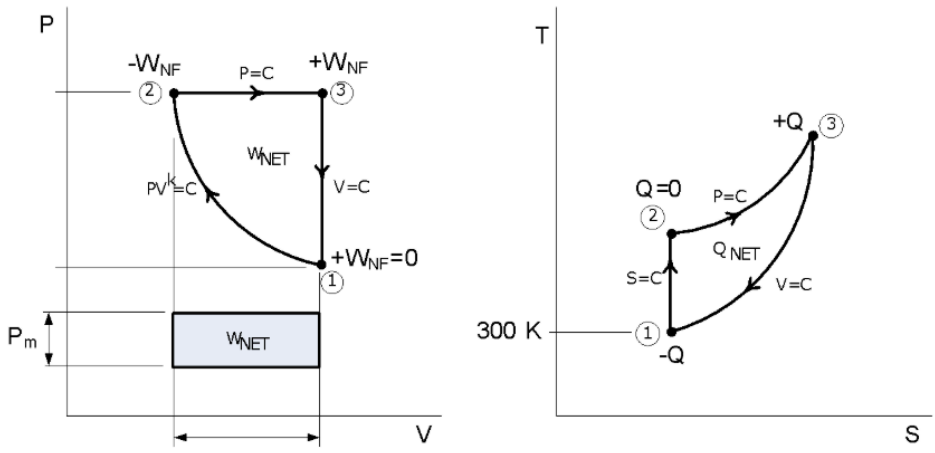

<u>Step 1:</u> Calculate the Isentropic Compression Ratio (r_k)

The compression ratio ($\mathbf{r_k}$) characterizes the structural volume constraints of the engine cycle across its primary compression path. For an ideal gas undergoing a reversible adiabatic (isentropic) compression from State 1 to State 2, absolute pressures and total volumes are governed by the process relationship $P_1V_1^k = P_2V_2^k$. Isolating the ratio of initial volume to compressed volume yields:

$$r_k = \frac{V_1}{V_2} = \left[\frac{P_2}{P_1}\right]^{\frac{1}{k}} = \left[\frac{1200\ kPa}{150\ kPa}\right]^{\frac{1}{1.4}}$$

$$r_k = 4.4164$$