B.Tech. Degree III Semester Examination, November 2008

SE 302 CHEMICAL ENGINEERING I

(2006 Scheme)

Time: 3 Hours Maximum Marks: 100

(8 x 5 = 40)

PART A

(Answer All questions)

I a) A body weighs 1.0 kg in air, 0.90 kg in water and 0.80 kg in a liquid. What is the specific gravity of the liquid?

b) Explain Dalton's law and Amaagat's law.

c) Define standard heat of reaction? How will you estimate the heat of reaction of a compound from standard heat of formation data?

d) Derive the Clausius – Clapeyron equation.

e) State and explain the Law of corresponding states.

f) Derive the Maxwell relation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$

g) Distinguish between differential and cumulative analysis.

h) Explain the principle of centrifugal separation.

PART B

(4 x 15 = 60)

II a) A batch of leather leaving a dryer weighs 1000 kg and contains 8% moisture. During drying the leather loses 50% of its original weight. Determine the amount of moisture removed per kg of bone dry leather and water removed as percent of the original water present. (8)

b) Natural gas has the following analysis. CH_4 – 92% C_2 H_6 – 6.5% and C_3 H_8 -1.5%. When it is burnt with 40% excess air to achieve complete combustion, compute the flue gas analysis. (7)

OR

III For the preparation of potassium nitrate, 10000 kg/h of a 15% KNO_3 solution is mixed with a recycle stream and sent to an evaporator. The rate of evaporation is 1.2 times the rate of introduction of recycle stream. The concentrated solution leaving the evaporator contains 50% KNO_3. This is admitted to the crystallizer which yields crystals containing 4% water. At the crystallization temperature the solubility is 60 kg/100 kg of water. Major part of the mother liquor leaving the evaporator is returned to the evaporator as recycle. Calculate

i) the concentration of KNO_3 in the stream entering the evaporator.

ii) the amount of recycle stream per hour.

iii) The rate of production of crystals. (15)

IV. (a) Calculate the standard heat of formation of acetylene (C_2H_2) given that the standard heat of combustion of acetylene is –1299.61 KJ, the standard heat of combustion of carbon is -393.51 KJ and the standard heat of formation of liquid water is -285.84 KJ. 10)

(b) State Hess's law and its applications. (5)

OR

V 0.5 mole hydrogen at 300K, a mixture of 1.5 mole nitrogen and 0.5 mole oxygen at 400K and 0.3 mol CO at 500 K are mixed. 50% of CO present reacts. If the final temperature of the system raises to 882 K under adiabatic conditions, calculate the standard heat of formation of CO_2, if it is four times the standard heat of formation of CO. The mean heat capacities in J/mol K are 32.5 for O_2, 31.1 for N_2, 29 for H_2, 31 for CO and 49 for CO_2. (15)

VI (a) Determine the change in entropy for an ideal gas when it is compressed isothermally. (7)

(b) Account for the fact that at equilibrium, free energy must be minimum and entropy should be maximum (8)

OR

VII (a) State and explain the first law of thermodynamics. Give its limitations. (8)

(b) Show that $\left(\frac{\partial H}{\partial V}\right)_T = 0$ for an ideal gas (7)

VIII (a) Derive an expression to calculate the effectiveness of screens (8)

(b) Explain the principle of operation of bucket elevators and preumatic conveyors. (7)

OR

IX (a) With a neat sketch, explain the working of a rotary drum vacuum filter. (9)

(b) Distinguish between free and hindered settling. (6)

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