SE. sem-IV (Chem.)
Sem IV (Chem) – CBGS.

29/5/14

CET – I

Chemical Engg. Thermodynamics – I

Q P Code : NP-19773

(33)

(3 Hours) [Total Marks : 80

N.B. : (1) Question No. 1 is **compulsory.**
(2) **Attempt** any **three** questions out of remaining five questions.
(3) **Figures** to the **right** indicate **full marks.**
(4) **Assume** suitable data if **needed** and **justify** the same.

1. (a) What do you mean by a cyclic process? State & explain the first law of thermodynamics for a cyclic process. **5**
(b) How is entropy change in an irreverrible process determined? **5**
(c) What is the principle of coresponding states? **5**
(d) Define fugacity & fugacity coefficient show that the fugacity & pressure are identical for ideal gas. **5**

2. One kmol of an ideal gas at 298K and 1 bar is subjected to the following process: **20**
(i) Compressed adiabatically to 10 bar pressure
(ii) Heated at constant pressure to 623K
(iii) Expanded at constant temperature to 1 bar
(iv) Cooled at constant pressure to 298K

Calculate Q, W, ΔU, ΔH & ΔS for each step and for the entire path, sketch the process on P-V diagram.

Data :

$$Cp = 29.170 \frac{KJ}{kmol.k}$$

$$Cv = 20.856 \frac{KJ}{kmol.k}$$

3. (a) Dieterici equation of state is given by : **10**

$$P = \frac{RT}{V-b} e \wedge \frac{-a}{RTV}$$

Find the value of a and b in terms of Pc and Tc.

(b) Find motor volume and compressibility factor for methane at 100°C and 10 bar pressure for the gas which obeys Dieterici equation of state. **10**
Data :
Tc = 190.6 K
Pc = 46 bar

TURN OVER

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4. (a) State carnot principle and derive the formula to calculate efficiency of carnot engine. 10

(b) A closed system contains 5 kg of air at 500 Kpa and 800 K. Determine the availability of system. The surrounding is at 100 kpa and 303 K. 10

Data :

Cp = 1.00 KJ/kg.k

Cv = 0.718 KJ/kg.k

R = 0.287 KJ/kg.k

5. (a) Derive the relations to estimate the residual enthalpy and residual entropy for a fluid using the Redlich Kwong Soave equation of state. 10

Redlich Kwong Soave equation of state is given by :

$$P=\frac{RT}{V-b}-\frac{a\alpha}{V(V+b)}$$

(b) Using vander waals equation find Joule-Thomson inversion temperature for Nitrogen gas at 10 MPa. 10

a = 136.69 kPa $(m^3/kmol)^2$

b = 38.64 × 10^{-3} $m^3/kmol$

6. Write short notes on any **four** of the following :— 20

(a) Application of first law of thermodynamics to reactive processes

(b) Compressibility factor chart

(c) Clausius inequality

(d) Exergy

(e) Helmholtz energy and Gibbs energy

(f) Mollier diagram.