* K D - 6 4 2 7 *

KD-6427

B. E. II (Sem. IV) (Chemical) Examination

December – 2012

Process Calculations

Time : Hours] [Total Marks : **100**

Instructions :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. 2 (Sem. 4) (Chem.)**

Name of the Subject :

☛ **Process Calculation**

☛Subject Code No. : **6 4 2 7** ☛Section No. (1, 2,.....) : **1,2**

Seat No. :

Student's Signature

(2) Figures to the right indicate full marks.
(3) Assume suitable data if necessary.
(4) Atomic weight : H=1, C=12, O=16, Na=23, K=39, S=32, Cl = 35.5
(5) Use of scientific calculator casio fx 82, 83, or fx 100 or equivalent of other companies are allowed.

SECTION - I

1 (a) Answer the following : **5**
(i) Define : Force
(ii) 1 Cal = _____ J.
(iii) Normality
(iv) Calculate kilograms of 'Na' of which amount is specified as 3 Katom.
(v) Mole % of A = Mole fraction of Ax _____

(b) A solution of caustic soda contains 20% NaOH by weight. Taking density of solution as 1.196 Kg/l. Find the normality molarity and molality of the solution. **4**

(c) Steam is flowing at the rate of 2000 kg/hr in a 3" NB 40 schedule pipe (3.068 in) at 440 KPa absolute and 180°C (453 K). Calculate the velocity of the steam in the pipeline. **7**

2 Answer the following : **16**

(a) Sodium chloride weighing 600 kg is mixed with 200 kg of potassium chloride. Find the composition of the mixture in (a) Mass % and (b) mole %. **4**

(b) Explain the block diagram with material balance of following operations : 4

(i) Distillation

(ii) Extraction.

(c) It is required to make 1000 kg of mixed acid containing 60% H_2SO_4, 32% HNO_3 and 8% water by blending 8

(i) the spent acid containing 11.3% HNO_3, 44.4% H_2SO_4 and 44.3% H_2O.

(ii) aqueous 90% HNO_3 and

(iii) aqueous 98% H_2SO_4

All percentages are by mass. Calculate the quantities of each of the three acids required for blending.

OR

(c) In a pulp mill, a three-stage cascade screening system shown in figure is employed to remove the oversize foreign particles from dilute sluries. If E_1, E_2 and E_3 are the fractions of foreign particles removed in the three screens respectively, develop a general relationship for the overall efficiency of the system. 8

$$\text{Efficiency of a screen} = \frac{\text{Foreign material rejected}}{\text{Foreign material entering}} \times 100$$

