

(A Constituent Institute of Manipal University)



III SEMESTER B.TECH (CHEMICAL ENGINEERING) MAKE UP EXAMINATIONS, DEC 2015

SUBJECT: CHEMICAL PROCESS CALCULATIONS (CHE 2101)

REVISED CREDIT SYSTEM

Time: 3 Hours

INSPIRED BY LIFE

MAX. MARKS: 100

Instructions to Candidates:

- ✤ Answer ALL the questions.
- ✤ Missing data may be suitably assumed.
- Atomic Mass- O:16, S: 32, Na: 23, H:1, C:12, Ca:40, Cl:35.5, Br: 79.9, K:39, Cr:52, Cu: 63.5, Mg: 24
- ✤ Use of humidity chart permitted.

1A. A 35 wt % aqueous MgSO₄ solution is originally present at 366 K. 5% of the water 12 initially present in feed is vaporized during evaporation. The solution is cooled to 294 K and MgSO₄.7H₂O solid-phase hydrate will form. If the crystallizer is operated at 5000 kg/h of feed, i. How many kg of crystals will be produced per hour? What will be the solid-phase yield based on MgSO₄ only? ii. (Solubility of MgSO₄ at 294K = 0.27kg MgSO₄/ kg of solution) **1B**. Determine the mass of copper sulfate penta hydrate (CuSO₄.5H₂O) crystals required 8 to obtain 1 L of solution having a conc. of 1000 mg/L of Cu(II) ions. A 250 mg/L Cu(II) ion solution is prepared using the solution of 1000 mg/L conc. prepared in step (a) above. Determine the amounts of the solution and plain water to be mixed to make 25 ml of the total solution assuming that the total volume equals sum of individual volumes. 2A. 12 By electrolyzing a mixed brine, a mixture of gases is obtained at the cathode having the following composition by wt. % Cl₂= 67%, Br₂=28%, O₂=5% Using ideal gas law calculate: i. Composition of gas by volume ii. Density of mixture in gm/lt at 25° C and 740 mmHg iii. Specific gravity of the mixture w.r.t. air.

2B.	A gas mixture consists of three components. Argon= 40 mole %; B= 18.75% by mass; C= 20 mole % Molecular Wt. of Argon =40 and Mol.Wt. of C =50. Find i. Mol. Wt. of B Average Mol. Wt. of the mixture	8
3A.	 The analysis of a coal indicates 75 wt% C, 17% H, 2% S, and the balance noncombustible ash. The coal is burned at a rate of 5000 kg/h, and the feed rate of air to the furnace is 3500 kmol/hr. All of the ash, having no carbon content leaves the furnace as a molten slag; All of the carbon leaves in the stack gas as CO₂; the hydrogen in the coal is oxidized to water vapor, and the sulfur emerges as SO₂. (a) Calculate the percent excess air fed to the reactor. (b) Calculate the mole fractions of the gaseous pollutant SO₂-in the stack gas. 	14
3B.	$CH_4(s) + 2O_2(g) \rightarrow 2H_2O(l) + CO_2(g) \Delta H^\circ = -212.8 \text{ kcal /mole}$ Find the gross and net calorific value of methane in kcal/kg. (Latent heat of vaporization of water = 540 kcal/ kg)	6
4A.	In the Decon process of manufacturing Chlorine gas, HCl gas is oxidized with air. The reaction is given as $4HCl+O_2 \rightarrow 2Cl_2+2H_2O$ If the air is used in 20% excess & the reaction is 70% complete, calculate the composition of the dry gas leaving.	10
4 B .	Hemlock bark contains 6% mixture, 10.8% tannin and 8.2% soluble non-tannin. The balance is insoluble lignin. After extraction the waste bark on dry basis contains 0.95% tannin and 0.22% soluble non tannin. If raw tannin brings Rs. 100 per kg, how much money is lost per 450 kg of original bark because of imperfect extraction of tannin? Also find % recovery of tannin?	10
5A	What is the maximum temperature that can be attained by combustion of CH_4 with 20 % excess air; both CH_4 and air enter at 25°C. Assume complete combustion. $\Delta H_R^{o=}$ –191760 cal. Mean C _p Data (cal/gmole ^o K) CO ₂ =12.95 H ₂ O=10.25 O ₂ =8.3 N ₂ =7.9.	10
58	Solid material with 15% water is to be dried to 7% water under the following conditions: Fresh air is mixed with recycled air and is blown over the solid. The humidity of fresh air = 0.01 kg water/ kg of dry air and the recycled air has a humidity=0.1 kg of water/ kg of dry air. They are mixed in such a way that the entering mix to the drier has a humidity of 0.03 kg water/ kg dry air. Calculate i. Kg of dry air/ 100 kg of wet material ii. Kg of water removed/ kg of feed iii. Ratio of recycled air to fresh air	10