Total No. of Questions—**8**] [Total No. of Printed Pages—**5**

Seat No.	

[5668]-174

S.E. (Chemical Engineering) (I Sem.) EXAMINATION, 2019

PROCESS CALCULATIONS

(2015 PATTERN)

Time : Two Hours **Maximum Marks : 50**

N.B. **:—** (*i*) Attempt Question Nos. Q. **1** *or* Q. **2**, Q. **3** *or* Q. **4**, Q. **5** *or* Q. **6** and Q. **7** *or* Q. **8**.

(*ii*) Figures to the right indicate full marks.

(*iii*) Neat diagrams must be drawn wherever necessary.

(*iv*) Assume suitable data, if necessary.

(*v*) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam table is permitted.

1. (*a*) The Volumetric flow rate of kerosene in an 80 mm nominal diameter pipe is 75 gallons per minute. Taking the density of kerosene as 0.8 g/cm^3, find the mass flow rate in kg/h. [6]

(*b*) A single effect evaporator is fed with 10000 kg/hr of weak liquor containing 15% caustic by weight and is concentrated to get thick liquor containing 40% by weight caustic (NaOH). Calculate : [6]

(*a*) kg/hr of water evaporated and

(*b*) kg/hr of thick liquor obtained.

P.T.O.

Or

2. (*a*) An aqueous solution of K_2CO_3 is prepared by dissolving 43 kg of K_2CO_3 in 100 kg of water at 293 K. Find Molarity, Normality and Molality of solution. Take density of solution 1.3 kg/L. [6]

(*b*) In a textile mill a double effect evaporator system concentrates weak liquor containing 4% (by weight) caustic soda to produce a lay containing 25% solids (by weight). Calculate the evaporation of water per 100 kg feed in the evaporator. [6]

3. (*a*) A coke is known to contain 90% carbon and 10% non-combustible ash (by weight) : [6]

(1) Find the moles of oxygen theoretically required to burn 100 kg of coke completely ?

(2) If 50% excess air is supplied, calculate the analysis of gases at the end of combustion.

(*b*) Stream of carbon dioxide flowing at a rate of 100 kmol/min is heated from 298 K (25°C) to 383 K (110°C). Calculate the heat that must be transferred using C^0_p data. [6]

Data : $C^0_p = a + bT + cT^2 + dT^3$ kJ/(kmol.K)

Gas	a	b×10^3	c×10^6	d×10^9
CO_2	21.3655	64.2841	−41.0506	9.799

Or

4. (*a*) The gaseous reaction $A \rightarrow 2B + C$ takes place isothermally in a constant pressure reactor. Starting with a mixture of 75% A and 25% of inerts (both on volume basis) in a specified time the volume doubles. Compute the % conversion of A achieved. [6]

(*b*) Calculate the heat of formation of liquid ethyl acetate at 298 K (25°C) [6]

Data :

Standard heat of formation of CO_2 (g) = –393.51 kJ/mol

Standard heat of formation of H_2O (l) = –285.83 kJ/mol

Standard heat of combustion of liquid ethyl acetate = $C_4H_8O_2$ = ΔH^o_C = –2230.91 kJ/mol.

5. (*a*) Define : [5]

(1) Dry Bulb Temperature

(2) Wet Bulb Temperature

(3) % Relative Humidity

(4) Dew Point

(5) Humid Heat.

(*b*) The crystallizer is fed with a saturated solution of $MgSO_4$ at 353 K (80 C). The mass is cooled to 303 K (30 C) to obtained $MgSO_4.7H_2O$ crystals. During cooling, 4% solution is lost by evaporation of water. Calculate the quantity of saturated

solution that should be fed to crystallizer in order to obtained 1000 kg of $MgSO_4.7H_2O$ crystals. [8]

Data : The solubility of $MgSO_4$ in water at 353 K = 64.2 kg $MgSO_4$/100 kg H_2O

The solubility of $MgSO_4$ in water at 303 K = 40.8 kg $MgSO_4$/ 100 kg H_2O.

Or

6. (*a*) The dry bulb temp. and dew point of ambient air were found to be 300 K (29 C) and 291 K (18 C) respectively, barometer reads 100 kpa, calculate : [7]

(*i*) absolute molal humidity

(*ii*) absolute humidity

(*iii*) % RH

(*iv*) % saturation

(*v*) Humid heat

(*vi*) Humid volume the relative saturation of 30%.

Data : Vapour pressure of water at 291 K = 2.0624 Kpa. Vapour pressure of water at 302 K = 4.004 Kpa.

(*b*) A gas mixture containing benzene vapors is saturated at 101.325 kpa and 323 K (50 C), Calculate the absolute humidity of if the other components of mixture is : [6]

(1) Nitrogen and

(2) Carbon dioxide.

Data : Vapour pressure of benzene at 323 K = 36.664 Kpa

7. (*a*) Define calorific value, GCV, NCV. [3]

(*b*) (1) Explain different types of Fuels ? [4]

(2) Calculate the net calorific value (NCV) at 298 K of a sample of fuel oil having C/H ratio 9.33 (by weight) and containing sulphur to the extent of 1.3% by weight. [6]

Data : The GCV of the fuel oil at 298 K (25ºC) = 41785 kJ/kg

Latent heat of water vapour at 298 K (25ºC) = 2442.5 kJ/kg

Or

8. (*a*) Write a short note on Proximate analysis and ultimate analysis of coal. [5]

(*b*) The Orsat analysis of the flue gases from a boiler house chimney by volume is as given below : [8]

CO_2 : 11.4%, O_2 : 4.2% and N_2 : 84.4%

Assuming the complete combustion takes place,

(1) Calculate the % excess air and

(2) Find the C : H ratio.