QP Code: RD21BTECH097 | Reg. No | | | | | | | | | | | AR 21

GIET UNIVERSITY, GUNUPUR – 765022

B. Tech (Third Semester - Regular) Examinations, December – 2022

21BCHPC23003 - Chemical Process Calculations

(Chemical Engineering)

Time: 3 hrs | Maximum: 70 Marks

Answer ALL questions

(The figures in the right hand margin indicate marks)

PART – A **(2 x 5 = 10 Marks)**

Q.1. Answer ***ALL*** questions		CO #	Blooms Level
a.	The specific gravity of hydrocarbon oil is 0.88 at 288 K. Calculate its value in Baume and API scale.	CO2	3
b.	Differentiate heat of mixing and heat of solution	CO2	3
c.	What is the use of Kistyakwosky rule?	CO2	3
d.	What are the assumptions of Clausius- Clapeyron equation?	CO2	1
e.	If the partial pressure and total pressure of an air-water vapour mixture is 15 kPa and 100 kPa respectively, calculate the absolute humidity of mixture	CO2	3

PART – B **(15 x 4 = 60 Marks)**

Answer ***ALL*** questions		Marks	CO #	Blooms Level
2. a.	The average molecular weight of a gas mixture of oxygen and sulphur dioxide is found to be 44.8. For 5 kg of of this mixture at 298 K and 200 kPa calculate i. The partial pressure of oxygen ii. The volume of the mixture. iii. The density at standard conditions	8	CO2	4
b.	Define the terms partial pressure and pure component volume in a gas mixture. Derive the relation mole fraction = pressure fraction = volume fraction from Dalton's law of partial pressure and Amagot's law of pure component volume.	7	CO2	4
	(OR)			
c.	An aqueous solution of NaCl contains 20% NaCl. Te density of the solution is 1.16 g/ml. 500 ml of water of density 1 g/ml is added to 1 litre of solution. What will be the molality and molarity of the resulting solution?	8	CO2	3
d.	A liquid mixture contains three components A (MW=72), B (MW= 58) and C (MW=56) in which A and B are present in the mole ratio of 1.5:1 and the weight % of B is 25%. A sample of mixture is found to contain 10 kg of C. Calculate the total number of moles of the mixture	7	CO2	3
3.a.	Moist air contains 0.025 kg water vapour per cubic metre of mixture at 313K and 103.15 kPa. Calculate the following: i. The relative saturation ii. The absolute humidity of the air iii. The percent saturation iv. The temperature to which the mixture be heated so that its percent saturation becomes 10%. The vapour pressure of water (in kPa) is approximated by the Antoine equation	8	CO2	3

as

$$lnP^S = 16.262 - \frac{3799.887}{T - 46.854}$$

b.	What are the characteristics of an ideal solution? How Raoult's law is related with ideal solution? Write its application.	7	CO3	2
	(OR)			
c.	An aqueous solution of acetaldehyde contains 2% acetaldehyde by weight. The partial pressure of acetaldehyde over the solution is found to be 41.4 kPa at 367 K. What will be the partial pressure over a 0.1 molal solution at the same temperature?	8	CO2	3
d.	Derive the expression relating vapour pressure and temperature from Clausius-Clapeyron equation. What is its application?	7	CO3	2
4.a.	The spent acid from a nitrating process contains 33% $H2SO_4$, 36% HNO_3 and 31% water by weight. This acid is to be strengthened by the addition of concentrated sulphuric acid containing 95% H_2SO_4 and concentrated nitric acid containing 78% HNO_3. The strengthened mixed acid is to contain 40% H_2SO_4 and 43% HNO_3. Calculate the quantities of spent and concentrated acids that should be mixed together to yield 1500 kg of the desired mixed acid.	8	CO2	3
b.	Propane is burned with excess air to ensure complete combustion. If 55 kg of CO_2 and 15 kg of CO are obtained when propane is completely burned with 500 kg air, determine: the mass of propane burnt in kg and the percent excess air.	7	CO2	4
	(OR)			
c.	A drier is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the drier is admitted to an oven which further brings down the moisture to 2%. If the drier can handle 1000 kg of wet solid per hour, calculate: (i) The weight of water evaporated in the drier and in the oven per hour. (ii) The percentage of original water that is removed in the drier and the oven.	8	CO2	3
d.	A synthesis gas analyzing 6% CO_2, 0.5% O_2, 40% CO, 50% H_2 and rest is N_2 is burned with 50% excess air. What is the composition of the flue gas?	7	CO2	4
5.a.	Obtain the empirical equation for calculating the heat of reaction at any temperature T (K) for the following reaction: $CH_4(g) + C_2H_6(g) \longrightarrow C_3H_8(g)$ Data: Standard heat of reaction at 298 k = -82.66 kJ/mol, Sp. Heat = a +bT+ cT2, kJ/(mol.K)	8	CO2	3

Component	a	bx103	C x106
CH4	19.2494	52.1135	11.973
C2H6	4.1261	155.0213	81.5455
C3H8	4.2227	306.264	158.6316

Using the same expression, calculate the heat of reaction at 600 0C

b.	. Calculate the std heat of formation of ethane gas at 25 0C using the following data. Heat of formation of $CO_2(g)$= -393.5 kJ/mol	7	CO3	2

Heat of formation of $H_2O(l)$= -285.8 kJ/mol

Heat of combustion of $C_2H_6(g)$= -1560.7 kJ/mol

(OR)

c.	Carbon monoxide reacts with water vapour to form CO_2 and H_2. $CO_{(g)} + H_2O_{(g)} \rightarrow CO_{2\,(g)} + H_{2\,(g)} \quad \Delta H^o_{298} = -41.19$ kJ The reactants are at 298 K. 75% of CO is converted in the reaction. The products leave the reaction chamber at 800 K. $C_{pm,CO} = 30.35 \frac{J}{mol.K}$ $C_{pm,H_2O\,(g)} = 36 \frac{J}{mol.K}$ $C_{pm,CO_2(g)} = 45.64 \frac{J}{mol.K}$ $C_{pm,H_{2\,(g)}} = 29.3 \frac{J}{mol.K}$ Determine the quantity of heat to be added or removed in the reaction chamber per 1000 kg of H2 produced.	8	CO2	3
d.	Derive the expression for effect of temperature on standard heat of reaction	7	CO2	3

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