

NPTEL ONLINE CERTIFICATION COURSE

Course

On

Chemical Engineering Thermodynamics

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Week - 2

Week outline:

- Entropy Change during Spontaneous Process
- Criteria for Spontaneity
- Thermodynamic Network
- Practice problems

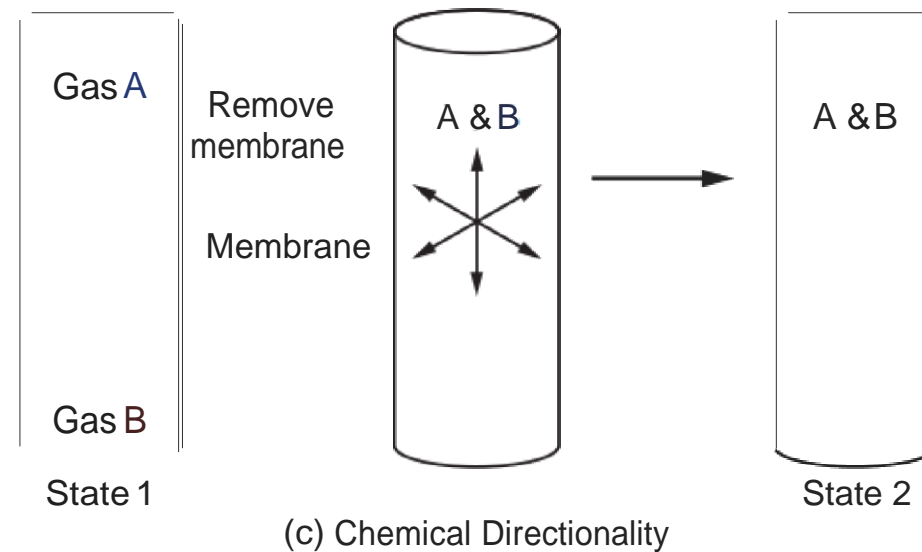
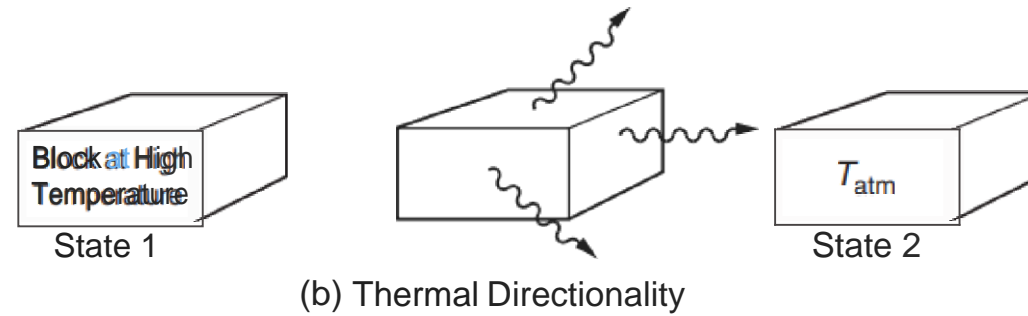
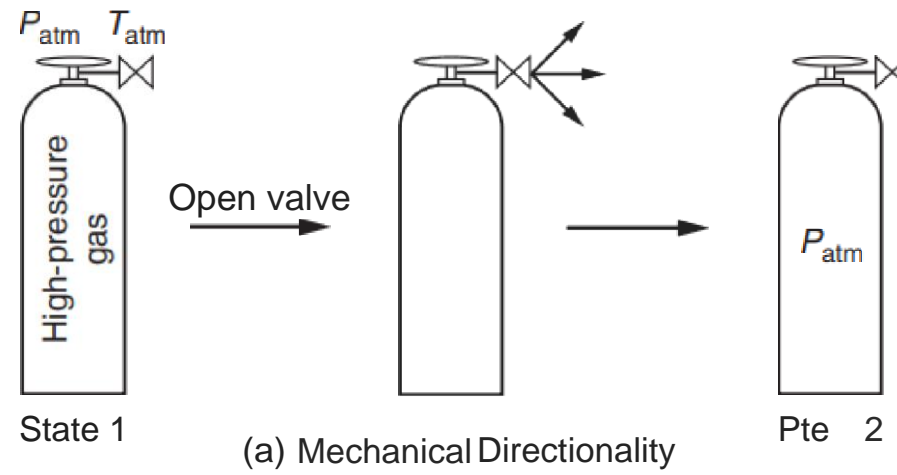
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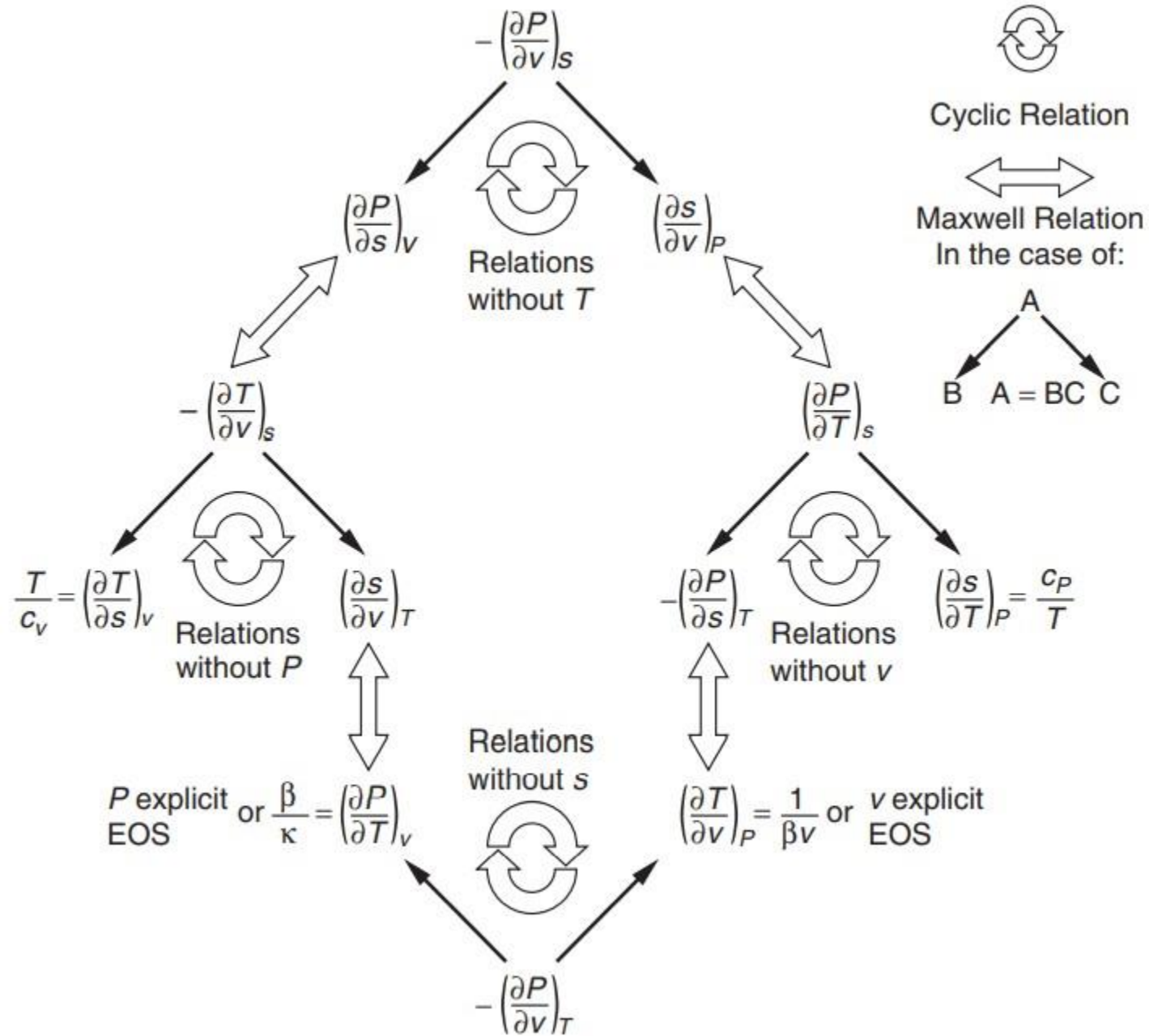
- Criteria for Equilibrium:

