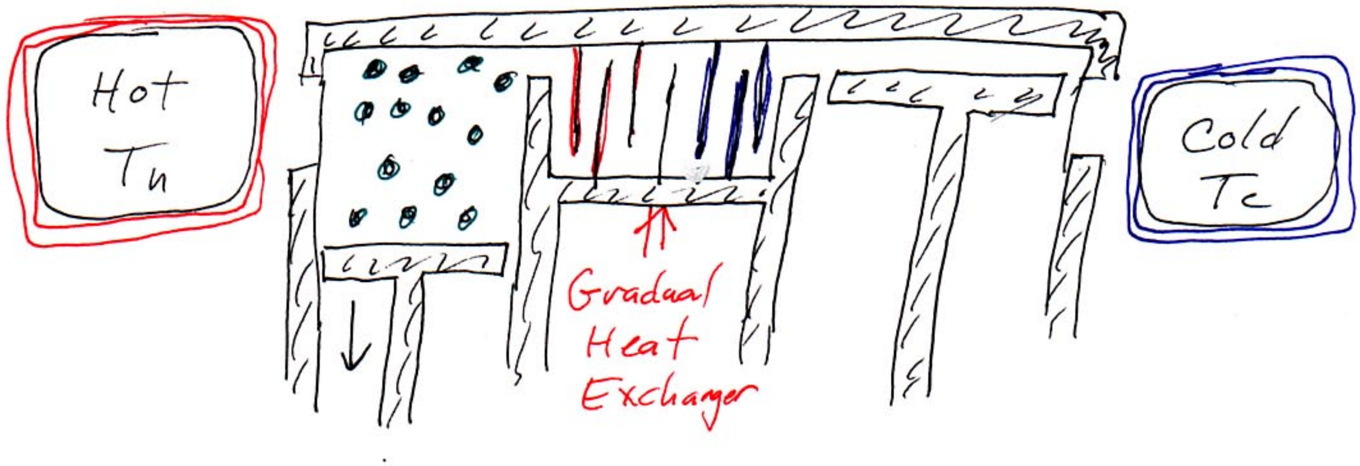
Stirling Engine

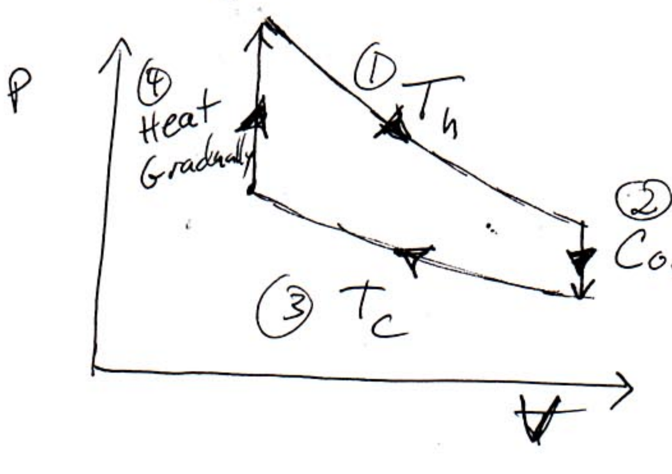


(1) Power (Shown): Gas on left expands, absorbing heat isothermally at T_h

(2) Transfer: Gas pushed into cold side, constant volume, <u>gradually</u> cooled by heat exchanger

(3) Compression: Gas on right compresses isothermally at T_c.

(4) Transfer to hot: Gas pushed to hot side, gradual heating



Gradual Heating & Cooling → No temp. difference → No entropy creation

→ Carnot efficiency!

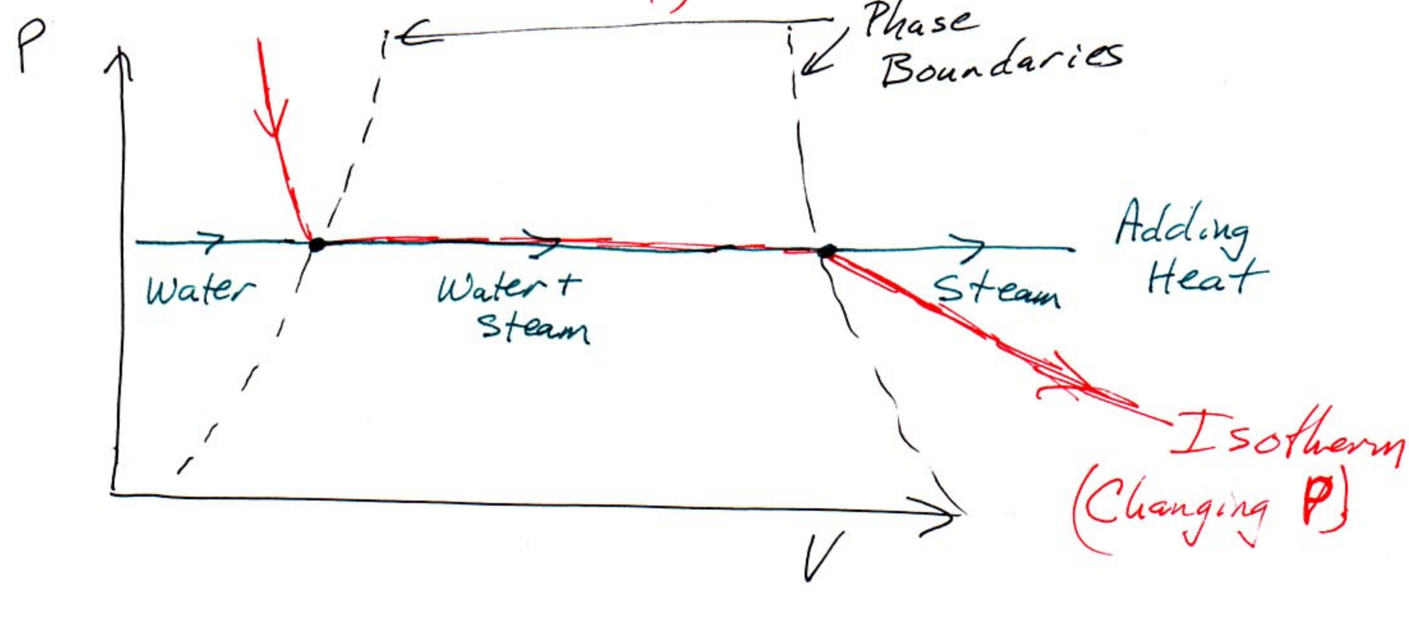
Boiling Water:

