_1 h_1 + \dot{m}_2 h_2}{\dot{m}_3} = \frac{\dot{m}_1 h_1 + \dot{m}_2 h_2}{\dot{m}_1 + \dot{m}_2} = \frac{\left(3\frac{lb}{min}\right)\left(1202.32\frac{Btu}{lb}\right) + \left(8.34\frac{lb}{min}\right)\left(28.2\frac{Btu}{lb}\right)}{3\frac{lb}{min} + 8.34\frac{lb}{min}} = 339\frac{Btu}{lb}$$

Answer B