[4363]-234

T.E (Petrochemical)

Examination – May 2013

(2008 Pattern)

Petrochemical Processes I

Total No. of Questions : 12 **[Total No. of Printed Pages :2]**

[Time : 3 Hours] **[Max. Marks : 100]**

(1) Answer 03 question from each section.

(2) Answers to the 03 section should be written in separate answer books.

(3) Figures to the right indicate full marks.

(4)Neat diagrams must be drawn whenever necessary.

Section I

Q1 (a) Describe with flowsheet the process for conversion of EDC to VCM by cracking. (12)

(b) Write a short note on the Schmid Nitrator. (06)

OR

Q2. (a) Distinguish between sulfonation and sulfation. (06)

(b) Write a note on the photo chlorination of cyclohexance. (06)

(c) Draw a neat labeled diagram to show the plant assembly for chlorination of benzene. (06)

Q3. (a) Describe with flow sheet the process of conversion of acetaldehyde to acetic acid. (10)

(b) Write a note on aminating agents. (06)

OR

Q4. (a) Describe the process of conversion of methanol of formaldehyde. (10)

(b) Give the general classification of hydrogenation catalysts. (06)

Q5. (a) Describe the process of conversion of benzene to ethyl benzene. (10)

(b) Draw a schematic layout of the batch process for the manufacture of ethyl acetate. (06)

OR

Q6. (a) Describe the process of manufacture of ethanol from ethylene via ethyl hydrogen sulfate. (10)

(b)Write a short note on the preparation and applications of cumene.(6)

Section II

Q7. (a) Describe the direct hydration process (Shell process) for the manufacture of ethanol. (08)

(b) Differentiate between chemical and biochemical process. (08)

OR

Q8. (a) What are the factors that affect the enzymatic reaction? Explain in detail. (08)

(b) Write notes on (08)

i) Fermentation products- Future trends.

ii) Essential requirements for growth and media fermentation.

Q9. (a) Explain in detail pearl polymerization. (10)

(b) Give the classification on of polymers. (08)

OR

Q10. (a) Describe with sheet the high pressure process for conversion of ethylene to polyethylene. (10)

(b) Write a short note on polycondensation. (08)

Q11. (a) Explain in detail solar furnace techniques for production of fullerenes. (08)

(b) Describe in detail LASER ablation techniques for production of carbon nanotubes. (08)

OR

Q12. (a) What Nanotechnology?

Enlist few applications of Nanotechnology. (08)

(b) Write a short note on single wall nanotube. (08)

Total No. of Questions : 12 [Total No. of Printed Pages :3]

T.E. (Petrochemical)

Examination - 2013

Instrumentation &

Instrumentation Analysis

(2008 Pattern)

[Time : 3 Hours] [Max. Marks : 100]

Instructions :

(1) Attempt Q1or Q2, Q3 orQ4, Q5 or Q6, Q7 or Q8,Q9 or Q10, Q11 or Q12

(2) Answers to the 03 section should be written in separate answer books.

(3) Figures to the right indicate full marks.

(4)Neat diagrams must be drawn whenever necessary.

(5) Use of logarithmic tables slide rule, Mollier charts, Electronic packet calculator and steam tables is allowed.

Section I

Q1. (a) Define the following terms: (08)

1) Sensitivity

2) Accuracy

3) Hysteresis

4) Resolution

(b) Drive the expression representing dynamic response of a mercury thermometer considered as a first order system subjected to a step change. (08)

OR

Q2. (a) A thermometer is calibrated between 0 to 100°C having accuracy of ±0.5% of full scale deflection. When it gives a reading of 35.8°C, then within what temperature range will the actual temperature lie. (06)

(b) A thermometer having a time constant of 0.1 min is at steady state temperature of 90°C. At time (t=0) the thermometer is placed in temperature bath maintained at 100°C. Determine (10)

i) The time needed for the thermometer to read 98°C.
ii) The time required for 90% response.
iii) The temperature reading on thermometer after 15 seconds.

Q3 (a) What are the different types of direct &indirect methods of liquid level measurement? Explain with neat sketch capacitance level indicators. (08)

(b) What is the principle of thermocouple? Give the different types of thermocouple. (08)

Q4. (a) What are different types of electrical pressure transducers commonly used in process industries. Explain the principle construction and work of a strain guage pressure transducer. (08)

(b) Describe the construction, working of optical pyrometer. (08)

Q5. (a) Discuss with neat sketch construction, working & principle of turbine flow meter with its advantages and disadvantages. (09)

(b) Define: i) Trundown ratio ii) Rangeability iii) Cavitation iv) Valve flow coefficient, C_v (09)

OR

Q6. (a) Discuss with neat sketch construction, working & principle of electro-magnetic flow meter with its advantages and disadvantages. (09)

(b) Explain the different types of values & value characteristics with neat diagram. (09)

Section II

Q7. (a) Write a short note on: (18)
i) Different types of X-Ray spectroscopy
ii) ASTM method for determination of flash point
iii) Crude oil assay.

OR

Q8. (a) Explain with neat diagram the instrumentation for IR spectroscopy. (09)
(b) Describe in detail IR sample preparation methods. (09)

Q9. (a) Explain the different types of chromatography with neat diagram. (08)
(b) Describe with neat diagram the instrumentation for gas chromatography. (8)

OR

Q10. (a) Explain in detail principle of mass spectroscopy. (6)
(b) Explain with neat diagram the instrumentation for HPLC. (10)

Q11. (a) Explain with neat diagram Oxygen analyzer: Magnetic susceptibility method. (08)
(b) Give the classification or different constituents of lubricant & methods of analysis. (08)

OR

Q12. (a) Enlist the various methods of density measurement methods. (08)
Describe any one of them.
(b) Describe in detail construction & working of Abbe's refactometer. (08)

UNIVERSITY OF PUNE

[4363-231]

T.E.(Petrochemical Engineering)

Numerical and Statistical Methods

(2008 pattern)

Time-Three hours **Maximum Marks-100**

[Total No. of Question=12] **[Total no. of printed pages= 8]**

Instructions:

(1)Answer Q1 or Q2 , Q3 or Q4, Q5 or Q6 from Section 1 and Q7 or Q8, Q9 or Q10, Q11 or Q12 from section 2.

(2)Answers to the two sections should be written in separate answer books.

(3)Neat diagram must be drawn necessary.

(4)Figures to the right indicate full marks.

(5)Use Electronic Pocket Calculator is allowed.

(6)Assume suitable data wherever necessary.

SECTION-I

Q.1

(a)Find all basic feasible solutions to the system of equations: (6)

$2x_1 + x_2 - x_3 = 2$

$3x_1 + 2x_2 + x_3 = 3$

(b)Solve the following Linear Programming problem using simplex method. (10)

Maximize $z = 400x_1 + 100x_2$

subject to the constraints:

$4x_1 + 2x_2 \leq 1600$

$5x_1 + 2x_2 \leq 2400$

$ax_1 + 3x_2 \leq 3200$

$x_1, x_2 \geq 0$

OR

Q.2

(a)Write the dual of the following primal problem. (6)

Maximize $z = x_1 - 2x_2 + 3x_3$

subject to the constraints

$-2x_1 + x_2 + 3x_3 \leq 2$

$2x_1 + 3x_2 + 4x_3 \geq 1$

$x_1, x_2, x_3 \geq 0$

(b)Apply the principle of duality to solve the following LPP: (10)

Maximize $z = 3x_1 - 2x_2$

subject to the constraints

$x_1 + x_2 \leq 5$

$x_1 \leq 4$

$1 \leq x_2 \leq 6$

$x_1, x_2 \geq 0$

Q.3 (a)A company has three warehouses a,b,c .It is required to deliver a product from these warehouses to three customers A,B,C.The number of units available at the warehouses a,b,c are 2,3,5 respectively and the customers A,B,C have requirements of 4,1,5 units respectively. The following table shows the cost of transporting one unit from warehouse to the customer . (10)

	Customer A	B	C
a	7	3	4
b	2	1	3
c	3	4	6

Find the optimum solution for above transportation problem for minimum cost using Vogel's Approximation method.