Pressure stays constant $\Rightarrow$ Gibbs $G(P,T)$
Temperature stays constant
Volume goes up big time,

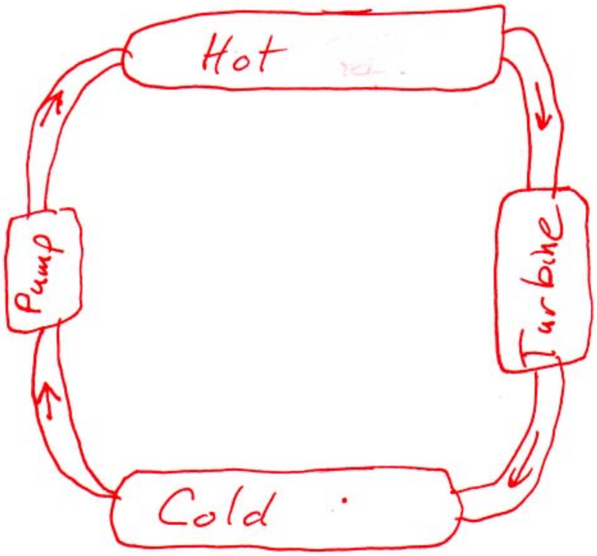
At constant pressure, Gibbs free energy is minimized. $P_{atm} \Rightarrow T_c = 212°F = 100C$.

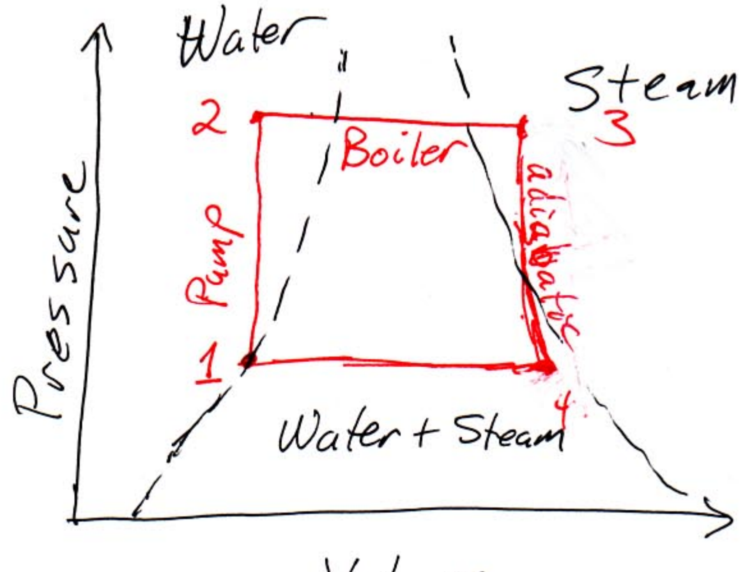
At coexistence, $\underset{\text{Water}}{G_W}(P_{atm}, T_c) = \underset{\text{Steam}}{G_s}(P_{atm}, T_c)$.

$$\left(\begin{array}{l} G = E - TS + PV = F + PV \\ \left.\frac{\partial G}{\partial V}\right|_T = \underbrace{\cancel{\frac{\partial F}{\partial V}}}_{= -P \text{ (Wednesday)}} + \frac{\partial P}{\partial V} V + \cancel{P} = \frac{\partial P}{\partial V} V \end{array} \right) \Rightarrow \text{Maxwell Equal Area}$$



Steam Engine





Steam Tables:

Look up enthalpy ($E+PV=H$) at point 1 (Coexistence curve: saturated water-steam) $H_w(T_1)$

Incompressible water: $H_2 = H_1$ (No need for water table)

Look up $H_3(P_3, T_3)$

Look up $S_3(P_3, T_3)$ - set equal to S_4, find mixture

$\lambda S_w(T_4) + (1-\lambda) S_{steam}(T_4) = S_3(P_3, T_3)$, $H_4 = \lambda H_w(T_4) + (1-\lambda) H_s(T_4)$