UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, December 2017

Program Name: Int. B. Tech ET + LLB (IPR) **Semester – III**

Course Name : Material and Energy Flow Computation **Max. Marks : 100**
Course Code : CHEG 201 **Duration : 3 Hrs**
No. of page/s:

Instructions:
Attempt **all** questions from **Section-A** (each carrying 10 marks); **all** Questions from **Section-B** (each carrying 12 marks) and any **one** Question from **Section-C** (carrying 20 marks).

	Section-A (Attempt **All** Questions**)**		
1.	An analysis of the vent gases from the chlorinator of a plant for making chlorinated rubber showed 70% by volume HCl, 20% by volume Cl_2 and the rest is CCl_4. Determine: (a) the % composition by weight (b) the average molecular weight of the gas (c) The density at standard conditions.	**[10]**	**CO2**
2.	The vapor pressure of diethyl ether at 273 K is 25 kPa and its latent heat of vaporization is 4.185×10^2 kJ/kg. Using the Classius-Clapeyron equation, estimate the vapor pressure at 293 K and 308 K.	**[10]**	**CO3**
	SECTION B (Attempt **All** Questions**)**		
3.	Barium Chloride reacts with Sodium Sulphate to precipitate Barium Sulphate : $BaCl_2 + Na_2SO_4 \rightarrow 2NaCl + BaSO_4$ (a) How many grams of Barium Chloride are needed to react with 100g of sodium sulphate? (b) For precipitating 50g of Barium Sulphate, how many gram of the reactants are consumed? (c) How many grams of Sodium Chloride would be obtained when 50g of Barium Sulphate is precipitated? Atomic weight of Barium=137.32 g/mol	**[12]**	**CO2**
4.	A mixture of Benzene and air contains 15% Benzene by volume at 300 K and 101.3 kPa. The vapor pressure of Benzene at 300 K is 13.8 kPa. Calculate the following: (a) The weight fraction of Benzene in the mixture (b) The molal humidity (c) The absolute humidity (d) The percent saturation (e) The percent relative saturation (f) The mass of air in 100 m^3 of the mixture	**[12]**	**CO4**

5.	The flue gas from an industrial furnace has the following composition by volume: CO_2=11.73%, CO=0.2%, N_2=0.09%, O_2=6.81%and N_2=81.17% Calculate the percentage excess air employed in the combustion if the loss of carbon in clinker and ash is 1% of the fuel used and the fuel has the following composition by weight: C= 74%,H_2= 5%,O_2=5%,N_2=1%, S=1%, H_2O=9% and ash=5%.	**[12]**	**CO5**
6.	A solution of potassium dichromate in water contains 13% $K_2Cr_2O_7$ by weight. 1000 kg of this solution is evaporated to remove some amount of water. The remaining solution is cooled to 20^0C. If the yield of $K_2Cr_2O_7$ crystals is 80%. Calculate the amount of water evaporated. Solubility of $K_2Cr_2O_7$ is 0.390 kgmol per 1000 kg water (20^0C) atomic weight: K = 39 g/mol, Cr = 52 g/mol.	**[12]**	**CO5**
7.	Fresh juice contains 14% solids and 86% water by weight and is to be concentrated to contain 42% solids by weight. In a single evaporator system, it is found that the volatile constituents of juice escape with water leaving the concentrated juice 56%, with a flat taste. To overcome this problem part of the fresh juice bypass the evaporator. Calculate: (i) The fraction of juice that bypass the evaporator (ii) The concentrated juice produced containing 42% solids by weight.	**[12]**	**CO5**
	SECTION C (Attempt Any One)		
8.	A continuous fractionating column, operating at 1 atm., is to be used to separate 15000 kg/h of a solution of Benzene and Toluene containing 50% (by weight) Benzene into an overhead product containing 96% (by weight) Benzene and 97% (by weight) Toluene in the bottom product. The feed will be at its boiling point and a reflux ratio of 2.5 kg of reflux per kg of distillate is to be used. Calculate the condenser and reboiler load. Data: Enthalpy of feed = 170.8 kJ/kg Enthalpy of reflux liquid = 67 kJ/kg Enthalpy of vapor leaving the column and entering the condenser = 540 kJ/kg Enthalpy of liquid leaving the reboiler = 201.8 kJ/kg	**[20]**	**CO6**
9.	Obtain an empirical equation for calculating the heat of reaction at any temperature T (in K) for the following reaction: $CO(g)+2H_2(g) \rightarrow CH_3OH(g)$ Data: $\Delta H_R^o at\, 298\, K = -90.41\, kJ/mol$ $C_p^o = a+bT+cT^2+dT^3, \frac{kJ}{kmol.K}$	**[20]**	**CO6**

Component	A	b x 10^3	c x 10^6	d x 10^9
CO	29.0277	-2.8165	11.6437	-4.7063
H_2	28.6105	1.0194	-0.1476	0.769
CH_3OH	21.137	70.843	25.86	-28.497

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