## **Question Paper**

Exam Date & Time: 25-Apr-2018 (09:30 AM - 12:30 PM)



## MANIPAL ACADEMY OF HIGHER EDUCATION

## INTERNATIONAL CENTRE FOR APPLIED SCIENCES II SEMESTER B.Sc (APPLIED SCIENCES) END - SEMESTER THEORY EXAMINATIONS APRIL - 2018 DATE: 25 APRIL 2018 TIME: 9:30 AM TO 12:30 PM Chemical Process Calculations [ICHM 121]

Marks: 100

2)

Duration: 180 mins.

## Answer 5 out of 8 questions.

- <sup>1)</sup> A solution of Caustic Soda (NaOH) in water contains 20% <sup>(10)</sup> by wt. of NaOH at 333K. The density of the solution is
  - A) 1.196 kg/lit. Find the molarity, normality and molality of the solution.
  - B) A solution containing sodium sulfate in water is crystallized <sup>(10)</sup> out by cooling the solution to 5°C. The original solution is saturated to 40°C and deca-hydrate crystals are obtained. Estimate the wt. of crystal obtained by cooling a batch of 2000 kg of this solution. Solubility at  $40^{\circ}C = 32.6 \%$ Solubility at  $5^{\circ}C = 5.75 \%$ Both solubilities have units of kg Na<sub>2</sub>SO<sub>4</sub>/ kg solution (Molecular Wts:  $Na_2SO_4 = 142$ ,  $Na_2SO_4.10H_2O = 322$ ) Pure  $CO_2$  can be prepared by treating limestone with aq. (10) $H_2SO_4$ . The limestone used contains CaCO<sub>3</sub>, MgCO<sub>3</sub> and A) inerts. The acid used contains 12% H<sub>2</sub>SO<sub>4</sub>. The residue from the process had the following composition: CaSO<sub>4</sub>:8.56%, MgSO<sub>4</sub>:5.23%, H<sub>2</sub>SO<sub>4</sub>:1.05%, Inerts:0.53%, CO<sub>2</sub>: 0.12%, water: 84.51% During the process,  $CO_2$  and water vapors are distilled. Calculate: i) The analysis of limestone ii) % excess of acid used B) (10)A treating plant operating under steady state conditions processes raw waste liquor containing 0.5% noxious

3)	A)	hazardous impurities. A treatment plant reduces the level of impurities to 0.01%. By local law a maximum of 0.1% of impurity may be discharged to the local river. What fraction of raw waste liquor stream the plant must bypass? In the Decon process of manufacturing Chlorine gas, HCl gas is oxidized with air. The reaction is given as $4HCl+O_2 \rightarrow 2Cl_2+2H_2O$ If the air is used in 30% excess & the reaction is 80% complete, calculate the composition of the dry gas leaving	(10)
	В)	A liquid mixture of compounds A, B and C containing 20 Kg of A , 25% by wt. of B, and contains 2 mole of C per mole of B. The respective molecular wts. of A, B, C are 56, 58 and 72 and specific gravities are 0.58, 0.6 and0.67 respectively. Calculate i. The analyses of the mixture in mole %, ii. Molecular wt. of the mixture iii. The volume % of A on B free basis iv. The total number of moles of mixture	(10)
4)	A)	Determine the flue gas analysis and air-fuel ratio by wt. when a fuel oil with 84.5% C, 11.8% H <sub>2</sub> , 3.2 % S, 0.4% O <sub>2</sub> , 0.1% ash is burned with 25% excess air.	(12)
	В)	Limestone is a mixture of calcium carbonate and magnesium carbonate. When 100 kg of limestone is calcined, 44 kg of CO <sub>2</sub> is obtained. If the inerts are 10%, find the analysis of limestone used. (At. Mass: Ca:40;Mg:24)	(8)
5)		The equation for methanol synthesis is given by the equation $CO_2 + H_2 \rightarrow CH_3OH + H_2O$ The H <sub>2</sub> and CO <sub>2</sub> entering in stoichiometric quantities contain 0.5% inert by volume. The process is under steady state. The conc. of the inerts going into the reactor must be held at 2% by volume. The conversion is 60 % per pass. Calculate: i) Moles recycled/ moles fed ii) Moles purged/ moles fed.	(20)
6)	A)	Acetone nitrile is produced by the reaction of propylene, ammonia and $O_2$ .	(12)

	В)	$C_3H_6 + NH_3 + 3/2 O_2 \rightarrow C_3H_3N + 3 H_2O$ The feed contains 10 % propylene, 12 % ammonia and 78 % air ( in mole %) i) Determine the limiting reactant ii) % by which the other reactants are in excess. Calculate the volume occupied by 1 mole of water vapour at 900 °C and 100 atm by i) Perfect gas law ii) Vander Waal's equation The Vander-Waal's constants are a= (5.404	(8)
7)	A)	L <sup>2</sup> .atm)/(mole <sup>2</sup> ); b= 0.03049 L/mole Air at a pressure of 1atm is at 40°C and has a humidity of 70%. Find using humidity chart: i) Absolute Humidity ii) Molal Humidity iii) Dew Point Temperature iv) Adiabatic Saturation Temperature v) Humid Heat vi) Humid Volume	(10)
	B)	A waste acid from a nitration process contains 21 % $HNO_3$ , 55 % $H_2SO_4$ , and 24 % water. The acid is to be concentrated to contain 28 % $HNO3$ , 62% $H_2SO_4$ by wt. by the addition of conc. $H_2SO_4$ and $HNO_3$ having concentrations 93 % and 90% by wt. respectively. Calculate the weight of the waste acid and conc. acid required to obtain a product of 1000kg.	(10)
8)	A)	Fresh orange juice contains 12% solids and balance water, the concentrated juice contains 42% solids. In the present process the evaporator is bypassed with a fraction of fruit juice. The juice that exits out of the evaporator is concentrated to 58% solids and the product is mixed with fresh juice to achieve the final concentration. Calculate i) Amount of concentrated fruit juice produce per 1000 kg of fresh juice.	(10)
	В)	<ul> <li>ii) Fraction of feed that bypasses the evaporator.</li> <li>It is desired to make a 24 % by wt. of caustic soda solution.</li> <li>It is done in 2 steps.</li> <li>i. The caustic soda is dissolved in a dissolution tank in a correct quantity of water to produce 50% solution.</li> <li>ii. After complete dissolution, the solution is taken to a dilution tank, where some water is added to produce 24%</li> </ul>	(10)

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by wt. of solution. Calculate the wt. ratios of water added to both the tanks.

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