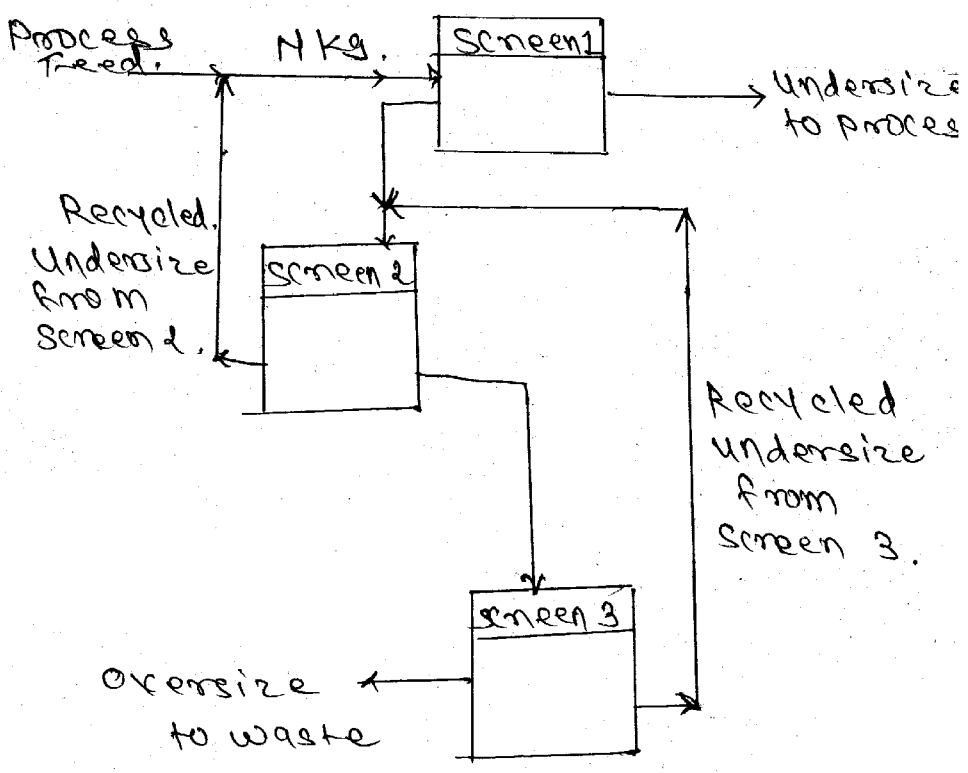

Fig. 1

3 Answer the following : 18

(a) Mono chloroacetic acid (MCA) is manufactured in a semibatch reactor by the action of glacial acetic acid with chlorine gas at 100°C in the presence of PCl_3 catalyst. MCA thus formed will further react with chlorine to form dichloroacetic acid (DCA) to prevent the formation of DCA, excess acetic acid is used. A small-scale unit which produces 5000 kg/d MCA, requires 4536 kg/d of chlorine gas. Also, 263 kg/d of DCA is separated in the crystalliser to get almost pure MCa product. Find the % conversion, % yield of MCA and selectivity.

OR

(a) Explain the outline procedure for material balance without chemical reaction.

(b) The feed containing 60 mole % A, 30 mole % B, and 10 mole %. Inerts, enters a reactor the product stream leaving the reactor is found to contain 2 mole % A reaction taking place is :

$2A + B \rightarrow C$

Find the percentage of original A getting converted to C.

OR

(b) Ethylene oxide is prepared by oxidation of ethylene. 100 k mol of ethylene and 100 k mole of O_2. are charged to reactor. The % conversion of ethylene is 85 and % yield of C_2H_4O is 94.12. Calculate the composition of product stream leaving the reactor.

SECTION - II

4 (a) Define the following : 7

(i) Potential Energy
(ii) Law of conservation of energy
(iii) Heat of formation
(iv) Calorific values of fuels
(v) GCV = NCV + _____
(vi) Excess air
(vii) Thermal efficiency of boiler.

(b) Heat capacity data for gaseous SO_2 are reported in table and also by the following equation. 8

$$C_{mp} = 43.458 + 10.634 \times 10^{-3}\ T - 5.945 \times 10^{5}\ \frac{1}{2}T.$$

Calculate heat required to raise temperature of 1 k mol pure SO_2 from 300 to 1000 K.

Gas SO_2	a	$b\times10^3$	$c\times10^6$	$d\times10^9$
Ref.7	25.7725	57.8938	-38.0844	11.122
Ref.9	24.7706	62.9481	-44.2582	32.4046

5 (a) The GCV of Gaseous n-propanol at 25°C is 2067.44 kJ/mol. Find its net calorific value using latent heat of water at 298 K (25°C) 3
Latent heat of water = 2442.5 K/kg

(b) A sample of fuel oil has C/H ratio 9.33 (by weight) and contain 1.3% sulphur (wt. basis) the NCV of fuel oil is 39685 kJ/kg at 25°C. Calculate its Gcv using latent heat of water at 298 K. 7

(c) Define Heat capacity with units and explain relation between C_p and C_v for ideal gas. 7

6 (a) Flue gases leaving the boiler stack at 523 K (250°C) have the following composition. 9
CO_2 : 11.31%, H_2O = 13.04%, O_2 = 2.17% and N_2 : 73.48% (by volume)
Calculate the heat lost in 1 kmol of gas mixture above 298 K. Using the heat capacity data given below.
Cp =- a+bT + CT^2 + dT^3, (Kj/Kmol.K)

Gas	*a*	$b \times 10^3$	$c \times 10^6$	$d \times 10^9$
CO_2	21.3655	64.2841	–41.0506	9.7999
H_2O	32.4921	0.0796	13.2107	–4.5474
O_2	26.0257	11.7551	–2.3426	–0.5623
N_2	29.5909	–5.141	13.1829	–4.968

(b) A coal having 68.1% total carbon is burned to produce gases having the following composition by volume on the moisture free basis. 4
CO_2 : 12.4%, CO : 1.2%, O_2 : 5.4% and N_2 : 81%.
Data :
(1) Heating value of coal = 28273.5 kJ/kg
(2) Heat of combustion of CO = –283.18 kJ/mol.

(c) The orsat analysis of the flue gases from a boiler house chimeney gives
CO_2 : 11.4%, O_2 : 4.2% and H_2 : 84.4% (mole %).
Assuming that compelete combustion has taken place :
(a) Calculate the % excess air and
(b) Find the C : H ratio in the fuel.