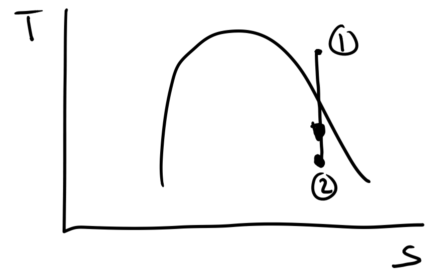
5.2) Isentropic Efficiencies

Isentropic Process

- Constant entropy



Isentropic Process for an Ideal Gas

$s_2 - s_1 = s_2^\circ - s_1^\circ - R\ln\left(\frac{p_2}{p_1}\right)$ ($s_2 - s_1 \to 0$ (Isentropic))

$\frac{p_2}{p_1} = \frac{e^{(s_2^\circ/R)}}{e^{(s_1^\circ/R)}}$

$e^{(s^\circ/R)} \Rightarrow p_r \Rightarrow$ Table A-22

$$\frac{p_2}{p_1} = \frac{p_{r2}}{p_{r1}}$$

$pv = RT \qquad p = \frac{RT}{v}$

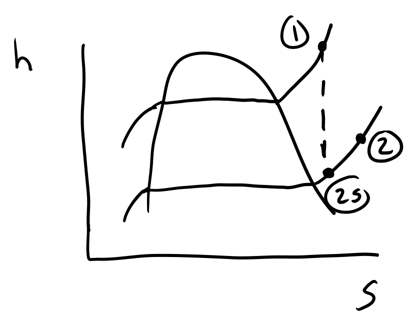
$$\frac{v_2}{v_1} = \frac{v_{r2}}{v_{r1}}$$

Air as an ideal gas (Table A-22)

Isentropic Efficiencies

Compares the actual performance with the performance that would be achieved under ideal circumstances (isentropic)

Isentropic Turbine Efficiency



$\eta_t = \frac{\dot{W}_{cv}/\dot{m}}{(\dot{W}_{cv}/\dot{m})_s}$ ← Isentropic

$\Delta KE = \Delta PE = \dot{Q}_{cv} = 0$

$\frac{\dot{W}_{cv}}{\dot{m}} = h_1 - h_2$

$$\left(\frac{\dot{W}_{cv}}{\dot{m}}\right)_s = h_1 - h_{2s}$$

$$\eta_t = \frac{h_1 - h_2}{h_1 - h_{2s}}$$

Isentropic Nozzle Efficiency

$$\eta_{nozzle} = \frac{V_2^2/2}{\left(V_2^2/2\right)_s}$$

Isentropic Compressor and Pump Efficiency

$$\eta_c = \frac{\left(-\dot{W}_{cv}/\dot{m}\right)_s}{-\dot{W}_{cv}/\dot{m}}$$