(b)Solve the following assignment problem for minimum time assignment. The estimated time that each machine requires is given below. (6)

Job → Machine ↓	A_1	A_2	A_3	A_4	A_5
M_1	160	130	175	190	200
M_2	135	120	130	160	175
M_3	140	110	125	170	185
M_4	50	50	80	80	110
M_5	55	35	80	80	105

OR

Q.4 (a)Use Vogel's Approximation method to find IBFS for the following transportation problem. Also find the optimal solution. (10)

To

		W	X	Y	Availability
	A	7	3	6	5
from	B	4	6	8	10
	C	5	8	4	7
	D	8	4	3	3
Requirement		5	8	10	

(b)A company is faced with the problem of assigning four different persons to four different jobs.The costs are estimated as follows. (6)

Job — Person	1	2	3	4
A	87	85	71	38
B	91	89	75	34
C	70	72	86	75
D	37	35	21	88

Solve the problem assuming that the objective is to minimize the total cost.

Q.5 (a)Find the coefficient of correlation for the following data. (7)

x	10	14	18	22	26	30
y	18	12	24	6	30	36

(b)During war,1 ship out of 9 was sunk on an average in making a certain voyage.What is the probability that exactly 3 out of 6 ships would arrive safely? (5)

(c)In a certain factory turning our razor blades,there is a small chance of $\frac{1}{500}$ for any blade to be defective. The blades are supplied in a packet of 10.Use poisson distribution to calculate the approximate number of packets containing no defective and two defective blades in a consignment of 10,000 packets. (6)

OR

Q.6 (a)Given the following information. (6)

	Variable x	Variable y
Arithmetic mean	8.2	12.4
Standard deviation	6.2	20

Coefficient of correlation between x and y is 0.9.Find the linear regression estimate of x.given y=10.

(b)The mean weight of 500 students is 63 kg and standard deviation is 8 kg. Assuming that the weights are normally distributed ,find how many students weight 52 kg.Weights are recorded to the nearest kg. (6)

Given z: 1.44 , 1.31

Area : 0.4251 , 0.4049

(c)Among 64 offsprings of a certain cross between guinea pigs 34 were red,10 were black and 20 were white.According to a genetic model,these numbers

should be in the ratio 9:3:4. (6)

Are the data consistent with the model at 5% level.

Given $x_2^2 : 0.05 = 5.991$

SECTION-II

Q.7 (a)With usual notations prove the following: (9)

(i) $\Delta\nabla = \Delta\nabla = \delta^2$

(ii) $(1+\Delta)(1-\Delta) = 1$

(iii) $E = e^{hD}$

(b)Find the first and second derivations of $y = f(x)$ at $x = 1.5$ from the data. (8)

x	1.5	2	2.5	3	3.5	4
y	3.375	7	13.625	24	38.875	59

OR

Q.8 (a)The table below shows the temperature f(t) as a function of time. (9)

Time t	1	2	3	4	5	6	7
Temperature f(t)	81	75	80	83	78	70	60

use(i)Simpson 1/3 method and (ii)3/8th method to estimate $\int_1^7 f(t)dt$

(b)Apply Lagrange's Interpolation formula to find $f(x)$,if

$f(1)=2$, $f(2)=4$, $f(3)=8$, $f(4)=16$, $f(7)=128.$

Hence find $f(5)$ and $f(6).$ (8)

Q.9 (a)Find a real root of $2x-\log_{10}x-9=0$ using successive approximation method. (8)

(b)Use the methods of Gaussian elimination to solve the following system of linear equations. (9)

$x_1+x_2+x_3-x_4=2$

$4x_1+4x_2+x_3+x_4=11$

$x_1-x_2-x_3+2x_4=0$

$2x_1+x_2+2x_3-2x_4=2$

OR

Q.10 (a)Using the Gauss-Seidal method solve the system of equations correct to three decimal places. (8)

$x+2y+z=0$

$3x+y-z=0$

$x-y+4z=3$

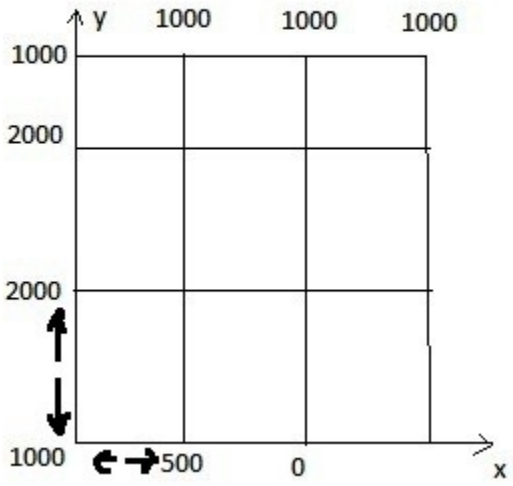
(b)Using the method False Position,find a real root of the equation $x^4-11x+8=0$ accurate to three decimal places. (9)

Q.11 (a)Using Fourth order Runge-Kutta method solve the differential equation

$\frac{dy}{dx}=x+y^2$ Assuming $y(0)=1$ .Estimate y(0.2)taking h=0.1 (8)

(b)Given the values of $u(x,y)$ on the boundary of the square in the figure given below,evaluate the function $u(x,y)$ satisfying the Laplace equation

$\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}=0$ at the pivotal points of this figure. (8)



Q.12 (a)Solve by Euler's modified method $\frac{dy}{dx}=\log(x+y)$ $y(0)=2$, at x=1.2 and 1.4 with h=0.2 (8)

(b)Solve the equation $\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}=-10(x^2+y^2+10)$ over the square with sides $x=0=y$, $x=3=y$,with u=o on the boundary and mesh length=1. (8)

UNIVERSITY OF PUNE

[4363]-232

T. E. (Petrochemical Semester -I)Examination - 2013

APPLIED HYDROCARBON THERMODYNAMICS(312402)

(2008 Pattern)

Total No. of Questions : **[Total No. of Printed Pages :3]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answer **any three** questions from each section.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Black figures to the right indicate full marks.

(4) Use of logarithmic tables, slide rule, Molliercharts, electronic pocket calculator and steam tables is allowed.

(5) Assume suitable data, if necessary.

SECTION-1

Q. 1. a) Distinguish between reversible and irreversible process. [4]

b) State the zeroth law of thermodynamics and state its significance. [4]

c) What do you mean by a cyclic process? State and explain the first law for a cyclic process. [4]

d) Calculate ΔU and ΔH in kJ for 1kmol of water, as it is vaporized at the constant temperature of 373 K and constant pressure of 101.3 kPa. The specific volumes of liquid and vapour at these conditions are 1.04×10^{-3} and 1.675 m^3/kmol respectively. Also 1030 kj of heat is added to water for this change. [6]

OR

Q. 2. a) Hydrogenation of an oil carried out in a reactor at a pressure of 136.8 kPa and a temperature of 453 K. The hydrogen gas at 293 K is heated to 453 K by passing through a coil where it experiences a pressure drop of 300 kPa. Hydrogen behaves like an ideal gas and its heat capacity at constant pressure is 29. 4 kJ/kmol. Neglecting kinetic energy effects determine the heat transfer rate in the coils per 1000 kg of hydrogen. [6]

b) Define enthalpy. Prove that when a system is heated at constant pressure, the change in enthalpy is equal to the heat supplied. [8]

c) Enlist the steps involved in the Carnot cycle with help of a neat labeled diagram. [4]

Q. 3. a) State any equations of state for real gases [8]

b) Estimate the molar volume of carbon dioxide at 500 K and 100 bar using van der Waals equation. The van der Waals constants are 0.364 $m^4/Nmol^2$ and 4.267 x 10^{-5} m^3/mol [8]

OR

Q. 4. a) Write a note on the PVT behavior of pure fluids. [8]

b) Determine the molar volume of gaseous methane at 300 K and 600 bar using Redlich kwong equation given that $T_c = 191.1$ *and* $P_c = 46.4$ bar. [8]

