QUESTION BANK OF CHEMICAL ENGINEERING THERMODYNAMICS

Q.1 Pressures up to 3000 bar are measured with a dead-weight gauge. The piston diameter is 4 mm. What is the approximate mass in kg of the weights required?

Q. 2 An electric motor under steady load draws 3.5 amperes at 230 volts, delivering 644 W of mechanical energy. What is the rate of heat transfer from the motor, in W?

Q.3 Draw PT Diagram for a pure substance showing phase regions solid, liquid and vapor.

Q.4 A tank containing 20 kg of water at 293.15 K (20°C) is fitted with a stirrer that delivers work to the water at the rate of 0.25 kW. How long does it take for the temperature of the water to rise to 303.15 K (30°C) if no heat is lost from the water? For water, *Cp* = 4.18 kJ/ kg ^{0}C .

Q.4 One mole of an ideal gas with Cp = (7/2)R and Cv = (512) R expands from P_1 = 8 bar and T_1 = 600 K to P_2 = 1 bar by each of the following paths: (a) Constant volume; (b) Constant temperature. Assuming mechanical reversibility, calculate W, Q, ΔU, and ΔH for each process.

Q.5 Heat of amount 7.5 kJ is added to a closed system while its internal energy decreases by 12 kJ. How much energy is transferred as work? For a process causing the same change of state but for which work is zero, how much heat is transferred?

Q.6 One kilogram of air is heated reversibly at constant pressure from an initial state of 300K and 1 bar until its volume triples. Calculate W, Q, ΔU and ΔH for the process on the basis of 1 mol of gas. Assume for air that PV/T = 83.14 bar.cm^3/ mol. K and Cp = 29 J/mol.K

Q.7 Calculate *Z* for ethylene by the Redlich/Kwong equation:

$$Z = 1 + \beta - q\beta\frac{Z-\beta}{(Z+\varepsilon\beta)(Z+\sigma\beta)}$$

Data : Tr = T/Tc = 1.2, Pr = P/Pc = 0.25

σ = 1, ε=0, Ω = 0.08664, Ψ=0.42748, $\alpha = T_r^{-1/2}$,

$\beta = \Omega (P_r/T_r)$, and $q = \Psi^* \alpha/(\Omega^* T_r)$

Take Z =1 as first guess and solve up to third iteration.

Q.8 For steady flow in a heat exchanger at approximately atmospheric pressure, what is the heat transferred when 10 mol of SO_2 is heated from 200 to 1100 °C. SO_2 heat capacity constants: A = 5.699, B = 0.801×10^{-3}, D = -1.015×10^{5}.

Q. 9 A Carnot engine receives 250 kJ/sec of heat from a heat source reservoir at 798.15 K and rejects heat to a heat sink reservoir at 323.15 K. What are the power developed and the heat rejected?

Q. 10 Estimate the change in enthalpy and entropy when liquid ammonia at 270 K is compressed from its saturation pressure of 381 kPa to 1200 kPa. For saturated liquid ammonia at 270 k, V^l = 1.551×10^{-3} $m^3.kg^{-1}$ and $\beta = 2.095 \times 10^{-3}$ K^{-1}.

Q. 11 Calculate the theoretical flame temperature when ethylene at 25 °C is burned with 25% excess air at 25 °C.

$C_2H_4 + 3O_2 \text{ -------> } 2CO_2 + 2H_2O$

$\Delta H^o_{f\ C2H4}$ = 52510 J/mol $\Delta H^o_{f\ CO2}$ = -393509 J/mol $\Delta H^o_{f\ H2O}$ = -241818 J/mol

Component	A	10^3B	$10^{-5}D$
CO_2	5.457	1.045	-1.157
H_2O	3.470	1.450	0.121
O_2	3.639	0.506	-0.227
N_2	3.280	0.593	-0.040

Q. 12 Five kilograms of liquid carbon tetrachloride undergo a mechanically reversible, isobaric change of state at 1 bar during which the temperature changes from 0°C to 25°C. Determine ΔV^t, W. The properties for liquid carbon tetrachloride at 1 bar and 0°C may be assumed independent of temperature: $\beta = 1.2 \times 10^{-3}\ K^{-1}$, $C_P = 0.84\ kJ \cdot kg^{-1}.K^{-1}$, and $\rho = 1590\ kg \cdot m^{-3}$.

