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Roll No

CM-5001-CBGS

B.E. V Semester

Examination, June 2020

Choice Based Grading System (CBGS)

Advanced Chemical Engineering

Thermodynamics

Time : Three Hours

Maximum Marks : 70

- Note:** i) Attempt any five questions.
ii) Each question carries equal marks.
iii) Assume suitable data wherever necessary.

1. A rigid storage tank of 0.8 m diameter and 1m length with air at 1 MPa, 350 K is connected to an air line. The valve is opened and air flows into the tank until the pressure reaches 5 MPa, at which point the valve is closed and the temperature inside the tank is 400 K.
 - a) What is the mass of air in the tank before and after the process?
 - b) The tank is eventually cools to room temperature, 300 K. What is the pressure inside the tank then?
2. A 1 L bottle is completely filled with benzene at 298 K. What pressure will develop within the bottle if it is heated to 304 K as a result of the sunlight coming through the lab window?
Data given:
for benzene $\beta = 1.21 \times 10^{-3} \text{K}^{-1}$ and $\kappa = 0.104 \times 10^{-3} \text{bar}^{-1}$.
Calculate the change in enthalpy of the system.
 $C_p = 112.4 \text{ J/mol K}$. MW = 78.11.

$$\text{[hint : } \left[\frac{\partial P}{\partial T} \right]_V = - \left[\frac{\partial V}{\partial T} \right]_P / \left[\frac{\partial V}{\partial P} \right]_T]$$

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3. a) Explain steady state process and thermodynamic equilibrium state with an example.
b) State first law of Thermodynamics for flow process. Verify the consistency of the unit for each term.
4. Describe the analytical method for the determination of partial molar properties in a binary mixture.
5. The partial molar volumes of acetone (MW = 58.08) and chloroform (119.38) in a mixture in which mole fraction of acetone is 0.5307 are $74.166 \times 10^{-6} \text{ m}^3/\text{mol}$ and $80.235 \times 10^{-6} \text{ m}^3/\text{mol}$ respectively. What is the volume of 1 kg of the solution?
6. Write and explain the different components of the vapor compression plant. Also, draw a near labeled schematic.
7. a) Explain the concept of fugacity departure.
b) What is chemical potential. Also, write its physical significance.
8. a) Discuss the Gibbs-Duhem equation and its various forms. What are the major fields of application of the Gibb's Duhem equations?
b) The standard Gibb's free energy change and enthalpy change at 25°C for the liquid phase reaction $\text{CH}_3\text{COOH}_{(l)} + \text{C}_2\text{H}_5\text{OH}_{(l)} \leftrightarrow \text{CH}_3\text{COOC}_2\text{H}_5_{(l)} + \text{H}_2\text{O}_{(l)}$ are given as $\Delta G^\circ_{298} = -4650 \text{ J/mol}$ $\Delta H^\circ_{298} = -3640 \text{ J/mol}$. If the solution is ideal and enthalpy change is assumed to be constant. Calculate the equilibrium constant at 95°C .

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