Q. 5. a) Derive the Clausius Clayperon equation and state its significance [6]

b) Write a note on the Joule Thomson Coefficient. [6]

c) Calculate the vapour pressure of water at 363 K, if the vapour pressure at 373 K is 101.3 kPa. The mean heat of vaporization at this temperature range is 2275 kJ/kg. [4]

OR

Q. 6. a) Define fugacity. Show that the fugacity and pressure are identical for an ideal gas. [8]

b) Calculate the fugacity of CO at 50 if the following data are applicable at 273 K

P,bar	25	50	100	200	400	800	1000
Z	0.9890	0.9792	0.9741	1.0196	1.2480	1.8057	2.0819

SECTION-II

Q. 7. a) Write a note on the boiling point diagram. What information do we obtain from it? [8]

b) What are azeotropes? Discuss the maximum and minimum boiling azeotropes with examples. [6]

c) n-Heptane and toluene from an ideal solution. At 373 K, their vapour pressurea are 106 and 74 kPa respectively. Determine the composition of liquid and vapour in equilibrium at 373 K and 101.3 kPa. [4]

OR

Q. 8. a) A mixture contains 45%(mol) menthol (A), 30% (mol) ethanol (B) and the rest n-propanol (C). Liquid solution may be assumed to be ideal and perfect gas law is valid for the vapour phase. [12]

Calculate the Following at a total pressure of 101.1kPa.

1) The bubble point and vapour composition
2) The dew point and liquid composition

The vapor pressures of pure liquids are given below:

$Temp, K$	333	343	353	363
P_A, kPa	81.97	133.29	186.61	266.58
P_B, kPa	49.32	73.31	106.63	166.61
$P_{C,} kPa$	39.32	62.65	93.30	133.29

b) Write a note on the phase rule for non-reacting systems. [6]

Q. 9. a) The azeotrope of ethanol-benzene has a composition of 44.8% (mol) ethanol with a boiling point of 341.4 K at 101.3 kPa. At this temperature the vapour pressure of benzene is 68.9 kPa and the vapour pressure if ethanol is 67.4 kPa. What are the activity coefficients in a solution containing 10% alcohol? [16]

OR

Q. 10. a) Write a note on the Margules equation. [6]

b) Discuss the methods of determining the partial molar properties [10]

Q. 11. a) Calculate the equilibrium constant at 298 K of the reaction [8]

$$N_2O_4(g) \rightarrow 2NO_2(g)$$

Given that the standard free energies of formation at 298 K are 97540 J/mol for N_2O_4 and 51310 J/mol for NO_2

b) Discuss the methods of determining the equilibrium constant. [8]

OR

Q. 12. a) Ethanol can be prepared by the following vapour phase reactions from ethylene: [8]

$$C_2H_4(g) + H_2O \Leftrightarrow C_2H_5OH(g)$$

The value of ΔG° for the above reaction at 1 atm and 125°C is 5040 J. Calculate the conversion if an isothermal reactor operating at 125°C and 2 atm is fed with a mixture containing 50 mole% ethylene and 50 mole % steam. Assume that equilibrium is reached at the exit of the rector and the gases behave ideally.

b) How would the equilibrium yield in a gaseous reactions be affected by increasing the pressure, if there is a decrease in the number of moles during reaction? [8]

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UNIVERSITY OF PUNE

[4363]-233

T. E. (Petrochemical Engineering) Examination-2013

MASS TRANSFER-I

(2008 Course)

Total No. of Questions : 12 **[Total No. of Printed Pages :7]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answer **any three** questions from each section.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Black figures to the right indicate full marks.

(4) Neat diagrams must be drawn wherever necessary.

(5) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(6) Assume suitable data, if necessary.

SECTION I

Q .1.a) Answer the following question in brief (Any Four) [18]

i) Discuss the brief methods to conduct the mass transfer operation

ii) Sketch the operation line and equilibrium curve for an absorber and stripper

iii) Differentiate between flash distillations, differential distillation and rectification

iv) Draw a graph showing concentration gradient for equimolar diffusion. Write down the final flux equation for this case.

v) Define: Stage, Stage efficient and Murphree efficiency.

vi) Give the different correlation for estimation of diffusivity in gases and liquid Explain the terms involved in it

OR

Q.2.a) Gas A is diffusing form a gas stream at point 1 to a catalyst surface at [9]

point 2 and reacts instantaneously and irreversibly as follows: $2A \rightarrow B$.

Gas B diffuses back to the gas a stream. Derive the final equation

for N_A at constant pressure P and steady state in terms of partial pressure.

b) A flat plug 30 mm thick having an area of 4.0 x 10^{-4} m^2 and made of vulcanized rubber is used for closing an opening in a container The gas CO_2, at 25° and 2.0 atm pressure is inside the container Calculate the total leakage of CO_2 through the plug to the outside in kgmol CO_2/s at steady state. Assume that the partial pressure of CO_2 outside the container is zero. [9]

Data: For CO_2 in vulcanized rubber S = 0.90 m^3 (STP)/m^3 .atm and D_{co2} = 0.11 x 10^{-9} m^2 /s

Q.3.a) The gas CO_2 (MW = 44) is diffusing at steady state through a tube 20 cm long having diameter of 1.0 cm and containing N_2 (MW = 28) at 298 K. The total pressure is constant at 101.32 kPa. The partial pressure of CO_2 at one end is 456 mm Hg and 76 mm Hg at the other end. The diffusivity D_{AB} is 0.167 cm^2/s at 298 k. Calculate the flux of CO_2 in N_2 [8]

Repeat your calculation in the diffusion is between (a) H_2 (MW = 2) and N_2, Where the diffusivity D_{AB} is 0.784 cm^2/s at 298 k.

Discuss on your results.

b) Discuss the winklemann's method to determine diffusivity of volatile substance such as carbon Tetra Chloride in air vapors. Give mathematical equations involved and assumptions, if any [8]

OR

Q.4a) An ethanol (A) –water (B) solution in the form of a stagnant film 2 mm thick at 294 K is in constant at one surface with an organic solvent in [8]

which ethanol is soluble and water is insoluble.(Hence N_B =0)At point 1, the concentration of ethanol is 16.8 - weight % and the solution density. P_1= 975 kg/ m^3 .At point 2 , the concentration of ethanol is 6.9 weight % and P_2 = 990 kg/ m^3. The diffusivity of ethanol is 0.745 x 10^{-9} m^2/sec. Calculate the steady-state flux N_A.

b) Ammonia is absorbed by water in a wetted – wall column being operated at 20^0C and 1 std.atm. The overall gas coefficient is 1 k mole NH_3/[(m^2) (std.atm)]. At one point in the column, the gas contains 10 mole% ammonia and the liquid phase contains 0.150 mole ammonia per m^3 of solution. 96% of the total resistance is in the gas phase. Assume Henry's law constant at 293 k = 4.55 x 10^{-3} std.stm (mole NH_3/m^3 solution). Determine the interfacial film coefficient and the interfacial composition [8]

Q.5.a) Develop the material balance equation for counter- current mass transfer process by giving the graphical representation of the final equation. [8]

b) Explain the working principle of following mass transfer equipments [8]

i) Ventury Scrubbers

ii) Wetted Wall Towers

OR

Q .6. a) An air stream at 52.6^{0}C and 2 atmospheres (abs.) flows through a dust at 1.524 m/s past sample of solid naphthalene. [8]

Naphthalene diffusivity at 0^0C and 101.32 kPa is 5.16 x 10^{-6} m^2/s.

Estimate mass transfer coefficient k'c for flow past the following shapes :

a) Parallel to a flat plate 152 mm long;

b) A lone sphere of 12.7 m diameter.

Data: at 52.6^0C and 2 atm (abs.)

