Thermodynamics (ESC-S202)

Lecture- 10
Work and Heat Transfer

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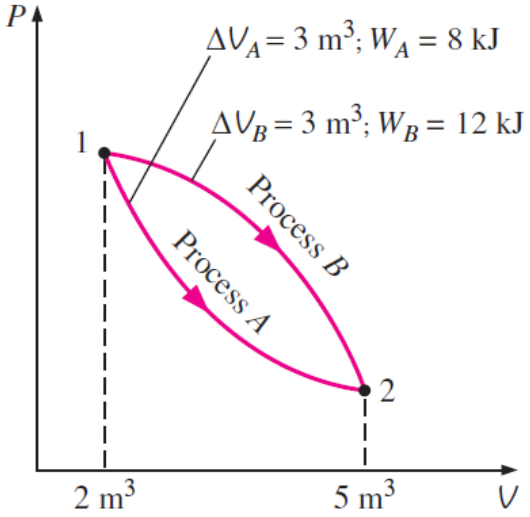
Point Function

- Thermodynamics properties are point functions.
- The change in thermodynamic property of a system in a change of state is independent of the path the system follows during the change of state, and depends only on initial and final states of the system.
- The differentials of point functions are exact.

The total volume change during a process between states 1 and 2 is

$$\int_1^2 dV = V_2 - V_1 = \Delta V$$

So the change in volume thus depends only on the end states of the system irrespective of the path of the system follows.



- Work done in a quasi-static process between two given states depends on the path followed.
- For a cyclic process , the initial and final states of the system are the same and hence ,the change in an property is zero.

$$\oint dV = 0\ ,\ \oint dp = 0,\ \oint dT = 0$$

pdV Work in Various Quasi-Static Processes

1. Isobaric Process-

$$W_{1-2} = \int_{V_1}^{V_2} pdV = p(V_2 - V_1)$$

2.Isochoric Process-

$$W_{1-2} = \int pdV = 0$$

3.Isothermal Process-

$$W_{1-2} = p_1 V_1 ln\frac{V_2}{V_1} \ , \ W_{1-2} = p_1 V_1 ln\frac{p_1}{p_2}$$

4.Polytropic Process-

$$W_{1-2} = \frac{p_1 V_1 - p_2 V_2}{n-1}$$

Q.1-An electric motor drives a stirrer fitted with a horizontal cylinder. The cylinder of 40 cm diameter contains a fluid restrained by a frictionless piston. During the stirring of fluid for 15 min the piston moves outwards slowly by a distance of 30 cm against the atmospheric pressure of 1 bar. The current supplied to the motor is 0.5 amp. From a 24 V lead acid accumulator. If the conversion efficiency from electrical work to mechanical work output is 90%, estimate the work done on the motor, stirrer and the atmosphere.

Q.2- A piston-cylinder device operates 1 kg of fluid at 20 atm pressure. The initial volume is 0.04 m^3. The fluid is allowed to expand reversibly following a process $pV^{1.45} = C$ so that the volume becomes double. The fluid is then cooled at constant pressure until the piston comes back to the original position. Keeping the piston unaltered, heat is added reversibly to restore it to the initial pressure. Calculate the work done in the cycle.