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B.M.S. College of Engineering, Bengaluru-560019

Autonomous Institute Affiliated to VTU

May 2023 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Chemical Engineering **Duration: 3 hrs.**
Course Code: 22CH3PCPPC / 19CH3DCPPC **Max Marks: 100**
Course: Process Principles and Calculations **Date: 22.05.2023**

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

UNIT - I

1 a) What is the meaning of dimensional consistent equation? Prove that $N_{Re} = \rho DV/\mu$ is a dimensionless number where ρ is density, D is diameter, V is velocity and μ is viscosity. **05**

b) When 2.5 g of oxalic acid is dissolved in 500 ml of water, what is the normality and molarity of the solution? **05**

c) The equation for the heat transfer to or form a stream of gas flowing in turbulent motion is as follows. **10**

$$h = \frac{\alpha C_p G^{0.8}}{D^{0.2}} = 16.6\frac{C_p G^{0.8}}{D^{0.2}}$$

Where,

$C_p\ is\ heat\ capacity, \frac{Btu}{lb\ °F}$

$D\ is\ the\ diameter\ of\ the\ pipe, inches$

$G\ is\ mass\ velocity\ of\ the\ pipe, \frac{lb}{s\ ft^2}$

$h\ is\ heat\ transfer\ coeffeient, \frac{Btu}{hft^{2}°F}$

Convert the equation to

$$h' = \frac{\alpha' C_p{}' (G')^{0.8}}{(D')^{0.2}}$$

Where,

$C'_p is\ heat\ capacity, \frac{kcal}{kg\ °C}$

$D'\ is\ the\ diameter\ of\ the\ pipe, cm$

$G'\ is\ mass\ velocity\ of\ the\ pipe, \frac{kg}{s\ m^2}$

$h'\ is\ heat\ transfer\ coeffeient, \frac{kcal}{s\ m^{2}°C}$

UNIT - II

2	a)	Draw the schematic representation of distillation column and represent material balance equation.	**06**
	b)	A solution of ethylalcohol containing 8.6% alcohol is fed at the rate of 1000 kg/h to a continuous distillation column. The product is a solution (distillate) containing 95.5 % alcohol. The waste solution from the column contains 0.1% of alcohol. All percentages are by weight. Calculate (a) the mass flow rates of top and bottom products in kg/h and (b) the percentage of loss of alcohol	**14**

OR

3	a)	A saturated solution of $MgSO_4$ at 353 K ($80°C$) is cooled to 303 K ($30°C$) in a crystallizer. During cooling, 4% solution is lost by evaporation of water. Calculate the quantity of the original saturated solution to be fed to the crystallizer per 1000 kg crystals of $MgSO_4.7H_2O$. Solubility of $MgSO_4$ at 303 K and 353K are 40.8 and 64.2 kg per 100 kg of water, respectively.	**10**
	b)	A mixture of acetic acid (47.5%) and water (52.5%) by weight is being separated by extraction. The operating temperature is 24°C and the solvent is used is pure isopropyl ether using the solvent ratio of 1:3 kg/kg feed. The final extraction composition of a solvent free basis is found to be 85% by wt. of acetic acid. The raffinate is found to contain 14% by wt. of acetic acid on solvent free basis. Calculate the percentage of acid of the original feed which remains un-extracted.	**10**

UNIT - III

4	a)	Explain the following terms (i) Limiting reactant (ii) Excess reactant (iii) Conversion (iv) Yield	**08**
	b)	Monochloroacetic acid (MCA) is manufactured in a semi-batch reactor by the action of glacial acetic acid with Cl_2 gas at 100°C in the presence of PCl_3 catalyst. MCA thus formed will further react with Cl_2 to form dichloroacetic acid (DCA). To prevent the formation of DCA, excess acetic acid is used. A small-scale unit which produces 5000 kg/d of MCA, required 4536 kg/d of chlorine gas. Also 263 kg/d of DCA is separated in the crystallizer to get almost pure MCA product. Find the % conversion, % yield of MCA and selectivity.	**12**

UNIT - IV

5	a)	Explain the ultimate and proximate analysis in combustion operations.	**04**
	b)	Explain the theoretical and excess oxygen in combustion operations.	**04**
	c)	The coal sample from Godavari Colliery has the following composition C-50.22%, H_2-2.79%, sulfur-0.37% and oxygen - 18.04 % by weight and rest ash. Calculate (a) Theoretical oxygen requirement per unit weight of coal burnt. (b) Theoretical dry air requirement per unit weight of coal burnt.	**12**

OR

6		The Orsat analysis of the flue gases from a boiler chimney gives CO_2: 11.4%, O_2:4.2% and N_2:84.4% (mol%). Assuming that complete combustion has taken place. Calculate (a) the % excess air and (b) C:H ratio in the fuel.	**20**

UNIT – V

7	a)	Explain the terms (i) Heat capacity (ii) Enthalpy (iii) Heat of formation (iv) Heat of reaction and (v) Heat of combustion	**10**
	b)	Toluene is heated from 290 K to 350 K at the rate of 0.25 kg/s. Calculate the heat required to be added to the toluene using the constants given below for the calculations of C_p (J/kmol K). a = 1.8083; $b\times10^3$ = 812.223 and $c\times10^6$ = -1512.67	**10**

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