μ = 1.96 x 10^{-5}kg/m.s

ρ = 1.087 kg/m^3

D_{AB} = 3.51 x 10^{-6} m^2/sec

b)Prove that show the following relationship starting with the flux equations [8]

i) Convert k'c to k_y and k_G;

ii) Convert k_L to k_x and k'_x;

iii) Convert k_G and k_y and k_C;

SECTION –II

Q.7. Answer the following question in brief : (Any three) [18]

a) Define all the humidity terms you know.

b) A mixture of oxygen and acetone vapor at a total pressure of 1050 mm Hg at 25^0C has a percentage saturation of 75%.

Calculate the following:

i) The model humidity

ii) Absolute humidity

iii) Relative humidity

The saturation vapor pressure of acetone at 25^0C is 290 mm Hg and the specific heats of oxygen and acetone vapor are 0.25 and 0.35 kcal/kg^0C respectivly.

c) Write a note on : Types of Industrial Dryers .

d) A wet solid is dried from 35% to 10 % moisture under constant drying condition in 5 hours. If the equilibrium moisture content is 4% and the

critical moisture is 14 % , how long will take to dry 6% moisture under the same conditions?

OR

Q.8 a) Define the following terms in connection with tray towers: [5]

i) Weeping
ii) Dumping
iii) Coning
iv) Loading
v) Priming

b) Specify the important properties a packing material should possess for being used in mass transfer equipment. Name a few packing materials. [5]

c) Discuss in brief rate of drying curve. Write down equation for total time require for drying operations [8]

Q.9.a) In a Drying experiment, a tray dryer containing a single tray of 1 m^2 area is used to dry crystalline solids. The table 1 gives the data for drying experiment [16]

Table 1 Drying data

Sr. No.	Time, Hour	Weight of wet material, kg
1	0	5.341
2	0.4	5.238
3	0.8	5.162
4	1.0	5.124
5	1.4	5.048
6	1.8	4.972
7	2.2	4.875
8	2.6	4.819

9	3.0	4.743
10	3.4	4.667
11	4.2	4.524
12	4.6	4.468
13	5.0	4.426
14	6.0	4.340
15	Infinite	4.120

Do as follow:

a)Calculate and plot drying rates. Find the critical moisture content

b)If dry air is available at 40^0C with an absolute humidity of 0.01 kg H_2O per kg dry air and the dryer is maintained at 90^0C calculate the amount of air required in first 2 hours.

Assume that the air is heated upto 90^0C and the dry air leaves the dryer at 90^0C with 5% saturation.

c)Test the consistency of the falling rate period (Choose critical moisture content and any one point in the falling rate period).

Q.10a) What are the different types of cooling towers used in process industries? Briefly explain them with neat sketches. [8]

b) In a Laboratory drying test with a solid material the following relation for the falling rate period was obtained: [8]

$\frac{dX}{dt}$ = -0.8(X-0.05)

Where X is the moisture content on dry basic of t is the time in hours. The critical moisture content is 1.5 kg moisture per kg of dry material.

Calculate the following:

i) The time required for drying the material from X_1 = 4.0 to X_2 = 0.15

ii)The equilibrium moisture content

Q.11.a) The average heat transfer coefficient for natural convection [16]

from a single sphere in a large body if fluid is given by

$\frac{hd}{k}$ =2+ 0.6 $\left(\frac{d^3\rho^2 g\beta\beta\,\Delta}{\mu^2}\right)^{1/4}$ $\left(\frac{c_p\mu}{k}\right)$1/3 for $Gr^{1/4}\ Pr^{1/3}$<200

Where d is the diameter of the sphere and the fluid properties are evaluated at the mean temperature if the sphere and bulk fluid. Using the analogy between mass the heat transfer, calculate the instantaneous rate if sublimation at the surface of a naphthalene sphere in air at 145^0C and 1 atm.

Explain the analogy between Nu = Sh, Sc= Pr, Gr= Gr_{AB}.

Data: P^{vap} naphthalene = 0.19 atm, D_{AB} = 5.81 x 10^{-6} m^2/s,

d = 9.5 x 10^{-2}m

ρair = 0.849 kg/m^3, μ_{air} = 2.15 x 10^{-5} kg/m.s

OR

Q.12. Write short notes on (Any Two) [16]

a) Types of moisture content in solid

b) Two Resistance Concept in Interphase Mass Transfer

c) Psychometric chart in simultaneous heat/mass transfer operations

d) Molecular and Eddy Diffusion

[Total No. of Questions:12] **[Total No. of Printed Pages: *4*]**

UNIVERSITY OF PUNE

[4363]-236

T. E. (*Petrochemical Engineering*) Examination - 2013

(Transport Phenomena)(2008 Course)

[Time: *3* Hours] **[Max. Marks: 100]**

Instructions:

1. *Answers to the **two sections** should be written in **separate answer-books**.*
2. *Draw neat diagrams wherever necessary.*
3. *Numbers to the right indicate **full marks.***
4. *Assume suitable data, if necessary.*
5. *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator is allowed.*
6. *Answer **any three** questions from each section.*

SECTION -I

Q.1 A What is the role of dimensionless numbers in transport phenomena? Express at least two dimensionless numbers in Heat, Mass and Momentum transport with the significance of each term involved. 8

B Write a short note on Film theory in mass transfer. 6

C A furnace is constructed with 200 mm of fire brick (k=5.2), 100 mm of insulating brick (k=0.5) and 200 mm of building brick (k=2.0). The inside temperature is 650°C and the outside temperature is 165°C. Find the heat loss per unit area and the temperature at the junction of the fire brick and the insulating brick. Here 'k' is the thermal conductivity kcal/hr m°C. 4

OR

Q.2 A What is no slip condition? Explain Newton's law of viscosity. What is the role of viscosity in momentum transfer? 6

B Express equations that give the analogies between Heat, Mass and Momentum transfer. Why do we need these analogies? 8

C Helium diffuses through a plane, plastic membrane 1mm thick. The concentration of helium in the membrane is 0.02 4

kmol/m^3 at the inner surface and 0.005 kmol/m^3 at the outer surface. If the binary diffusion coefficient of helium with respect to the plastic is 10^{-9} m^2/sec, what is the diffusion flux of helium through the plastic?

Q. 3 A Derive three dimensional form of mass conservation equation over a control volume. 8

B Derive Momentum transfer boundary layer equation. 8

OR

Q. 4 A Derive Navier Stokes equation and give the significance of each term involved in it. 8

B Derive Mass transfer boundary layer equation. 8

Q. 5 A What do you mean by turbulent shear stresses? Explain Reynolds Average Navier Stokes equation and give the significance of each term involved. 8

B Explain with neat sketch the thermal boundary layer and with respect to Prandtl number variation compare it with the hydrodynamic boundary layer. 8

OR

Q. 6 A A smooth flat plate is exposed to wind velocity of 6km/minute. If the laminar boundary layer exists upto a value of $Re=2\times10^{-5}$ Find the maximum distance upto which laminar boundary layer exists and its maximum thickness 8

B A stream of air at 100 kPa pressure and 300K is flowing on the top surface of a thin flat sheet of solid naphthalene of length 0.2m with a velocity 20m/sec. Mass diffusivity of naphthalene vapor in air is 6×10^{-6} m^2/sec. Kinematic viscosity of air is 1.5×10^{-5} m^2/sec. Concentration of naphthalene at the air solid naphthalene interface is 1×10^{-5} kmol/m^3 Calculate: 8

i) the average mass transfer coefficient over the flat plate

ii) the rate of loss of naphthalene

SECTION II

Q. 7 A It is desired to agitate a liquid having viscosity of 1.5×10^{-3} Pa.s and density 969kg/m^3 in a tank having a diameter of 0.91 m. The agitator will be a six-blade open turbine having a diameter of 0.305 m operating at 180 rpm. The tank has four vertical baffles, each with a width J of 0.076 m. Also W=0.0381 m. Calculate the required kW. (Use the graph provided at the end.) 8

B With help of suitable industrial examples explain the purpose of agitation. 8

OR

Q. 8 A Name various types of agitator normally used-provide a comparative study of them. 6

B A turbine agitator having six blades and a disk diameter of 0.203m is used in a tank having diameter of 0.61 m and height of 0.61m. The width W=0.0405 m. Four baffles are used with J =0.051 m. The turbine operates at 275 rpm in a liquid having density 909 kg/m^3 and viscosity of 0.020 Pa.s. Scale up the system to a vessel having a volume of 40 times the original for the case of equal mass transfer rates. (Graph provided at the end can be used). 10

Q. 9 A Obtain the shell balance equation for a Fixed-bed axial flow reactor with exothermic reaction taking place. Draw a neat diagram. Provide the relevant Boundary Conditions as well. 8

B Name various numerical techniques can be employed to solve the above defined problem. Discuss any of these methods in details and provide the temperature profile expected. 8

OR

Q. 10 A A non-insulated metallic bar 1m long is held in air of temperature 20°C. One end of the bar is maintained at 100°C and the other end maintained at constant temperature of 40°C. The temperature distribution along the length at steady state may be assumed to be 8

$$\frac{dT}{dx^2} + h(T_a - T) = 0$$

Where T is temperature in degree celcius, x is the distance measured from the hot end, T_a is ambient temperature and h=0.01. Calculate temperatures at 250, 500 and 750mm from hot end.

