37.78 $50\frac{lb}{min}$ **of steam enters a turbine at** $800°F$ **and** $600psia$ **and exits at** $10psia$**. How much power is produced by the turbine assuming 100% efficiency?**

A. $233KW$

B. $259KW$

C. $320KW$

D. $375KW$

Consider the entering superheated steam as State 1 and the exiting saturated steam as State 2. State 1 is full defined. Use the properties of Superheated Steam table to obtain the enthalpy and entropy for State 1.

$$P_1 = 600psia$$

$$T_1 = 800°F$$

$$h_1 = 1408\frac{Btu}{lb}$$

$$s_1 = 1.635\frac{Btu}{lb \cdot R}$$

Use the properties of Saturated Water and Steam table to obtain enthalpy and entropy values for saturated steam at P_2. The expansion process is isentropic i.e. 100% efficient. Calculate the quality and enthalpy at State 2.

$$P_2 = 10psia$$

$$h_f = 161.24\frac{Btu}{lb}$$

$$h_{fg} = 981.82\frac{Btu}{lb}$$

$$s_f = 0.2836\frac{Btu}{lb \cdot R}$$

$$s_{fg} = 1.504\frac{Btu}{lb \cdot R}$$

$$s_2 = s_1 = 1.635\frac{Btu}{lb \cdot R}$$

$$\chi_2 = \frac{s_2 - s_f}{s_{fg}} = \frac{1.635\frac{Btu}{lb \cdot R} - 0.2836\frac{Btu}{lb \cdot R}}{1.504\frac{Btu}{lb \cdot R}} = 0.899$$

$$h_2 = h_f - \chi_2 h_{fg} = 161.24\frac{Btu}{lb} + 0.899\left(981.82\frac{Btu}{lb}\right) = 1043.4\frac{Btu}{lb}$$

Determine the power produced by the turbine. Convert units to KW.

$$\dot{W}_{out} = \dot{m}\left(h_1 - h_2\right)$$

$$\dot{W}_{out} = \left(50\frac{lb}{min}\right)\left(\frac{60min}{hr}\right)\left(1408\frac{Btu}{lb} - 1043.4\frac{Btu}{lb}\right) = 1.09 \times 10^6\frac{Btu}{hr}$$

$$\dot{W}_{out} = \left(1.09 \times 10^6\frac{Btu}{hr}\right)\left(\frac{1KW}{3412\frac{Btu}{hr}}\right) = 320KW$$

Answer C