

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER-III (NEW) EXAMINATION – SUMMER 2019

Subject Code: 2130504

Date: 07/06/2019

Subject Name: Process Calculation

Time: 02:30 PM TO 05:30 PM

Total Marks: 70

Instructions:

1. Attempt all questions.
2. Make suitable assumptions wherever necessary.
3. Figures to the right indicate full marks.
4. Atomic weights: C:12, O:16, S:32, Cl:35.5, Na:23, N:14, Mg:24, B:11, Si:28, Al:27, Fe:56, Zn:65, P:31

- Q.1**
- (a) The volumetric flow rate of kerosene in 80 mm nominal diameter pipe is 75 Imperial gallons per minute. Taking the density of kerosene as 0.8 kg/dm^3 , find the mass flow in kg/s . **03**
 - (b) The available nitrogen in an urea sample is found to be 45% (by mass). Find the actual urea content in the sample. **04**
 - (c) The conductance of a fluid flow system is defined as the volumetric flow rate, referred to a pressure of one torr (133.322 Pa). for an orifice, the conductance C can be computed from **07**

$$C = 89.2 A \sqrt{\frac{T}{M}}, \frac{ft^3}{s}$$

Where, A = area of opening (ft^2), T = temperature ($^{\circ}R$), M = Molar mass
 Convert the empirical equation into SI unit.

- Q.2**
- (a) Iron metal weighing 500 lb occupies a volume of 29.25 L. Calculate the density of Iron in kg/dm^3 . **03**
 - (b) Define terms: -Normality, Molality, Molarity, Limiting Reactant **04**
 - (c) A solution of sodium chloride in water contains 20% NaCl (by mass) at 333 K. The density of the solution is 1.127 kg/L . Find the molarity, normality and molality of the solution. **07**

OR

- (c) The analysis of a sample of glass yields 7.8% Na_2O , 7.0% MgO , 9.7% ZnO , 2.0% Al_2O_3 , 8.5% B_2O_3 and 65.0% SiO_2 (By mass), Convert this composition into mole %. **07**
- Q.3**
- (a) Find the equivalent mass of (a) PO_4 radical, and (b) Na_3PO_4 **03**
 - (b) Using Antoine equation calculate the vapor pressure of Aniline at 380 K. **04**
 Data: $A=6.4450$ $B= 1731.50$ $C= -67.05$
 - (c) A multiple-effect-evaporator system has a capacity of processing one tone per day of solid caustic soda when it concentrates weak liquor from 4 to 25 % (both on weight basis). When the plant is fed with 5% weak liquor and if it is concentrated to 50% (both on weight basis), find the capacity of the plant in terms of solid caustic soda, assuming water evaporating capacity to be same in both the cases. **07**

OR

- Q.3**
- (a) Define terms: Excess Reactant, Conversion, Yield **03**
 - (b) Explain importance of process flow sheet in Chemical Engineering Industry with a typical example. **04**

- (c) The average molar mass of a flue gas sample is calculated by two different engineers. One engineer uses the correct molar mass of 28 for N_2 and determines the average molar mass to be 30.08, the other engineer, using an incorrect value of 14, calculates the average molar mass to be 18.74. (i) Calculate the volume % of nitrogen in the flue gases, (ii) If the remaining components of the flue gases are CO_2 and O_2 , Calculate the volume % each of them. **07**
- Q.4 (a)** Define terms: Heat of formation, Heat of combustion, Heat of reaction. **03**
- (b)** Discuss uses of recycling and bypassing operation. **04**
- (c)** In the Deacon process for manufacturing chlorine, hydrochloric acid gas is oxidized with air. The reaction taking place is $4HCl + O_2 \rightarrow 2Cl_2 + 2H_2O$ If the air is used in excess of 30% of that theoretically required. Calculate the weight of air supplied per kilogram of acid. **07**
- OR**
- Q.4 (a)** Explain the material balance of crystallizer. **03**
- (b)** For o-xylene, Calculate latent heat of vaporization at 298.15 K using Watson equation. **04**
 Latent heat of o-xylene at 417.5 K = 36819 kJ/kmol,
 Critical temperature of o-xylene = 630.30 K.
- (c)** Pure methane is heated from 303 K to 523 K at atmospheric pressure. Calculate the heat added per kmol methane, using given data. **07**
 $a=19.2494$, $b=52.1135 \times 10^{-3}$, $c=11.973 \times 10^{-6}$, $d=-11.3173 \times 10^{-9}$
- Q.5 (a)** Give classification of fuel in brief. **03**
- (b)** Define terms: Dry-Bulb Temperature, Absolute Humidity, Percentage Humidity, Wet Bulb Temperature **04**
- (c)** Obtain an expression relating the heat of reaction and the temperature of the reaction **07**
 $SO_{2(g)} + 0.5 O_{2(g)} = SO_{3(g)}$, Using the same expression, Calculate the heat of reaction at 775 K. $\Delta a = -15.748$, $\Delta b = 52.799 \times 10^{-3}$, $\Delta c = -45.438 \times 10^{-6}$, $\Delta d = 13.528 \times 10^{-9}$,
 $\Delta H^\circ_R = -98910$ kJ/kmol
- OR**
- Q.5 (a)** Define GCV and NCV for fuels. Give its importance. Also give the names of the equipments used for measuring CV of solid, liquid and gases. **07**
- (b)** Discuss Proximate and Ultimate analysis of coal. **07**
