MEGR3111

$w = \int P\, dv$ Quasi-equilibrium (reversible) process; $h = u + Pv$ Definition, always true

$PV = mRT = n\bar{R}T$ Ideal gas ($T > 2{*}T_{crit}$, $P < 10$ MPa)

$u \approx u_f @ T$; $v \approx v_f @ T$ Subcooled liquid

$h \approx h_f @ T + v_f(P - P_{sat})$ Subcooled liquid

$Q - W = E_2 - E_1$ First law for a process, no constraints

$v = v_f + x(v_g - v_f)$, $u = u_f + x\, u_{fg}$ Two-phase

$Q - W = U_2 - U_1$ First law for a process, closed system, negligible changes in kinetic and potential energy

$C_v = \dfrac{\partial u}{\partial T}$, $C_p = \dfrac{\partial h}{\partial T}$ Definition; $C_v = \dfrac{du}{dT}$, $C_p = \dfrac{dh}{dT}$ u and h functions of temperature only

$u_2 - u_1 = \int C_v\, dT$ Internal energy is a function of temp only; $h_2 - h_1 = \int C_p\, dT$ Enthalpy is a function of temp only

$\oint \delta Q = \oint \delta W$ *Any* thermodynamic cycle

$\dot{m} = \rho \vec{V} A$ steady, 1-d flow

$\dot{Q} + \sum \dot{m}_i\left(h + \dfrac{\vec{V}^2}{2} + gZ\right)_i = \dot{W} + \sum \dot{m}_e\left(h + \dfrac{\vec{V}^2}{2} + gZ\right)_e + \dfrac{dE}{dt}$ First law for control volume

$q + h_1 + \tfrac{1}{2}\vec{V}_1^{\,2} + gZ_1 = w + h_2 + \tfrac{1}{2}\vec{V}_2^{\,2} + gZ_2$ Single-inlet, single-exit, steady flow

$\eta_{th} = \dfrac{w_{net}}{q_H} = 1 - \dfrac{q_L}{q_H}$ Heat engine; $\beta = \dfrac{q_L}{w_{net}}$ Heat pump (cooler); $\gamma = \dfrac{q_H}{w_{net}}$ Heat pump (heater)

$w = -\int v\, dP - \tfrac{1}{2}(\vec{V}_2^{\,2} - \vec{V}_1^{\,2}) - g(Z_2 - Z_1)$ Reversible, steady flow

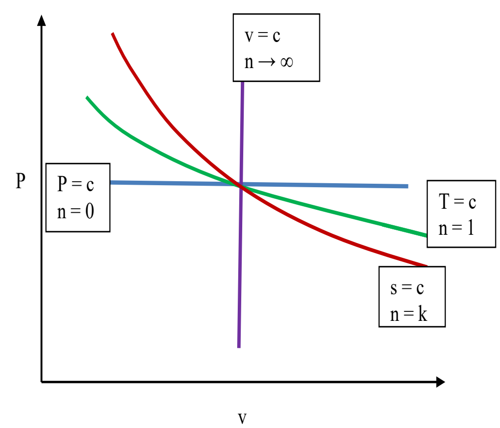
$q = \int T ds$ Reversible process $Q_H/Q_L = T_H/T_L$ Carnot cycle

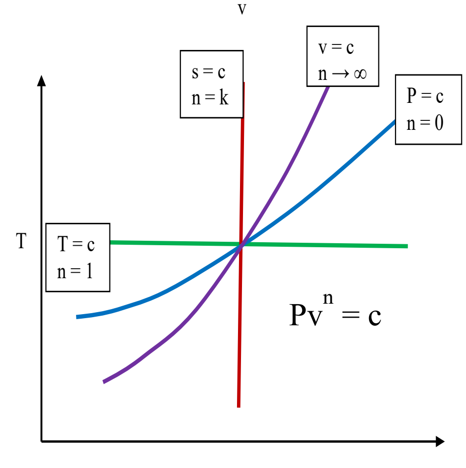
$\dfrac{T_2}{T_1} = \left(\dfrac{P_2}{P_1}\right)^{\frac{k-1}{k}}$; $\dfrac{T_2}{T_1} = \left(\dfrac{v_2}{v_1}\right)^{1-k}$; $\dfrac{P_2}{P_1} = \left(\dfrac{v_1}{v_2}\right)^{k}$ s = const, IG, Cp = const

$\Delta s = C_p \ln\dfrac{T_2}{T_1} - R\ln\dfrac{P_2}{P_1}$, $\Delta s = C_v \ln\dfrac{T_2}{T_1} + R\ln\dfrac{v_2}{v_1}$ IG, const specific heats

$\dfrac{P_{R2}}{P_{R1}} = \dfrac{P_2}{P_1}$; $\dfrac{v_{R2}}{v_{R1}} = \dfrac{v_2}{v_1}$ Isentropic, ideal gas, non-constant specific heats

$\eta_{turbine} = w_a/w_s$ $\eta_{compressor} = w_s/w_a$ $\eta_{pump} = w_s/w_a$ $\eta_{nozzle} = \dfrac{\vec{V}_a^{\,2}}{\vec{V}_s^{\,2}}$





Polytropic processes