LECTURE 8

First Law Analysis to Non-flow Processes

Constant Volume process:

1. Heating of gas enclosed in a rigid vessel:

   $dU = dQ$ or $U_2 - U_1$, $Q = m\, C_v\, (T_2 – T_1)$

2. Shaft work done on a system at constant volume
   $dU = dQ - dW = dQ – (dW_{pdv} + dW_s)$

   or $dU = - dW_s$ or $-W_s = U_2 - U_1$

3. Constant volume process involving electrical work:
   $$- W_s = U_2 - U_1$$

For an adiabatic process the work is done is independent of path.

Constant Pressure Process

1. Reversible heating of a gas

2. Phase Change at constant pressure(Rev.)

3. Shaft work at constant pressure

4. Electrical work at constant pressure

$W = P(V_2 - V_1)$

$dU = dQ - dW = dQ - PdV = dQ - d(PV)$

or, $dQ = dU + d(PV) = d(U + PV) = dH$

$Q = \Delta H$ the heat interaction is equal to increase in enthalpy

Constant Temperature Process

$$dU = dQ - dW = dQ - PdV$$

for an ideal gas u= u(T) then dU = 0

$$dQ = PdV = RT\,(dv/v)$$

$$Q = W = RT \ln (v_2 / v_1)$$

Reversible Adiabatic Process

$$dU = -dW \quad \text{or } W = -\Delta U$$

This equation is true for reversible as well as irreversible process.

$$C_v\, dT = -Pdv = -RT/v\, dv$$

$$dT/T = -R/C_v\, dv/v$$

$$R/C_v = \gamma - 1$$

$$dT/T = -(\gamma-1)\, dv/v$$

$$T_2/T_1 = (v_1/v_2)^{(\gamma-1)} \quad Tv^{(\gamma-1)} = \text{constant}$$

Also Pv^{γ} = Constant using perfect gas relation