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Question Paper Code: 2033385

B.E. / B.Tech. DEGREE EXAMINATIONS, NOV/ DEC 2024
Third Semester
Chemical Engineering
U20CH304 - CHEMICAL PROCESS CALCULATIONS
(Regulation 2020)

Time: Three Hours Maximum: 100 Marks

Answer ALL questions

PART – A (10 x 2 = 20 Marks)

1. What are various Unit systems?

2. State Raoult's Law.

3. Draw the block diagram of Evaporator for finding material balance.

4. Write the overall and component material balance equation for the Crystallization process.

5. Differentiate Yield and Selectivity.

6. For the reaction $SO_2+1/2O_2 \rightarrow SO_3$ (mole basis), if the amount of SO_3 product stream is 80kmol, Find% conversion of SO_2.

7. Define Heat capacity.

8. State Hess's law of constant Heat of Summation.

9. What do you mean by Excess air?

10. What is the relation between GCV and NCV in terms of Latent Heat (λ)?

PART – B (5 x 16 = 80 Marks)

11. (a) (i) Convert 50kg of NH4OH to mol (Atomic weight: N=14,H=1,O=16). (6)
(ii) A gaseous mixture has the following composition by volume: CO_2=8%,CO=14%O_2=6%,H_2O=5%,CH_4=1% and N_2=66% Calculate,
a)The average molecular weight of the gas mixture
b)the density of gas mixture at 303Kand 101.325kPa. (10)

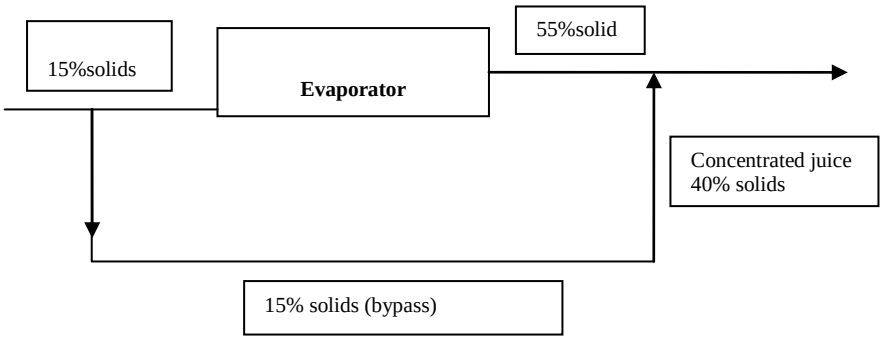
(OR)

(b) A solution containing 55% benzene, 28% toluene and 17% xylene by Weight is in contact with water vapour at 373K, Calculate the total pressure and molar composition of the liquid and vapour. (16)

12. (a) The waste acid from nitrating process containing 20%HNO_3,55%H_2SO_4 and 25%H_2O by weight is to be concentrated by addition of concentrated sulphuric acid containing 95%H_2SO_4 and concentrated nitric acid containing 90% $HNO_3$to get desired mixture containing26%HNO3and 60%H_2SO_4.Calulate the quantities of waste and concentrated acids required for 1000kg of desired mixed acid. (16)

(OR)

(b)



Fresh juice contains 15% solids and 85%water by weight and is to be concentrated to contain 40% solids by weight in a single stage evaporation system, it is found that volatile constituents of juices escape with water leaving the concentrated juice with flat taste .In order to overcome this problem ,part of the fresh juice bypasses the evaporator as shown in diagram calculate:
(a) Fraction of juice that bypasses the evaporator
(b) The concentrated juice produced (containing 40% solids) per 100 kg of fresh juice fed to the process. (16)

13. (a) Ethylene oxide is prepared by oxidation of ethylene 100kmol of ethylene and kmol of O_2 are charge to a reactor. The percent conversion of ethylene is 85 and percent yield of C2H4O is 94.12.Calculate the composition of product stream leaving the reactor. The reaction taking place are:

$$C_2H_4+1/2O_2 \rightarrow C_2H_4O$$
$$C_2H_4+3O_2 \rightarrow 2CO_2+2H_2O$$

(16)

(OR)

(b) (i) Notes on ,
Purge stream, Recycle stream, Bypass Stream. (6)
(ii) Calcium carbide is produced as per the reaction
$CaO+ C \rightarrow CaC_2+ CO$
Calculate the requirement of lime containing 96%CaO and Coke containg 90% (C) Carbon, the production of 1000kg of calcium carbide having a composition of 78%CaC_2, 15%CaO, 3%C and 4%other impurities by weight. (10

14. (a) Flue gas leaving the boiler stack at523K have the following composition. (16)
CO_2=11.31%,H_2O=13.04%,O_2=2.17% and N_2=73.48%(by volume)
Calculate the heat lost in 1kmol of gas mixture above 298K,Using heat capacity data given below:
$C_p^\circ = a+bT^2+cT^3$, (kJ/kmol.K)

Gas	a	bx10^3	cx x10^6	dx10^9
CO_2	21.63655	64.2841	-41.0506	9.7999
H_2O	32.4921	0.0796	13.2107	-4.5474
O_2	26.0257	11.7551	-2.3426	-0.5623
N_2	29.5909	-5.141	13.1829	-4.968

(OR)

(b) A natural gas has the following composition on mole basis. (16)
CH_4=84% ,C_2H_6=13% and N_2=3%
Calculate:
(a) The heat added to heat 2 kmol of gas mixture from 311K(38°C) to 533 K(260°C)
(b) The heat to be added to heat 200 Kg of natural gas from 311K(38°C) to 533K(260°C)

Gas	C^o_{pm}(311-298K)	C^o_{pm}(533-298K)
CH_4	36.0483	41.7800
C_2H_6	53.5240	67.4954
N_2	29.1317	29.3578

15. (a) The products and by-products obtained from combustion of coal can create environmental problems if the process of combustion is not carried out properly.
A fuel containing 74.1% C,8.9% Hand 17%ash by weight is burned with air and the resulting flue gas contains 12.4% CO_2,1.2%CO,4%O_2 and 82.4% N_2 by volume on a dry basis calculate:
(i) The Kg of coal fired per 100 Kmol of flue gas,
(ii) The % excess air used, and
(iii) The Kg of air used per kg of coal. (16)

(OR)

(b) A natural gas contains 85% methane and 15% ethane by volume. Calculate the GHV of this fuel in KJ/kg from the standard heats of combustion of methane and ethane.
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ $\Delta H^\circ C$ = -802.62 KJ/mol
$C_2H_6(g)+ 3.5O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$ $\Delta H^\circ C$=-1428.64 KJ/mol
Latent heat of water vapour at 298K (25°C) = 2442.5 KJ/kg. (16)

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