36.39 What is the quality of $1300 psia$ steam produced by a boiler that adds $600 \frac{Btu}{lb}$ to $250°F$ saturated liquid feedwater?

A. 0.22

B. 0.39

C. 0.61

D. 0.78

Consider the feedwater as State 1 and the saturated mixture leaving the boiler as State 2. Use the Properties of Saturated Water and Steam table by temperature to obtain the enthalpy at State 1.

$$T_1 = 250°F \, (saturated)$$

$$h_1 = h_f = 218.6 \frac{Btu}{lb}$$

Calculate the enthalpy at State 2 by accounting for the heat added by the boiler.

$$\Delta h = h_2 - h_1 = 600 \frac{Btu}{lb}$$

$$h_2 = h_1 + 600 \frac{Btu}{lb} = 218.6 \frac{Btu}{lb} + 600 \frac{Btu}{lb} = 818.6 \frac{Btu}{lb}$$

Use the steam table by pressure to obtain the enthalpy values h_f and h_{fg} at $1300 psia$. Then calculate the quality at State 2.

$$P_2 = 1300 psia$$

$$h_f = 585.6 \frac{Btu}{lb}$$

$$h_{fg} = 593.9 \frac{Btu}{lb}$$

$$\chi_2 = \frac{h_2 - h_f}{h_{fg}} = \frac{818.6 \frac{Btu}{lb} - 585.6 \frac{Btu}{lb}}{593.9 \frac{Btu}{lb}} = 0.39$$

Answer B