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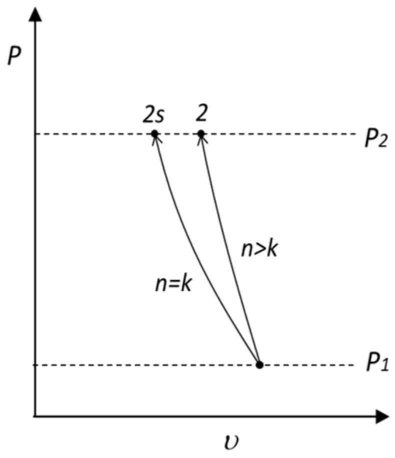
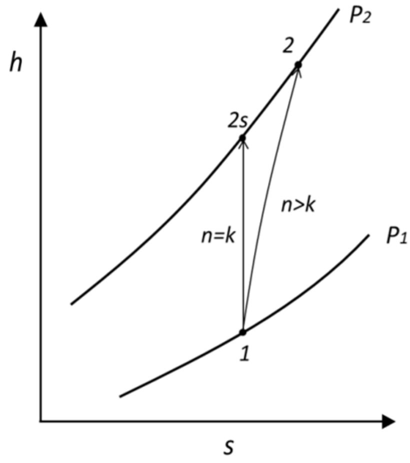
Compression processes – Dry gas





Isentropic compression process: $pv^k = constant$

$$\frac{T_{2s}}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}}$$

Polytropic compression process: $pv^n = constant$

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

$Ideal\ gas: \quad pv = RT$

$Real\ gas: \quad pv = ZRT$

$Specific\ Enthalpy: \quad h = u + pv \quad \left[\frac{J}{kg}\right]$

$Specific\ Heats: \quad C_p = \left(\frac{\partial h}{\partial T}\right)_P \quad \left[\frac{J}{kg.K}\right]$

$C_v = \left(\frac{\partial u}{\partial T}\right)_v \quad \left[\frac{J}{kg.K}\right]$

$k = \frac{C_p}{C_v}$

$Ideal\ gas: \quad h = C_p \cdot T \quad \left[\frac{J}{kg}\right]$

Isentropic efficiency:

$$\eta_c = \frac{\left[\left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} - 1\right]}{\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]}$$

Isentropic enthalpy head:

$$\Delta h_s = T_1 Z_{av} R \frac{k}{k-1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{k-1}{k}} - 1\right]$$

Polytropic efficiency:

$$\frac{n-1}{n} = \frac{k-1}{k \cdot \eta_p}$$

Polytropic enthalpy head:

$$\Delta h_p = T_1 Z_{av} R \frac{n}{n-1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

Polytropic head:

$$H_p = \frac{\Delta h_p}{g} = \frac{T_1 Z_{av} R}{g}\frac{n}{n-1}\left[\left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} - 1\right]$$

Required power:

$$Power = \frac{\dot{m} \cdot \Delta h_s}{\eta_c \cdot \eta_m} = \frac{\dot{m} \cdot \Delta h_p}{\eta_p \cdot \eta_m} = \frac{\rho \cdot g \cdot Q \cdot H_{\mathrm{p}}}{\eta_p \cdot \eta_m}$$

Discharge (exit) temperature:

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