S.E. (Chemical) (Sem. III) May '08.
Sub: Process calculations.

59

309–08. 13/6/08 (REVISED COURSE) CO–9610

(3 Hours) [Total Marks : 100

N.B.:- 1) Question number 1 is compulsory.
2) Attempt any four questions from remaining six questions
3) Assume suitable data if required and indicate it clearly

Q1 a) Define atomic weight, molecular weight, kg atom and kg mole. (4)

b) i) Calculate kg atom of carbon in 36 kg. (2)

ii) Convert 88 kg carbon dioxide in to kg mole (2)

c) Define equivalent weight of a substance, normality, molarity and molality of the solution (4)

d) For an ideal gas mixture (3)
Prove that Volume % = Mole % = Partial Pressure %

e) A gas mixture contains. 3 kg mole of HCL, 4 kg mole of Nitrogen and 1 mole of oxygen. Calculate average molecular weight of the gas . (5)

Q2 a) How many grams of liquid Propane will be formed by liquification of 500 Lit of the gas at NTP? (4)

b) A fuel gas contains 70 % methane, 20 % ethane and 10 % oxygen. The fuel air mixture contains 200% excess $O_2$ before combustion, 10% of the hydrocarbon remains unburned. Of the total carbon burned 90 % forms $CO_2$ and the rest forms CO. Calculate the composition of the flue gas on dry and wet basis. (8)

c) Aviation gasoline is Iso Octane $C_8H_{18}$. It is burned with 20% excess air and 30% of the carbon forms CO and rest goes to dioxide. What is the analysis of the exit gases (on dry basis) ? (8)

Q3 a) A sample of fuel oil has C/H ratio 9.33 (by mass) and contains sulphur to the extent of 1.3% (by mass). The GCV of the fuel is measured to be 41785 KJ/kg at 25°C. Calculate Its NCV at 25 °C (8)
Data $\lambda$ = 2256 KJ/Kg.

b) Formaldehyde is manufactured by the catalytic oxidation of methanol using an excess air. A secondary reaction also takes place – (8)

$$CH_3OH + 0.5\ O_2 \longrightarrow HCHO + H_2O$$

$$HCHO + 0.5\ O_2 \longrightarrow HCOOH$$

[ TURN OVER

$$\frac{d^2u}{dx^2} + \left(1 - \frac{\gamma^2}{x^2}\right) u = 0$$



The product gases have the following composition $CH_3OH$- 8.6%, HCHO- 3.1% HCOOH- 0.6%, $H_2O$ – 3.7%, $O_2$- 16%, $H_2$- 68%.
Find the following :-

i) the percentage conversion of $CH_3OH$ to HCHO
ii) % methanol lost in second reaction
iii) Molar ratio of feed to air and the % excess air used.

c) In an evaporator a dilute solution of 4 % NaOH is concentrated to 25 % NaOH. Calculate the evaporation of water per kg. of feed.

Q 4 a) 10000 kg/hr of 6% solution of salt in water is fed to an evaporator. Saturated solution is produced and some salt crystallizes out. The hot crystals with some adhering solution centrifuged to remove some of the solution. Then the crystals are dried to remove the re of water. During an hour test 837.5 kg of concentrated solution was removed in evaporator, 198.7 kg of solution was separated in the centrifuge and 361.7 kg of dried crystals obtained.
Previous test on the centrifuge shows that it removed 60% of adhering solution.
Calculate –i) Solubility of the salt,
ii) Water removed in drier,
iii)Water leaving the evaporator.
The solution leaving the evaporator and centrifuge maintains the same concentrated and i Saturated from evaporator, the various streams leaving are water vapor, saturated solution and crystals with adhering solution.

b) Define the following terms :-
i) Yield
ii) Selectivity
iii) Humid Heat
iv) Adiabatic Saturation temperature

Q5 a) In synthesis of methanol fresh feed containing 32% CO, 64% $H_2$ & 4% inerts (by vol.) is mixed with recycle feed, mixed feed entering the results in 20% per pass conversion of CO. The product stream from rector is fed to condenser where all methanol formed gets condenser and the gases from condenser are recycled. In order to prevent build up of inerts in recycle loop, a small portion of gases leaving the condenser is continuously purged. If mixed feed contains 13 mole% inerts.
Calculate –i) recycle ratio
ii) purge ratio

b) Write note on Proximate analysis and Ultimate analysis

Q6 a) Calculate the heat of reaction at 298.15 K of the following reaction:-

$$3CaSO_4\,(S) + SiO_2\,(S) \longrightarrow 3\,CaO.SiO_2\,(S) + 3\,SO_2\,(g) + 1.5\,O_2\,(g)$$

S.E.(Chemical)(Sem. IV) (CBSGS) May'08.
Sub: Applied Mathematics IV

-5-nk-08. 80

. 2728-08. 19/6/08 CO-9835

(REVISED COURSE)

(3 Hours) [Total Marks : 100

S.E.(Chemical)(Sem. III) May'08



Data:

| Component | ΔH°F at 298.15 K (KJ/mol) |
|---|---|
| $CaSO_4$ (S) | -1432.7 |
| $SiO_2$ (S) | - 903.5 |
| $CaO.SiO_2$ (S) | - 2879 |
| $SO_2$ | - 296.81 |
| $O_2$ | - 0.0 |

b) Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the reaction. (10)

$CO(g) + 2H_2(g) \longrightarrow CH_3OH(g)$

Data: $\Delta H°R = -90.41$ KJ/mol

$CP° = a + bT + cT^2 + dT^3$ KJ/ Kmol.K (J/mol.K)

| Component | a | b x $10^{-3}$ | c x $10^{-6}$ | d x $10^{-9}$ |
|---|---|---|---|---|
| O (g) | 29.0277 | -2.8165 | 11.6437 | -4.7063 |
| $_2$ (g) | 28.6105 | 1.0194 | -0.1476 | 0.769 |
| $CH_3OH$ (g) | 21.137 | 70.843 | 25.86 | -28.497 |

7 a) The Orsat analysis of the flue gases from a boiler house chimney by mole is as given (12)
$CO_2$ : 11.4%, $O_2$ : 4.2% and $H_2$ : 84.4%
Assuming that complete combustion takes place—
Calculate i) the % excess air
ii) C : H ratio in the fuel

b) Define the following terms :- (8)
i) Dew point
ii) Partial combustion
iii) Calorific value of fuel
iv) Molarity.