B Obtain the generalized Unsteady state Conduction Equation. 8

Q. 11 A With the help of neat sketch derive the mathematical expression for 1-Dimensional Unsteady State Molecular Diffusion through a slab. 6

B Obtain the Finite Difference discretization of the above defined problem. Also provide the simplified Schmidt method expression. 6

C Write a short note on Turbulent Mass Diffusivity. 6

OR

Q. 12 A A solid slab 0.01 m thick has an initial uniform concentration of solute A of 1.0 kg mol/m^3. The diffusivity of A in the solid is $D_{AB}=1.0 \times 10^{-10}$ m^2/s. All surfaces of the slab are insulated except the top surface. The surface concentration is 10

suddenly dropped to zero concentration and kept constant at that value. Unsteady-state diffusion occurs in the one x-direction with rear surface insulated. Using a numerical method, determine concentrations after 12×10^4 seconds. Use Δ x=0.002m and M=2.0. The value of K can be considered to be 1.

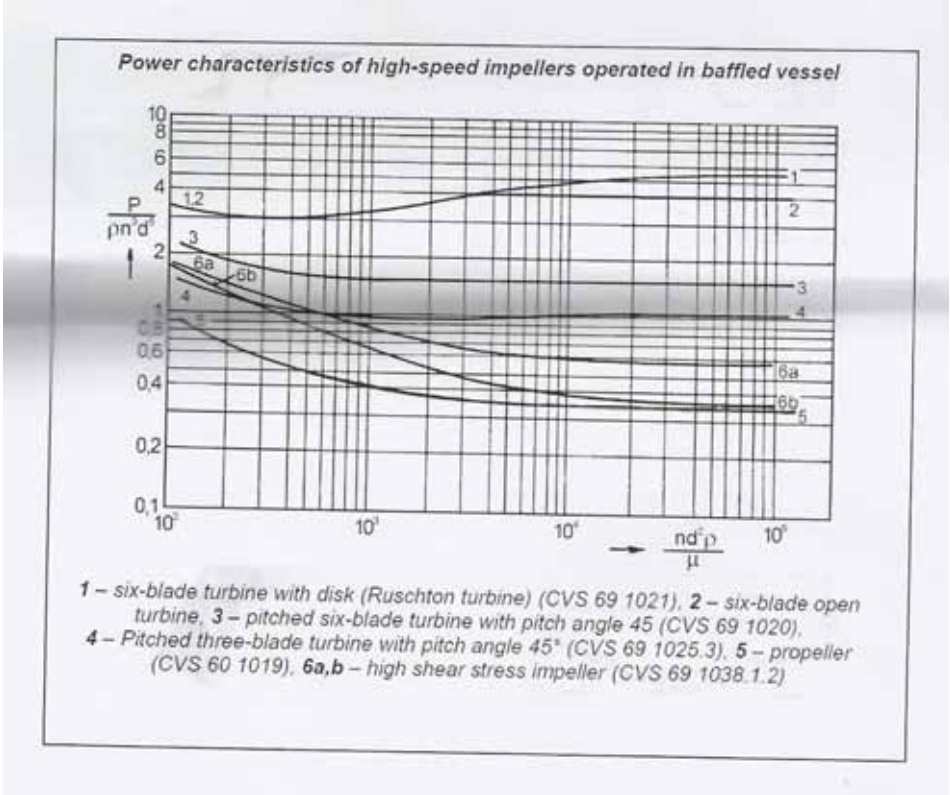
B Starting with equation of continuity for binary mixture in vector notation as given by 8

$$\frac{\partial \rho_A}{\partial t} + (\nabla . \boldsymbol{n}_A) = r_A$$

Prove that, for constant density system, following relation holds:

$$\frac{\partial \rho_A}{\partial t} + (\boldsymbol{\upsilon} . \nabla . \rho_A) - (\nabla . \mathrm{D_{AB}} \nabla \rho_A) = r_A$$

Where $\boldsymbol{n}_A = \boldsymbol{j}_A + \rho_A \boldsymbol{\upsilon}$, all the symbols have their usual significances



1 – six-blade turbine with disk (Ruschton turbine) (CVS 69 1021), 2 – six-blade open turbine, 3 – pitched six-blade turbine with pitch angle 45 (CVS 69 1020), 4 – Pitched three-blade turbine with pitch angle 45° (CVS 69 1025.3), 5 – propeller (CVS 60 1019), 6a,b – high shear stress impeller (CVS 69 1038.1.2)

UNIVERSITY OF PUNE

[4363]-237

T. E. (Petrochemical Engg.)

Examination - 2013

MASS TRANSFER-II

(2008 Pattern)

[Time : 3 Hours] **[Max. Marks : 100]**

Total No. of Questions : 12 **[Total No. of Printed Pages :9]**

Instructions :

*(1) Answer **any three** questions from each section.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Black figures to the right indicate full marks.

(4) Neat diagrams must be drawn wherever necessary.

(5) Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

(6) Assume suitable data, if necessary.

SECTION I

Q1) Attempt Any Three from the following: [18]

a) What is the equation for q line? Explain in brief the five possible feed conditions using x-y plot.

b) H_2S is being absorbed in a gas-absorber unit. The height of the transfer unit based on the overall mass transfer coefficient on the gas side is 0.4 m. The equilibrium data is given by $y = 1.5\ x$. The bulk concentration of H_2S has to be reduced from 0.05 to 0.001 mole fraction in the gas side. Determine the height of the tower (in meter) corresponding to an operating line given by: $y = 5x + 0.001$.

c) A binary distillation column separates 100 mole/hr of a feed mixture into distillate D and residue W. The McCabe-Thiele diagram for this process is given in

Figure 1. the relative volatility of the binary system is constant at 2.4

Determine the following:

i) Distillate and residue flow rates (in mole/hr)

ii) Ratio of liquid to vapor molar flow rates in the rectifying section

iii) The minimum number of theoretical stages (inclusive of reboiler) for the process.

