Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–III(OLD) • EXAMINATION – WINTER 2016

Subject Code:130504 **Date:06/01/2017**

Subject Name:Process Calculation

Time:10:30 AM to 01:30 PM **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Atomic weight: Ca=40, C=12, O=16, H=1, Mg=24, N=14, K=39, S=32

Q.1 **(a)** Vapor pressure of benzene in the temperature range of 7.5˚C to 104 ˚C can be calculated using the following Antoine Equation **07**

$$log_{10}\, p = 6.9057 - \frac{1211.0}{(t + 220.8)}$$

Where p = vapor pressure in Torr (mmHg) and
t= Temperature in ˚C
Convert above equation in SI Units.

(b) By titration, it was found that a sample of water contains hardness equivalent to 500 mg/L (ppm) $CaCO_3$. Assuming that the water contains temporary hardness in 60% $Ca(HCO_3)_2$ form, and 40% $Mg(HCO_3)_2$ form, find the concentrations of both in water. **07**

Q.2 **(a)** Ethanol is present in the aqueous solution to the extent of 1000 mg/L. Find TOC and ThOD of the solution in mg/L. **07**

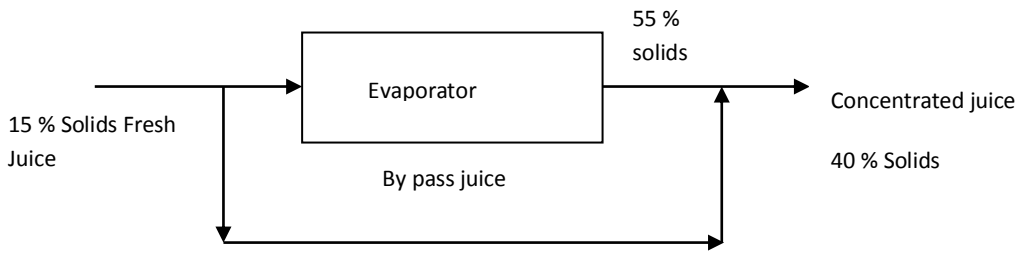
(b) With the neat sketch explain the use of recycling, bypassing and purging operations. **07**

OR

(b) Convert followings: **07**

1. 50 lb/ft^3 to gm/cm^3
2. 294 gm/L H_2SO_4 to Normality

Q.3 **(a)** Fresh juice contains 15% solids and 85% water by weight and is to be concentrated to contain 40 % solids by weight. In single evaporation system, it is found that volatile constituents of juice escape with water leaving the concentrated juice with a flat taste. In order to overcome this problem, part of the fresh juice bypasses the evaporator. The operation is shown schematically in below figure. **07**



Calculate (i) the fraction of juice that bypasses the evaporator and (ii) the concentrated juice product per 100 kg fresh juice fed to the process.

(b) The NH_3- Air mixture containing 0.2 kg NH_3 per kg air enters into absorption system where ammonia is absorbed in water. The gas leaving the system is **07**

found to contain 0.004 kg NH_3 per kg of air. Find the % recovery of ammonia.

OR

Q.3	**(a)**	Gaseous benzene reacts with hydrogen in presence of Ni catalyst. 30% excess hydrogen is used above that theoretical required. Conversion is 50% and yield is 90%. Calculate the requirement of benzene and hydrogen gas for 100 moles of cyclohexane produced.	**07**
	(b)	A distillation column separates 10000 kg/hr of a 50% benzene and 50% toluene. The product recovered from the top contains 95% benzene while the bottom product contains 96% toluene. The stream entering condenser from the top of the column is 8000 kg/hr. A portion of the product is recycled to the column as reflux and the remaining withdrawn as top product. Find the ratio of the amount refluxed to the product.	**07**
Q.4	**(a)**	Develop the energy balance equation for steady state flow of incompressible fluid.	**07**
	(b)	Write a short note on analysis of coal.	**07**

OR

Q.4	**(a)**	Calculate the heat required to raise the temperature of 1 kmol pure sulfur dioxide from 300 to 1000 K. Use the following equation for C_P data. $$C_p = 43.458 + 10.634 * 10^{-3}T - 5.945 * \frac{10^5}{T^2}$$	**07**
	(b)	An aqueous solution of K_2CO_3 is prepared by dissolving 44 g K_2CO_3 in 100 g water at 293 K. Find molarity, normality and molality of the solution. Take density of solution as 1.3 kg/lit.	**07**
Q.5	**(a)**	Define latent heat. State various equations used to calculate latent heat.	**07**
	(b)	A sample of fuel oil has C/H ratio 9.33 (by mass) and contains sulfur to the extent 1.3% (mass). The GCV of the fuel is measured to be 41785 kJ/kg at 25°C. Calculate its NCV at 25 °C. Latent heat of water vapor at 25 °C is 2442.5 kJ/kg.	**07**

OR

Q.5	**(a)**	A heat exchanger for cooling hot oil uses 10000 kg/hr of cooling water, which enters the exchanger at 294 K. The hot oil at the rate of 5000 kg/hr enters at 423 K and leaves at 338 K and has an average heat capacity of 2.51 KJ/kg K. Calculate the outlet temperature of the water.	**07**
	(b)	Write short note on Classification of fuels.	**07**

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