P P SAVANI UNIVERSITY

Third Semester of Diploma Examination

November 2022

IDCH2021 Industrial Stoichiometry

23.11.2022, Wednesday **Time: 10:00 a.m. To 12:30 p.m.** **Maximum Marks: 60**

Instructions:

1. Make suitable assumptions and draw neat figures wherever required.
2. Use of scientific calculator is allowed.

Q - 1	Answer all MCQ. Choose ONE option only.	**[05]**	**CO**	**BTL**
(i)	Pick out the wrong statement about the recycle stream in a process. (a)Recycling in a process stream helps in utilizing the valuable reactants to the maximum with minimum loss of reactants (b)The ratio of the quantity of a reactant present in the reactor feed of a recycling operation to the quantity of the same reactant entering the process as fresh feed is called combined feed ratio (c)Recycling in a process does not help in getting higher extent of reaction (d)Recycling is exemplified by refluxing back a part of the distillate to the distillation column to maintain the quantity of liquid within the column		**3**	**1**
(ii)	A 'limiting reactant' is the one, which decides the _____ in the chemicalreaction." (a) Equilibrium constant (b) Conversion (c) Rate constant (d) None of these.		**3**	**1**
(iii)	The reactant with the smallest maximum extent of reaction is the_____ (a) Excess (b) Limiting (c) Neither excess nor limiting (d)None of the mentioned		**3**	**1**
(iv)	The objective of material and energy balance is to assess the (a) input-output (b) conversion efficiency (c) losses (d) all the above		**1**	**1**
(v)	Which of the following is not true regarding balanced chemical equations?" (a) They contain the same number of atoms on each side (b) Electrons are also balanced (c) An equal number of molecules on both the side (d) Follows the law of conservation of mass		**3**	**1**
Q - 2 (a)	Define: Normality, Molality, Molarity	**[05]**	**2**	**1**
Q - 2 (b)	Calculate molecular weight of (i) H_3PO_4 (ii) H_2SO_4 (iii) H_2SO_3 (iv) H_2CO_3	**[05]**	**2**	**5**
	OR			
Q - 2 (a)	Define (1) Excess Reactant (2) Limiting Reactant (3) Conversion (4) Yield (5) Selectivity	**[05]**	**5**	**1**
Q - 2 (b)	Write material balance equation for distillation column.	**[05]**	**3**	**1**
Q - 3 (a)	A sample of ground nut seeds contains 45% oil, 40% solids & rest moisture. After extraction, cake composition is 80% solids, 5% oil & rest moisture. Find the quantity of oil recovered.	**[05]**	**3**	**5**

Q - 3 (b)	98 grams of Sulphuric acid are dissolved in water to prepare one litre of solution. Find normality and molarity of the solution.	[05]	2	5
	OR			
Q - 3 (a)	NaCl weighing 200 kg is mixed with 600 kg potassium chloride. Calculate the composition of the mixture in (i) weight % (ii) mole %.	[05]	2	5
Q - 3 (b)	15 kg of carbon monoxide is compressed at a temperature of 303 K (30 ^{0}C) to a volume of 0.5 m^3. Calculate the pressure required for given duty. Assume ideal gas law is applicable.	[05]	2	5
Q - 4	Attempt any ONE.	[05]	6	
(i)	Calculate the standard heat of reaction : $4NH_3(g) + 5O_2(g) \longrightarrow 4NO(g) + 6H_2O(g)$ Enthalpy of formation ΔHf^0 are $NH_3(g) = -45.94$, $NO(g) = +90.25$, $H_2O(g) = -241.82$, kJ/mol			5
(ii)	Explain proximate analysis in detail.		6	2
Q - 5	Answer all MCQ. Choose ONE option only.	[05]		
(i)	The stochiometric ratio of H_2 to CO is (a) 2 (b) 3 (c) 1 (d) 0		1	1
(ii)	Recycling in a chemical process facilitates (a) Increased yield (b) Enrichment of product (c) Heat conservation (d) All (a), (b) &(c)		3	1
(iii)	A chemical process is said to occur under unsteady state, if the (a) Inventory changes do not take place (b) Ratio of streams entering/leaving are independent of time (c) Flow rates & composition both are time dependent (d)None of these		3	1
(iv)	A bypass stream in a chemical process is useful, because it (a) Facilitates better control of the process (b) Improves the conversion (c) Increases the yield of products (d) None of these		3	1
(v)	Which of the following is used for the separation of the components of theliquid mixture with the suitable liquid solvent (a) Adsorption (b) Evaporation (c) Distillation (d) Extraction		3	1
Q - 6 (a)	Explain: Heat of reaction, Standard heat of formation and standard heat of combustion.	[05]	6	2
Q - 6 (b)	Ammonia is Produced by the following reaction: $N_2 + 3H_2 \rightarrow 2NH_3$ Calculate the molal flow rate of hydrogen corresponding to nitrogen feed rate of 25 kmol/h if they are fed in the stoichiometric proportion.	[05]	4	5
	OR			

Q - 6 (a)	A gaseous mixture has the following composition by volume: CO_2 = 8 %, CO = 14 %, O_2 = 6 %, H_2O = 8 %, CH_4 = 8 % and N_2 = 8 %. Calculate (i) the average molecular weight of the gas mixture & (ii) the density of the gas mixture at 303 K (30 °C) and101.325 kPa.	**[05]**	**2**	**5**
Q - 6 (b)	Derive the general heat capacity equation.	**[05]**	**6**	**6**
Q - 7 (a)	In the production of SO_3, 100 kmol of SO_2 and 200 kmol of O_2 are fed to a reactor. The product stream is found to contain 80 kmol SO_3. Find the percent conversion of SO_2.	**[05]**	**6**	**5**
Q - 7 (b)	A single effect evaporator is fed with 10000 kg/h of weak liquor containing 15 % caustic by weight and is concentrated to get thick liquor containing 40 % by weight caustic (NaOH). Calculate: (a) kg/h of water evaporated and (b) kg/h of thick liquor obtained.	**[05]**	**3**	**5**
	OR			
Q - 7 (a)	Write about importance of material balance in chemical engineering.	**[05]**	**3**	**1**
Q - 7 (b)	The dilute acid containing 25% sulphuric acid is mixed with 98% to obtain 65 % concentrated acid. Find quantities of acids required to make 1000 kg desired acid.	**[05]**	**3**	**5**
Q - 8	Attempt any **ONE**.	**[05]**		
(i)	A stream of CO_2 is to be heated from 298 K to 383 K. Calculate heat to be added for gas flow rate of 100 kmol/min. The molar heat capacity of gas is given by, $Cp = 21.3655 + 64.2841 \times 10^{-3} T - 41.0506 \times 10^{-6} T^2 + 9.7999 \times 10^{-9} T^3$, kJ/kmol.		**6**	**5**
(ii)	Analysis of flue gas from chimney is 11.4% CO_2, 4.2% O_2 & 84.4% N_2 by moles. Assuming complete combustion, Calculate % excess air used.		**5**	**5**

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CO : Course Outcome Number BTL : Blooms Taxonomy Level

Level of Bloom's Revised Taxonomy in Assessment

1: Remember	2: Understand	3: Apply
4: Analyze	5: Evaluate	6: Create