Chemical Engineering (Thermodynamics I) (UCH305)

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Lecture 5

Thermodynamic processes

Outline

- Quasi-static or quasi equilibrium Process
- Various thermodynamic processes
- Cyclic process
- Static process
- Steady-state process
- Point (State) functions & Path functions

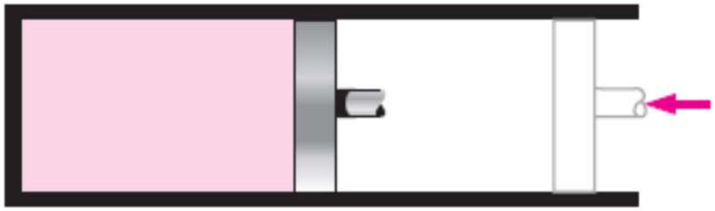
Quasi-static Process

- When a process proceeds in such a manner that the system remains infinitesimally close to an equilibrium state at all times, it is called a **quasi-static**, or **quasi-equilibrium**, **process**.

- A quasi-equilibrium process can be viewed as a sufficiently slow process.

- This allows the system to adjust itself internally, so that properties in one part of the system do not change any faster than those at other parts.

(*a*) Slow compression (quasi-equilibrium)



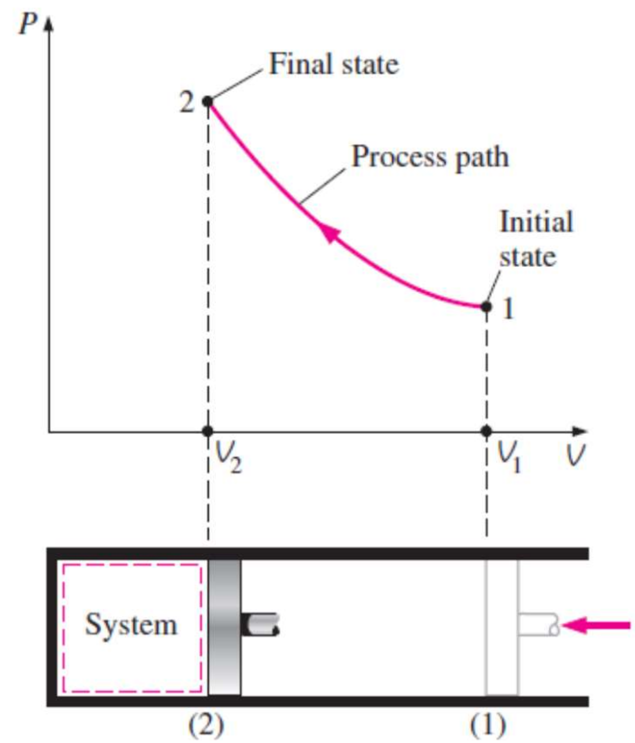
(*b*) Very fast compression (nonquasi-equilibrium)

Quasi-equilibrium and nonquasi-equilibrium compression processes.

Quasi-static Process….

- A quasi-equilibrium process is an idealized process and is not a true representation of an actual process.
- Engineers are interested in quasi-equilibrium processes for two reasons.

1. they are easy to analyse.
2. work-producing devices deliver the most work when they operate on quasi-equilibrium processes.



Different Processes

- The prefix ***iso-*** is often used to designate a process for which a particular property remains constant.

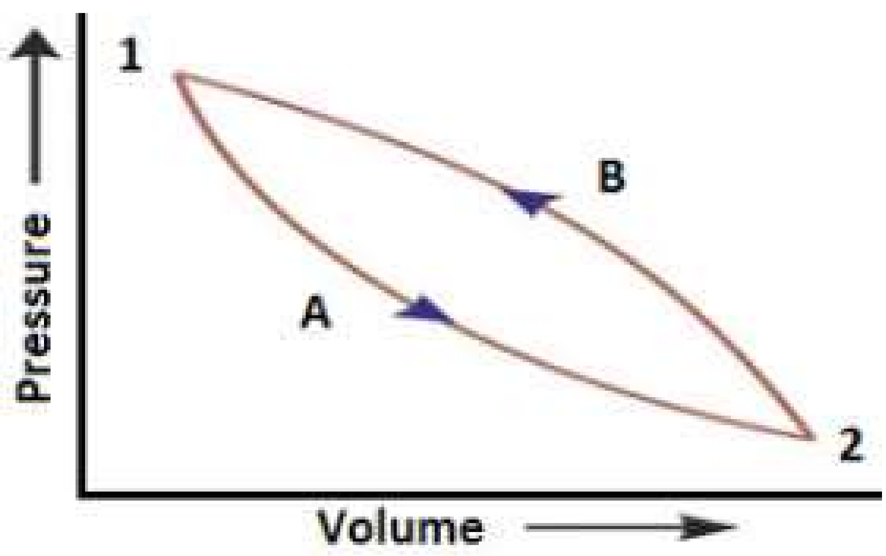
- An ***isothermal process*** is a process during which the temperature T remains constant;

- An ***isobaric process*** is a process during which the pressure P remains constant; and

- An ***isochoric*** (or **isometric**) **process** is a process during which the specific volume (volume/mass) v remains constant.