Mechanical – Equality of pressure

Thermal – Temperature as a driving force

Chemical – Chemical potential as a driving force





Hot water inside a closed thermos flask is an example of_____

- a. open system
- b. closed system
- c. isolated system
- d. depends on contents of flask.

Correct Answer: c. isolated system

Detailed Solution: Hot water inside a closed thermos flask cannot exchange mass as well as energy in the form of work or heat with the surroundings. So it is an example of an isolated system.

Which among the following is NOT an extensive property?

- a. Gibbs free energy
- b. Enthalpy
- c. Helmholtz free energy
- d. Chemical Potential

Correct Answer: d. Chemical Potential

Detailed Solution: Chemical potential is an intensive property as it is independent of the extent of the system

A reversible adiabatic process is an _____

- a. isobaric process.
- b. isentropic process.
- c. isothermal process.
- d. isochoric process.

Correct Answer: b. isentropic process

Detailed Solution: If a system undergoes an adiabatic process, $dQ = 0$ and $dS \geq 0$. However, if the process is reversible adiabatic, then $dS = \frac{dQ}{dT} = 0$. Hence, a reversible and adiabatic process can also be called as an isentropic (constant entropy) process.

- (i) What is the degree of freedom of a system comprising of a closed container half filled with boiling water and water vapor in the top half?
- (ii) Estimate the degree of freedom if the water in the container is replaced by salt solution?

- a. (i) 0 (ii) 1
b. (i) 1 (ii) 2
c. (i) 1 (ii) 0
d. (i) 2 (ii) 1



Correct Answer: b. (i) 1 (ii) 2

Detailed Solution:

(i) According to Gibbs Phase rule, the degrees of freedom is given as, $F = C - P + 2$ where, C is the number of components involved, which is 1 (water) in this case. P is the number of phases = 2 (liquid water and vapor) Thus, $F = 1 - 2 + 2 = 1$

(ii) Here, $C = 2$ (Water and salt) $P = 2$ (liquid salt solution and vapor) $F = 2 - 2 + 2 = 2$

For a process described by $PV^{(1/n)} = \text{constant}$, match the values of n with the corresponding processes.

Processes	Values of n
A. Isochoric	a. $1/\gamma$
B. Isobaric	b. 1
C. Adiabatic	c. 0
D. Isothermal	d. ∞

- a. A-a, B-b, C-c, D-d
- b. A-b, B-c, C-d, D-a
- c. A-c, B-d, C-a, D-b
- d. A-d, B-a, C-b, D-c



Correct Answer: c. A-c, B-d, C-a, D-b

Detailed Solution: For the given process, $PV^{(1/n)} = \text{constant}$. Isochoric process means volume $V = \text{constant}$ which implies $(1/n)$ is infinite and $n = 0$. Isobaric process is a constant pressure (P) process which implies $(1/n) = 0$ and $n = \text{infinity}$. For adiabatic process the exponent $(1/n) = \gamma$, thus $n = 1/\gamma$. For isothermal process $T = \text{constant}$; hence $(1/n) = n = 1$, which leads to $PV = \text{constant}$.

• Thank you!