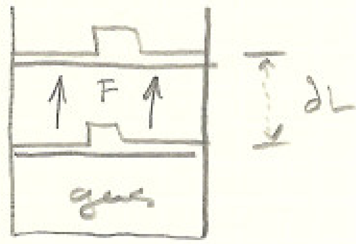
§4.1.5 MOVING BOUNDRY WORK.

consider the piston cylinder device with a gas, as a system, contained in it, as shown in figure

Let one of the small weights be removed from the piston, will move upward as a result of the distance ∂L. The amount of work done by the system during quasi-equilibrium process can be calculated, as follows:



The total force on the piston $F = PA$.

The work done $= \partial w = F \, dL$

∂: inexact derivative

d: exact derivative

$\delta w = PA \, dL$

and we know that

$$d\forall = A \, dL$$

therefore

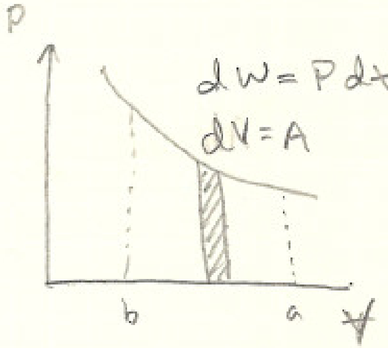
$$\partial w = P \, d\forall$$

REMARKS:

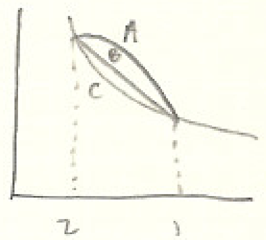
- The integration of $w = \int P \, d\forall$ can be proformed if we know the relationship b/t P and $\forall$. Normally this given in graphical form.

EX.

for example, the compression of air in a cylinder in a quasi-equilibrium process is represented graphically by



Since the area underneith each curve represents the work of eact process.



$$({}_1W_2)_A \neq ({}_1W_2)_B \neq ({}_1W_2)_C$$

we say work is a path function.

The thermodynamic properties considered point or state functions. The differentials of point functions are exact differentials.

$$\int_1^2 d\forall = V_2 - V_1 = \Delta\forall \qquad \int_1^2 dU = U_2 - U_1 = \Delta U.$$

It is mathimatically wrong to say

$$\int_1^2 \delta W = W_2 - W_1$$

instead we write

$$\int_1^2 \delta W = {}_1W_2$$

EX Consider a gas contained in a cylinder. The initial pressure of the system is 300 kPa and the initial volume is 0.03 m^3. The system was allowed to expand to 0.12 m^3, while the pressure remains constant

REQUIRED: Calculate the work associated with the expansion process.

ANALYSIS: $${}_1W_2 = \int_1^2 P\,d\forall$$

Since P is a constant process, we can write

$$= P\Delta V$$

WORK FOR POLYTROPIC PROCESS'S

a polytropic system is one where the pressure and volume are related by the functional relationship.

$$PV^n = \text{constant}.$$

Throughout the process. Where n = any value, depending on the particular process. The work done in a polytropic process can be defined as follows.

$$W_{21} = \int_1^2 P\,dV$$

for the polytropic process

$$P_1 V_1 = P_2 V_2 = \text{constant}$$

then

$$P_2 = \frac{\text{constant}}{V^n} = \frac{P_1 V_1^n}{V^n}$$

then

$$\int P\,dV = \text{constant} \int \frac{dV}{V^n} = \text{constant} \left(\frac{V^{-n+1}}{-n+1} \right)_{V_1}^{V_2}$$

$$= \frac{P_2 V_2 - P_1 V_1}{1-n} \qquad n \neq 1$$