Cyclic Process

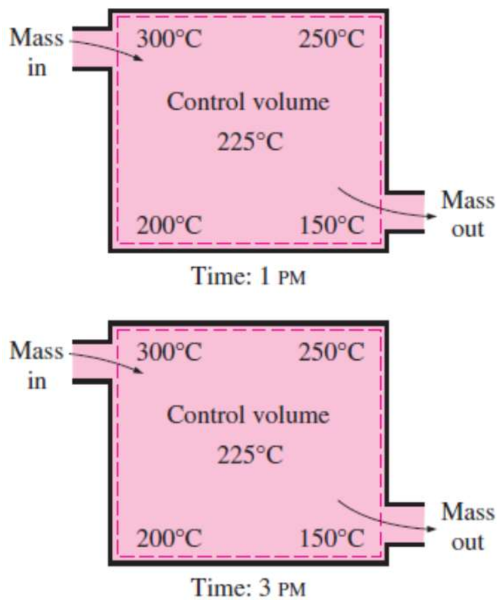
- A system is said to have undergone a ***cycle*** if it returns to its initial state at the end of the process.
- For a **cycle, or cyclic process**, the initial and final states are identical.



The Steady-Flow Process

The terms ***steady*** and ***uniform*** are used frequently in engineering, and thus it is important to have a clear understanding of their meanings.

- The term ***steady*** implies *no change with time.*
- The opposite of steady is ***unsteady***, or *transient*.
- The term ***uniform*** implies *no change with location* over a specified region.
- These meanings are consistent with their everyday use (steady flow, uniform properties, etc.).



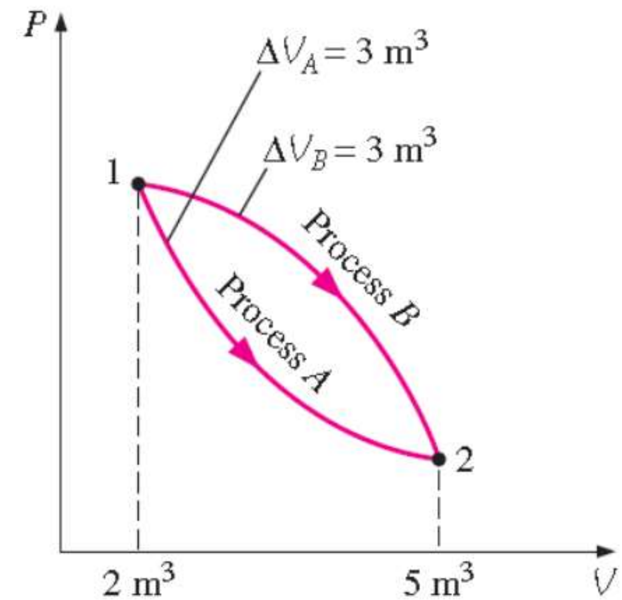
Point (State) functions & Path functions

- Properties are **point functions** (if they depend on the state only, and not on how a system reaches that state), and they have ***exact differentials*** designated by the symbol ***d***.

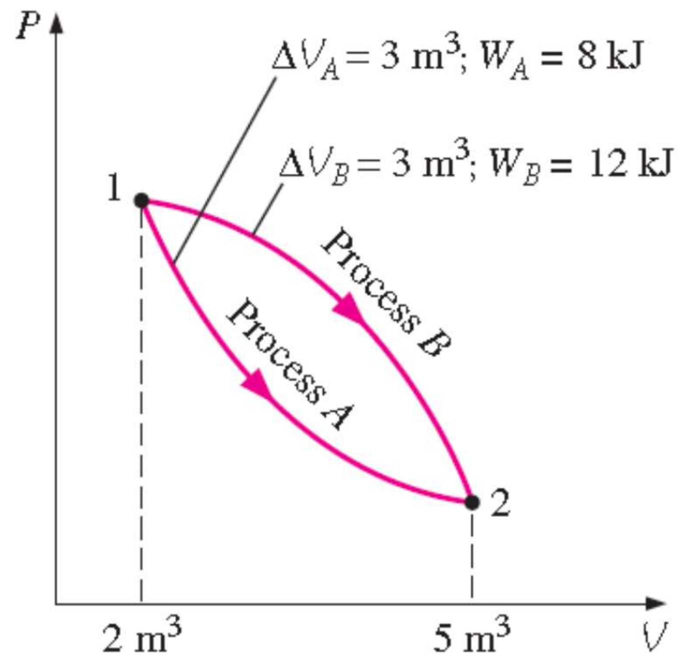
- A small change in volume is represented by *dV*, and the total volume change during a process between states 1 and 2 is:

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

- That is, the volume change during process 1–2 is always the volume at ***state 2*** minus the volume at ***state 1***, regardless of the path followed.



- Heat and work are path functions (their magnitudes depend on the path followed).



- **Path functions** have **inexact differentials** designated by the symbol δ.
- Therefore, a differential amount of heat or work is represented by δQ or δW, respectively, instead of dQ or dW.
- The total work done during process from state-1 to state-2 , however, is:

$$\int_1^2 \delta W = 1W_2 = W_{12} = W$$

References

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Thank you for your Patience