**Chemical Engineering 141 Notes**

H = U + PV

ΔH = ΔU + Δ(PV)

**Mass balance in open system**

or = uAp u is the velocity, A is the area, and u is the mass density or the molar density

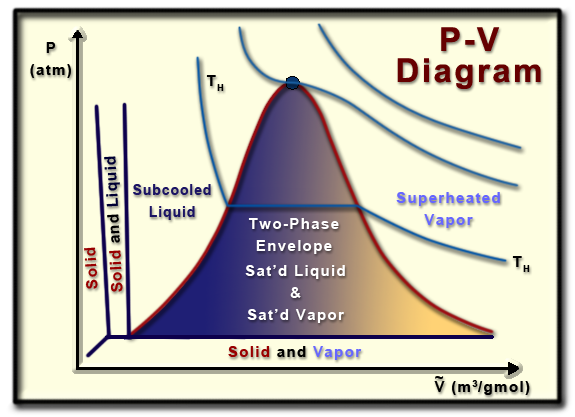
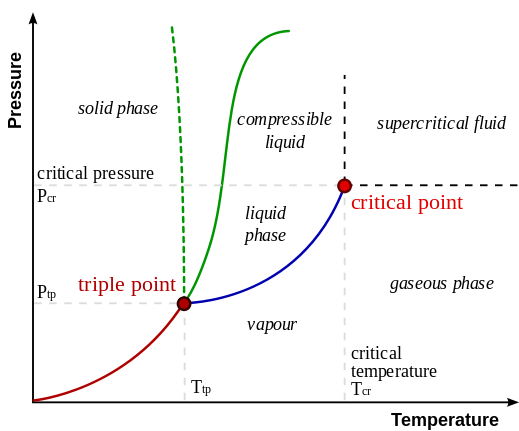
**Energy balance in open system**

Usually, are neglected

In a closed system where there is no flow stream, is neglected.

Energy balance on filling up an empty gas tank

V = V(T,P)



**Virial equations of state**

if b = aB’, c = aC’

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Q | W | U | H |
| Isothermal |  |  | 0 | 0 |
| Isobaric |  |  |  |  |
| Isochoric |  | 0 |  |  |
| Adiabatic | 0 | = | Same as W |  |

**Van der Waals EOS**

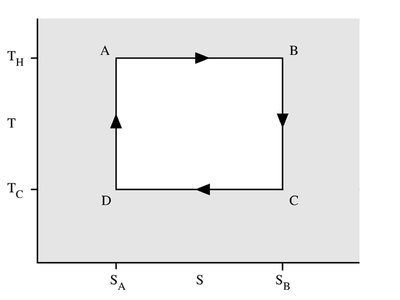
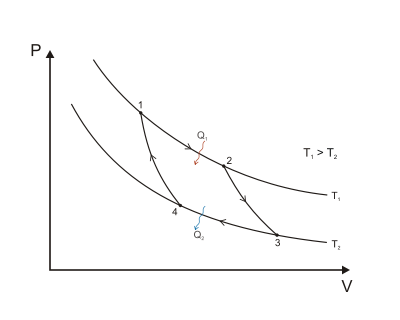
**Critical parameters**

**Reduced temperature and pressure**

**Redlich/Kwong EOS**

P={\frac  {R\,T}{V_{m}-b}}-{\frac  {a}{{\sqrt  {T}}\;V_{m}\,(V_{m}+b)}}, a={\frac  {0.4275\,R^{2}\,T_{c}^{{5/2}}}{P_{c}}},\qquad b={\frac  {0.08664\,R\,T_{c}}{P_{c}}},

**Carnot engine**



Reversible [isothermal](http://en.wikipedia.org/wiki/Isothermal) expansion of the gas at the "hot" temperature, 1🡪2, A🡪 B

\Delta S=Q_1/T_1

[Isentropic](http://en.wikipedia.org/wiki/Isentropic_process) ([reversible adiabatic](http://en.wikipedia.org/wiki/Reversible_adiabatic_process)) expansion of the gas (isentropic work output). 2🡪3, B🡪 C

Reversible isothermal compression of the gas at the "cold" temperature, *T2*. 3🡪4, C🡪 D

\Delta S=Q_2/T_2

Isentropic compression of the gas (isentropic work input). 4🡪1, D🡪 A

W = \oint PdV = 

                            (T_H-T_C)(S_B-S_A)



S = k_{\mathrm{B}} \ln \Omega \, ,

H = U + PV

A = U – TS

G = H – TS

dU = TdS – PdV

dH = TdS + VdP

dA = -PdV – SdT

dG = VdP – SdT

Enthalpy as a function of T and P

Entropy as a function of T and P

Internal Energy as a function of P

Idealgas

Alternative forms for liquids

**Internal Energy as function of T and V**

**The Gibbs Energy as a Generating Function**

**Residual properties**

MR = M-Mig