Q.13 Prepare T-x,y diagram at pressure of 101.33 kPa for a binary system Benzene(1) and Ethyl benzene(2). Assume that Raoult'slaw is valid and use the following Antonie equation. $\ln P_i^{sat} = A - B/(T + C)$, where P_i^{sat} in kPa and T is in K.

Component	A	B	C
Benzene	13.7819	2726.81	-55.578
Ethylbenzene	13.9726	3259.93	-60.850

Q.14 Prepare P-x,y diagram at temperature of 363.15K for a binary system Benzene(1) and Ethyl benzene(2). Assume that Raoult'slaw is valid and use the following Antonie equation. $\ln P_i^{sat} = A - B/(T + C)$, where P_i^{sat} in kPa and T is in K.

Component	A	B	C
Benzene	13.7819	2726.81	-55.578
Ethylbenzene	13.9726	3259.93	-60.850

Q. 15 Define azeotropes and explain minimum boiling and maximum boiling azeotropes with suitable examples and neat diagrams

Q.16 Derive an expression for fundamental property relation for single phase fluid of variable composition

Q. 17 Write a brief note on Ideal and non ideal solutions

Q. 18 Define chemical potential. Discuss the effect of temperature and pressure on chemical potential

Q. 19 Define fugacity and fugacity coefficient. Discuss any two methods to evaluate fugacity coefficient

Q. 20 Derive the phase equilibrium criteria in terms of chemical potential.

Q. 21 Derive an expression for phase rule and Duhem theorem

Q. 22 Explain Lewis Randall rule and Henry's law

Q. 23 Discuss models for Excess Gibb's Energy

Q. 24 Discuss the consistency tests for VLE data by using Gibbs-Duhem equation

Q. 25 Enlist the methods to test consistency for any VLE data and describe any two

in detail.

Q. 26 Discuss any two group contribution methods to determine Activity coefficients

Q. 27 How is the activity coefficient related to the excess free energy?

Q. 28 Write a brief note on Excess properties.

Q. 29 List the various activity models and describe their limitations

Q. 30 Prove that enthalpy change of mixing for ideal gas is zero.

Q. 31 Discuss the criteria of chemical equilibrium

Q. 32 Derive from the first principles, $\Delta G_0 = - RT \ln K$

QUESTION BANK

Subject:- Chemical Engineering Thermodynamics

Subject Code:-BTCHC 401

1) Give the statement of Second law of thermodynamics. [2M]

2) State Clausius inequality. Give the expression for reversible and irreversible process[4M].

3) Prove that Cp – Cv = R for an ideal gas. [4M]

4) Write Van-der Waal's equation of state. Also explain Van-der Waal's constant [4M].

5) Define system, surrounding, boundary [4M].

6) State Third law of Thermodynamics[4M].

7) Define extensive and intensive property with example[3M].

8) A system consisting of some fluid is stirred in a tank. The rate of work done on the system by the

stirrer is 1678 J/S. The heat generated due to stirring is dissipated to the surroundings. If the heat transferred to the surroundings is 3400 kJ/hour, determine the changes in internal energy. [5M].

9) Show that internal energy is a state function. [4M].

10) Derive the relation between Δ G and K[4M].

11) Explain Mollier diagram[3M].

12) Derive an equation for entropy change of an ideal gas in terms of temperature and volume. [4M].

13) Define open system and closed system. [3M].

14) What is meant by partial molar property? [2M].

15) What are excess properties and give its significance? [4M].

16) State Gibbs Duhem equation. [3M].

17) . Define the term activity coefficient[3M].

18) Define COP of refrigerator. [2M].

19) Define COP of pump. [2M].

20) State Henry's law. [2M].

21) Define Clausius-Clapeyron equations. [3M].

22) Derive the expressions for the effect of temperature and pressure on activity coefficient[4M]