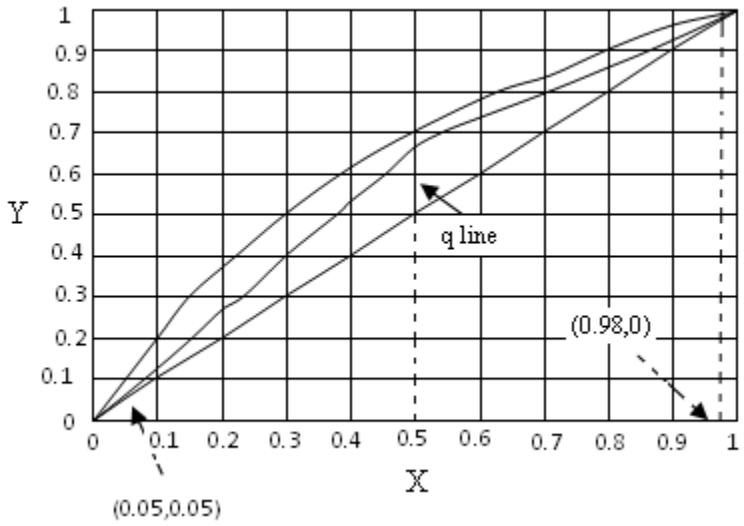


Figure 1.McCabe-Thiele diagram

For Q No. 1.(c)

d) An equilibrium mixture A and B (A being volatile) is flash distilled continuously at a feed rate of 100 kmol/hr, such that the liquid product contains 40 mole % of A. If the relative volatility is 6, Then determine vapor product rate in kmol/hr.

e) In multistage countercurrent isothermal stripping column, feed containing 0.05 mole of solute/mole of solute free oil is treated with steam. The absorption factor A = 0.65. The equilibrium relation is given by: $Y^* = 2X$, where Y^* and X refer to equilibrium ratio in the steam and oil phase respectively. The Kresmer equation is given as follows ('0' refers to inlet at the top, 'N_P' refers to the last stage at the

bottom)

$$N_P = \frac{log\left[\frac{\left(X_o - \frac{Y_{N_P+1}}{m}\right)}{\left(X_{N_P} - \frac{Y_{N_P+1}}{m}\right)}\right](1-A)+A}{\log\left[\frac{1}{A}\right]}$$

If steam is initially free of solute and its exit mole ratio (mole solute/mole steam) is 0.0624, determine the number of equilibrium stages.

OR

Q2) a) Carbon disulphide is to be absorbed from a dilute gas mixture of $CS_2 - N_2$ into pure nonvolatile oil at 1 atm. In a counter-current absorber. The mole fraction of CS_2 in inlet gas stream is 0.05 and the flow rate of gas stream, G, is 1500 kmol/hr. The equilibrium relation is given by, y = 0.5 x, where x is the mole fraction of CS_2 in liquid stream. It is desired to reduce the mole fraction in the gas stream is 0.005 [9]

a) Calculate the minimum value of L/G. where L is the liquid flow rate in kmol/hr

b) Derive the equation for the operating for the operating line if L/G is equal to 1.5 times the minimum values.

b) 15000 kg/hr. of a SO_2 – Air mixture containing 10 % by volume of SO_2 is to be scrubbed with 4,00,000 kg/hr of water in a packed tower. The exit concentration of SO_2 is reduced to 0.25 %. The tower operates at 1 atm. The equilibrium relation is given by: [9]

$$Y = 30\ X$$

where $Y = \frac{Mole\ SO_2}{Mole\ air}$

$$X = \frac{Mole\ SO_2}{Mole\ water}$$

If the packed height of tower is 0.45 m, calculate the height of transfer unit.

Q3) A counter-current multistage stripper is as shown in Figure 2 Is used to remove an [16]

impurity from a cream using pure steam. 100 kg/hr of liquid cream containing 20 parts per million (ppm) by weight of impurity is fed to the stripper. It is desired to reduce the concentration of impurity in the cream to 1 ppm. Assume that the liquid cream does not evaporate and steam does not condensate. The equilibrium relation is y = 10x, where y and x are the ppm of impurity in steam and cream, respectively.

i) Indicate schematically on a x-y plot, the equilibrium line and operating line for minimum steam flow rate.

ii) Determine the minimum flow rate of steam required.

iii) If the rate of steam to the stripper is 1.5 times the minimum, determine the required integral number of theoretical stages.

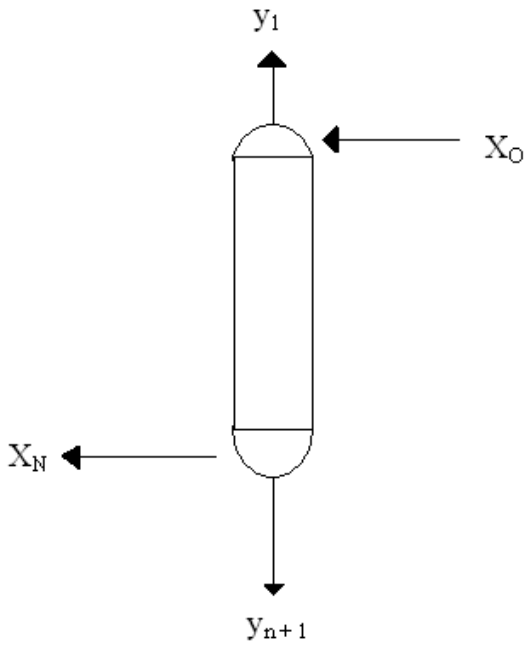


Figure 2 A counter current multistage stripper

For Q No. 3

OR

Q4) a) Solutions of methanol and ethanol are substantially ideal. Compute the vapor [16]

liquid equilibrium data for this system at 1 atm. Pressure and plot x-y and t-x-y diagram. Compute also relative volatilities and determine and determine an average value.

The vapor pressure-temperature relationship are:

$$\log P_{M_C OH} \text{ (mmHg)} = 7.84863 - \frac{1473.11}{230 + t^0C}$$

$$\log P_{EtOH} \text{ (mmHg)} = 8.04494 - \frac{1554.3}{222.65 + t^0C}$$

Q5) a) Explain in brief the procedure to determine number of stages for distillation column by Ponchon-Savarit ,ethod. [8]

b) Derive Fenske equation for calculating minimum number of plates in a distillation column. State assumptions, made, if any. [8]

OR

Q6) It is desired to separate by distillation at 760 mm Hg mixture containing 42- mole % heptane and 58-mole % m ethyl benzene to produce a distillate containing 97 – mole % heptane and residue containing 99-mole % ethyl benzene. [16]

a) Using a reflux ratio of 2.5 determine the number of equilibrium stages needed for a saturated liquid feed and reflux by the McCabe-Thiele Method.

b) Determine the minimum reflux ratio.

c) Determine the number of equilibrium stages at total reflux.

Equilibrium data: Vapour liquid equilibria for heptanes-ethyl benzene System at 760 mm Hg.

x	0	0.08	0.18	0.25	0.33	0.48	0.65	0.78	0.91	1.0
y	0	0.233	0.42	0.51	0.60	0.72	0.81	0.90	0.96	1.0

SECTION II

Q7) Attempt Any Three from the following: [18]

a) A counter-current extraction column is designed to remove 99% of solute C from a solution of solvent A and solute C using pure solvent B. the initial concentration of solute in the solution of A+C is 20 wt % and the total flow of solution is 1000 kg/hr. If the equilibrium relation is Y = 2X,
where Y = mass of C/mass of A and X = mass of C/mass of B
Calculate minimum flow rate of solvent B required in kg/hr.

b) In triangular diagram as Shown in Figure 3, for a batch separation process, a stream F is mixed with a solvent B to produce R and E. Substance A is the carrier liquid and C is the solute to be extracted. The amounts of B and E are 1 kg and 20 kg respectively. The length of Fm is 3.1 and length FB is 8.5 units on the figure. Estimate ratio R/E. Note: Figure not scale.

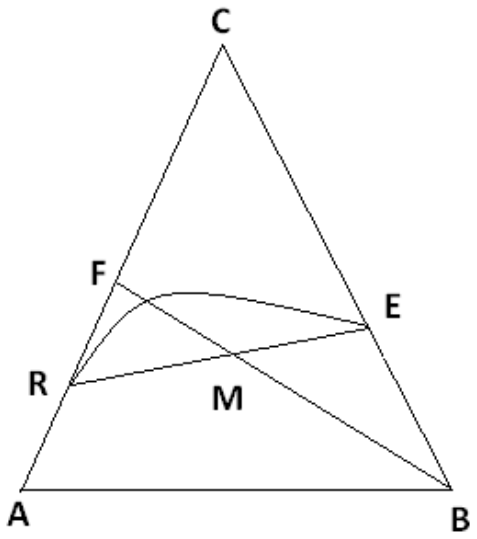


Figure 3 Triangular diagram for a batch separation process

For Q No. 7 (b)

c) Discuss in brief the factors, which govern the selection of solvents used for liquid-liquid extraction operations.

d) Classify the commercial extraction equipments. State working principles of any one extraction equipment.

e) Develop material balance equations for multistage cross current extraction operations. Show graphical representations of the final equations developed.

