34.4 **$1000\frac{lb}{min}$ of $90°F$ atmospheric air is compressed and stored in a tank at $150psia$. The compressor has an efficiency of 92%. How much power is required to drive the compressor?**

A. $2100hp$

B. $2700hp$

C. $3200hp$

D. $5600hp$

Consider the entering air as State 1 and the exiting air being stored in the tank as State 2. Look up Constant Entropy Process and use the equation below to find the *isentropic exit temperature* i.e. the ideal exit temperature if the compression process was isentropic. Use absolute temperature units i.e. Rankine.

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$$

$$T_{es} = T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} = (550R)\left(\frac{150psia}{14.7psia}\right)^{\frac{1.4-1}{1.4}} = 1068R = 608°F$$

Use the Compressor Isentropic Efficiency to find the actual exit temperature for the compressor, T_e.

$$\eta_C = \frac{T_{es} - T_i}{T_e - T_i}$$

$$T_e = T_i + \frac{(T_{es} - T_i)}{\eta_C}$$

$$T_e = 90°F + \frac{(608°F - 90°F)}{0.92} = 653°F$$

Calculate the power to drive the Compressor. Use Measurement Relationships to convert units to hp.

$$\dot{W}_{comp} = \dot{m}c_p\left(T_e - T_i\right)$$

$$\dot{W}_{comp} = \left(1000\frac{lb}{min}\right)\left(0.24\frac{Btu}{lb°F}\right)(653°F - 90°F) = 135,130\frac{Btu}{min}$$

$$\dot{W}_{comp} = 135,130\frac{Btu}{min}\left(\frac{1hp}{42.4\frac{Btu}{min}}\right) = 3178hp$$

Answer C