OR

Q8) a) A solute is recovered from an aqueous solution containing 35% of the solute by weight using kerosene as the solvent. The distribution of the solute in water and kerosene may be described by x' = 5.75 y' where x' is the kg of solute per kg of water and y' is the kg of solute per kg kerosene. Calculate the final concentration in the final raffinate if the extraction is done in 3 simple equilibrium contacts using 5 kg solvent per kg of initial solution in each stage. [9]

b) A feed (F) containing a solute is contacted with a solvent (S) in an ideal stage as Shown in Figure 4. Only the solute transfers into the solvent. The flow rates of All the streams are as shown on a mole ratio basis. The extract leaving the contactor is divided into two equal parts, one part collected as the product (P) and the other stream is recycled to join the solvent. The equilibrium relationship is given by : $Y^* = 2X$. Estimate the product flow rate (P_S) and composition (Y_{Out}). [9]

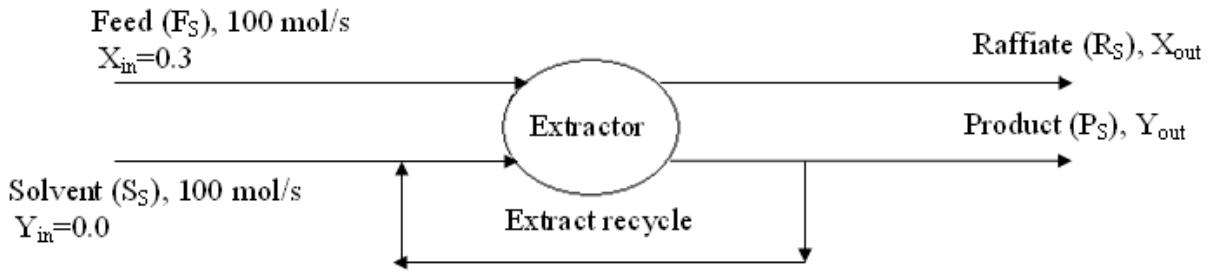


Figure 4 A feed containing a solute is contacted with a solvent in an ideal stage for Q No. 8 (a)

Q9) The adsorption of ethane on Linde molecular sieve type 5A was studied by Glessner and Myers (1969) at 35^0C. The data is given below: [16]

Data:

P, [mm Hg)	Uptake, V [cm^3 (STP/gm]
0.17	0.059
0.95	0.318
5.57	1.638
12.09	3.613
111.32	24.236
220.87	34.278
300.05	38.340
401.25	41.779
500.18	44.037
602.74	45.693

a) Determine if the Langmuir equation can be used to model the data.

b) Calculate the total surface area of solid, it Density of Ethane = 0.35 gm/cc

OR

Q10) a) A waste water solution having a volume of 2.5 m^3 contains 0.25 kg phenol/m^3 of solution. This solution is mixed thoroughly in a batch process with 3 kg of granular activated carbon until equilibrium is reached. Calculate the final equilibrium values and percent phenol extracted. [8]

Equilibrium Data:

C, $\frac{kg\ phenol}{m^3\ solution}$	0.322	0.117	0.039	0.0061	0.0011
q, $\frac{kg\ phenol}{kg\ carbon}$	0.150	0.122	0.094	0.059	0.045

b) Explain the breakthrough concentration curve and discuss in brief capacity of column and scale up design method for fixed bed adsorption column. [8]

Q11) a) Acetaldehyde 10 percent by weight in solution with toluene and is to be extracted with water in a 5 stage cocurrent unit. 30 kgs of water are sued (as solvent) per 100 kgs of feed for each stage. The equilibrium relation is given by: [16]

Y* = 2.20 X, where Y* = kg of acetaldehyde/kg of water, X = kg of acetaldehyde/kg of toluene.

i) Calculate the amount of acetaldehyde extracted in percent and the final concentration.

ii) If all the solvent (150 kgs) is used in one stage, calculate the % extraction and the concentration of final solution?

OR

Q12) Write short notes on (Any Two) [16]

i) Classification of membrane separation processes

ii) Ultrafiltration, Nanofiltration and Microfiltration : Principle and Applications

iii) Reverse Osmosis: Principle and Applications

iv) Membrane modules for membrane processes.

[Total No. of Questions: *8*] **[Total No. of Printed Pages: *3*]**

UNIVERSITY OF PUNE
[4363]-238
T. E. (*PETROCHEMICAL*), Examination - 2013
REACTION ENGINEERING-I
(2008 Course)

[Time: *3* Hours] **[Max. Marks: 100]**

Instructions:

1. *Attempt any three questions from each section.*
2. *Answers to the **two sections** should be written in **separate answer-books**.*
3. *Black figures to the right indicate full marks.*
4. *Assume Suitable data where ever necessary.*
5. *Use of electronic pocket calculator and steam tables is allowed.*

SECTION -I

Q.1 A Derive batch reactor performance equation starting from general mol balance. [8]

B Liquid phase reaction converting A into products obeys following kinetics: [8]

$$-r_A = \frac{0.1C_A}{1+0.5C_A} \; mol/lit.min$$

Find the time needed in batch reactor to drop the reactant concentration from 10mol/L to 0.025 mol /L

Q.2 Pure gaseous A at 3 bar and 303 K is fed into a 1-Lit laboratory mixed flow reactor at various flow rates. There it decomposes in an irreversible reaction as: A→3R. Exit concentration of A is measured for each flow rate at steady state. The data generated from 4 runs is given below. Suggest a rate equation to represent the kinetics of the decomposition of A. [16]

Run	1	2	3	4
v_0 liter/min	0.06	0.48	1.50	8.10
C_A,mmol/liter	30	60	80	105

Q. 3 An aqueous feed containing A at concentration of 1 mol/L enters a 2-Liter reactor and undergoes a dimerization reaction given as follows: [16]

$2\ A \rightarrow R$ - $r_A = 0.05\ C_A^2$ mol/L.s

Find the exit concentration of A for a feed rate of 0.5 liter/min assuming that the reactor is (a) PFR and (b)CSTR.

Q. 4 Results of CSTR runs on a liquid reaction involving A as a reactant are reported below: [18]

Run No.	Space time,sec	C_A mol Feed Stream	C_A mol/ L Exit Stream
1	300	2.00	0.65
2	240	2.00	0.92
3	250	2.00	1.00
4	110	1.00	0.56
5	360	1.00	0.37
6	24	0.48	0.42
7	200	0.48	0.28
8	560	0.48	0.20

What space time will be needed in a PFR to obtain 75% conversion of a feed sent with concentration of A as 0.8 mol/L?

SECTION-II

Q. 5 Liquid phase isomerization reaction A→R follows the following kinetics: - $r_A = C_A^{1.5}$ mol/lit.hr. This reaction is to be carried out in a series of two equal volume mixed tank reactors. Feed stream to the first reactor has concentration of A as 5.0 mol/L which is to be reduced by 60% in the exit of the second reactor. Using graphical procedure, find the residence times required to be spent in two mixed tanks. Report the reactor sizes if feed is 1000 Lit/hr. [18]

Q. 6 Consecutive first order reactions A→R→S are to be carried out in a batch reactor. Derive expression for optimum batch time in terms of rate constants so that [16]

production of R per batch is maximum.

Q. 7 A first order liquid phase reaction A→R is to take place in an adiabatically operated plug flow reactor. The reaction is exothermic with maximum possible temperature rise of 175 C over the feed temperature. Feed temperature is 30 C. Rate constant of the reaction is given as $k = 0.7\ e^{-4000/T}\ s^{-1}$. Report the volume of the PFR required for a feed rate of $50 m^3$/ hr and for the desired conversion level of 80%. [16]

Q. 8 Write notes: [16]
a) Recycle Reactor
b) Choice of mixing pattern for parallel reactions
c) Optimum arrangement of reactors for given kinetics

UNIVERSITY OF PUNE

[4363]-239

T. E. (Petrochemical)(Semester - II)

Examination-2013

PETROCHEMICAL PROCESSES II

(2008 Pattern)

[Time : 3 Hours] **[Max. Marks : 100]**

Total No. of Questions : 12 **[Total No. of Printed Pages :2]**

Instructions :

*(1) Answer **any three** questions from each section.*

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3) Black figures to the right indicate full marks.

(4) Use of logarithmic tables, slide rule, Molliercharts, electronic pocket calculator and steam tables is allowed.

(5) Assume suitable data, if necessary.

SECTION I

Q1) a) Distinguish between the Brent crude and the WTI crude. [6]

b) 'Natural gas is considered as a potential alternative fuel for the future'. [6]

Do you agree? Discuss your viewpoint.

c) What are the various additives used for gasoline. [6]

OR

Q2) a) Explain the process of formation of petroleum. [9]

b) Give the classification of crude. [9]

Q3) a) How does crude oil get contaminated with salt water? Discuss the method of desalting of crude. [8]

b) What are the properties to be considered for the manufacture of good quality lube oil? [8]

OR

Q4) a) Draw a neat labeled diagram of HF alkylation process. [4]

b) Explain the need for vacuum distillation. [4]

c) Describe a typical fixed bed hydroprocessing unit with a neat diagram. [8]

Q5) a) Write a note on the various catalysts used in the catalytic cracking process. Give the advantages of using zeolite catalysts. [8]

b) Explain the SCOT process for the recovery of sulphur from refinery gases. [8]

OR

Q6) a) With the help of a neat diagram explain the process of Flexi coking. [8]

b) Why is bitumen air blown? Explain with the help of a neat labeled diagram. [8]

SECTION II

Q7) a) Write a note on disproportionation of toluene. [9]

b) Explain the process of steam reforming of hydrogen. [9]

OR

Q8) a) Draw a neat labeled diagram of the semi-regenerative process for catalytic reforming. [6]

b) Write a note on the various reforming catalysts. [6]

c) Enlist the various reactions during catalytic reforming. [6]

Q9) a) Explain the various types of polymerization reaction. [8]

b) Discuss the Union carbide process for the manufacture of polypropylene. [8]

OR

Q10) a) Describe in brief the manufacture of urea formaldehyde resin. [8]

b) Give the various process technologies for the manufacture of polyethylene. [8]

Q11) a) Describe the process for the manufacture of adipic acid. [8]

b) Distinguish between synthesis fibres and natural fibres. [8]

OR

Q12) a) Draw a neat labeled diagram for the process for the manufacture of DMT. [6]

b) Give the process steps involved in the manufacture of nylon-6. [6]

c) Enlist the various processes for the manufacture of terephthalic acid (TPA). [4]

[Total No. of Questions: 12] **[Total No. of Printed Pages: 4]**

UNIVERSITY OF PUNE
[4363]-240
T. E. (Petrochemical Engineering) Examination - 2013
PROCESS EQUIPMENT DESIGN & DRAWING (2008 Course)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

1. *Answer three questions from each section*
2. *Answers to the two sections should be written in separate answer-books.*
3. *Neat diagrams must be drawn wherever necessary.*
4. *Black figures to the right indicate full marks.*
5. *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
6. *Assume suitable data, if necessary.*

SECTION -I

Q.1	A	Discuss the factors on which magnitude of factor of safety depends.	6
	B	Discuss different theories of failure along with their equations and applications.	6
	C	What are the basic qualities required in Process Equipment design engineer for better designs?	4
		OR	
Q.2	A	What is importance of codes and standards in design of any equipment? What are the different organizations which creates codes & standards?	8
	B	What are the differences between equipment design and process design?	8
Q. 3	A	A **cross** belt arrangement has center distance between pulleys as 1.5 m. The diameter of bigger and smaller pulleys are 'D' and 'd' respectively. The smaller pulley rotates at 1000 r.p.m. and the bigger pulley at 500 r.p.m. The flat belt is 6 mm thick and transmits 7.5 kW power at belt speed of 13 m/s approximately. The coefficient of belt friction is 0.3 and the density of belt material is 950 kg/m3. If the permissible tensile stress for the belt material is 1.75 MPa. Calculate: Diameter of pulleys & length and width of belt.	12

	B	Discuss the different types of belt drives along with their applications and capacity for different purpose.	4
		OR	
Q. 4	A	Design a cast-iron protective type flange coupling to connect shafts in order to transmit 15 hp at 500 rpm. The following permissible stresses may be used. Shear stress for shaft, bolt & key material = 400 KgF/Cm^2 Crushing stress for bolt and key = 800 KgF/cm^2 Shear stress for cast iron = 80 KgF/cm^2 Width of Key = 12 mm & Number of bolts = 3	10
	B	What do you mean by Factor of Safety? What is its importance in designing any equipment?	6
Q. 5	A	A pressure vessel internal diameter 1.25 m is subjected to combine Loading, operates at an internal pressure of 10 kg/cm^2. Material used for fabrication having allowable stress 980 Kg/cm^2. Weight of vessel with its content is 6500 kg. Joint efficiency is 85%, Torque induced is 55 kg.cm, Bending movement induced can be neglected. Calculate the various Stresses induced in vessel and verify that the equivalent stress is less than permissible stress.	12
	B	Draw different types of heads used in pressure vessel along with their criteria for selection.	6
		OR	
Q. 6	A	Discuss the area for area method of nozzle compensation with neat sketch.	6
	B	Write a note on overprotection devices used in pressure vessel. (with neat sketch.) 1) Pressure relief valves 2) Rupture disc 3) Steam trap	12

SECTION II

Q. 7	A	How fouling effects the performance of heat exchanger. What are the different types of fouling which occurs in heat exchangers?	8
	B	What are the different criteria used for selection of any heat exchanger for desired operations?	4
	C	Discuss the detailed classification of heat exchangers and techniques for performance evaluation.	4
		OR	

Q. 8 For the heat exchanger data find out diameter and thickness of shell: 16

Data:

i) Number of tubes= 64
ii) Number of passes = 2
iii) Outside diameter of tube = 20 mm
iv) Pitch (square) = 25 mm
v) Proportionality Factor
(β)=0.8(Triangular Pitch)
E = 0.7 (Square Pitch)
vi) Internal shell pressure (Pi) = 0.55 N/mm^2
vii) Material is carbon Steel.
viii) Permissible stress of the material = 130 N/mm^2
ix) Welding efficiency = 85%

Also find the diameter of shell if triangular pitch is selected.

Q. 9 A Write the detailed process along with equations and diagrams for design of storage tank including the bottom plate, shell and roof dimensions calculations. 10

B Discuss with neat sketch types of floating roof along with accessories used for the sealing in storage of volatile liquids. 6

OR

Q. 10 A Discuss the types of losses in to storage tanks of volatile materials 6

B Design a shell of Circular Cylindrical Tank for storage of crude oil. 10

Tank diameter = 16 m (Approx)
Tank height = 12 m (Approx)
Material Mild Steel with permissible stress = 90 N/mm^2
Joint efficiency = 85%
Assume suitable density for crude oil.
Plate sizes available are
(6300mm x 1800 mm, 5000mm x 2500mm, 5600 mm x 1100mm)

Q. 11 A Design a Shell of Pressure vessel with following data 12

Shell Data:
Internal diameter (Approx) = 1400 mm
Material = Stainless Steel
Permissible stress at 150^0 = 140 N/mm^2
Internal pressure = 0.35 N/mm^2
Weight = 38000 N
Joint efficiency = 0.85
Torque Offset piping = 500 N - m

B Explain the causes of vibrations in a shell and tube heat exchangers and their effect on the performance of heat exchangers. 6

OR

Q. 12 Write short notes on (Any four): 18

a) Use of Wind girders in Storage tank (with sketch)
b) Pipeline color codes for different pipe lines
c) IS Code for design of equipment
d) Stress Concentration
e) Steps in design activity
f) ASME & TEMA CODES