Total No. of Questions : 8] **[Total No. of Pages : 2**

P1221

[3564]-330

B.E. (Petrochemical)

CATALYSIS TECHNOLOGY & FLUIDIZATION ENGINEERING

(2003 Course) (412411)

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

Instructions to the candidates:

1) ***Answer any three questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***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

Q1) a) Derive Langmuir Adsorption Isotherm with the help of important assumptions. **[6]**

b) With help of diagram explain how catalyst changes rate of reaction. **[4]**

c) Differentiate between deactivation and Poisoning of catalyst with help of suitable example. **[6]**

Q2) a) For the catalytic gas phase reaction : $A + B \rightarrow C$ where all A, B, C are adsorbed appreciably, derive rate expression considering Langmuir-Hinshelwood mechanism in terms of partial pressure of respective components.

If inert I be present in the system which is also strongly adsorbed, what will be the modified rate expression? **[10]**

b) "Zeolites are very useful catalyst" – Explain in light of present day industrial scenario. **[6]**

Q3) a) Discuss the industrial method of preparing ammonia with special emphasis on the type of reactor employed. **[8]**

b) Write importance of Catalyst supports and name four of them. **[4]**

c) Write down important characteristics of a catalyst in order to be suitable for industrial purposes. **[4]**

Q4) a) With a specially designed catalyst of 175.8 gm following data were obtained:

Vol. of Helium displaced by sample = 78.5 cm^3.

Vol. of Mercury displaced by sample = 83 cm^3.

Calculate pore volume and catalyst particle porosity. **[6]**

P.T.O.

b) Define the followings:

i) Active Site.

ii) Functionality.

iii) Turnover Number. **[4]**

c) Name four methods of manufacture of industrial catalysts. **[4]**

d) Differentiate between Structural Promoters and Textural Promoters. **[4]**

SECTION - II

Q5) a) How fluidizing particles are classified? Write down important characteristics of different group of particles. **[6]**

b) Write down advantages of fluidization. **[4]**

c) Compare the performance of different types of distributor. **[6]**

Q6) a) Write a short note on bubble movement and its hydrodynamics through fluidized bed emphasizing Coalescence and Bubble break up phenomena. **[6]**

b) With help of sketch explain the slug flow through a narrow pipe under fluidized condition. **[4]**

c) Define followings: **[6]**

i) Minimum fluidization velocity.

ii) Agglomeration.

iii) Pneumatic Conveying.

Q7) a) Explain small and large bubbles and their interactions in fluidized bed. How are they moving through the bed? Highlight mixing caused by them. **[8]**

b) What are advantages of fluidized bed driers over conventional ones? **[4]**

c) Write a short note on Cloud formation in fluidized bed. **[4]**

Q8) a) With help of suitable diagram show the operation of different types of fluidized bed driers. **[6]**

b) With help of neat sketch explain fluidized catalytic cracking. Show that it contains two fluidized bed operating simultaneously and operation of one bed affects the other. **[8]**

c) Write a short note on heat transfer from fluidized particle to gas phase. **[4]**

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

P1220

[3564]-329

B.E. (Petrochemical)

PROCESS ECONOMICS AND PROJECT ENGINEERING

(2003 Course)

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

Instructions to the candidates:

1) ***Answer 03 questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) Answer **Any Three** from the following: **[18]**

a) Discuss breakdown of Fixed Capital Investment (FCI) items for a chemical process.

b) Write a brief note on: "Estimates of Total Product Cost".

c) A shell-and-tube heat exchanger of 1000 ft² surface area fabricated of carbon steel was purchased in 1995 for Rs. 30,000.

i) Estimate the purchased price for a 2500 ft² exchanger using the six-tenths exponent.

ii) You read in the literature that exchangers of this size had a 0.70 cost capacity exponent. What is the difference in price compared to that using an exponent of 0.6?

Data: The 1995 CE Index is 381 and the present one is 399.

d) Discuss with suitable example(s) the factors affecting investment and production cost of typical refinery project.

e) Discuss in brief the various components of a balance sheet and Profit and loss account statements.

OR

Q2) a) The plant of a chemical company has an initial worth of Rs. 50 crores, and an estimated salvage of 2 crores in service life of 8 years. **[9]**

i) Given a choice between the straight-line and declining-balance methods of depreciation. Which method would you recommend to save tax and why?

P.T.O.

ii) Estimate the book value of the plant at the end of 4 years for each of the two methods of depreciation.

b) Discuss the tree diagram showing cash flow for industrial operations. **[9]**

Q3) a) Discuss the types of cost indices available in the Chemical Engineering literature. Discuss the importance of these cost indices for cost estimation of chemical engineering equipment. **[6]**

b) Ajax Petrochemical is considering the manufacture of 18MMlb/yr of a speciality-chlorinated hydrocarbon. In the process some 4MMlb/yr of chlorine is required. Ajax has an older caustic-chlorine facility at the same location that has a rated capacity of 100 tons/day. The book value of the chlorine unit's capital investment is Rs. 20MM. Calculate the amount of allocated capital to be charged to the chlorinated hydrocarbon unit if the chlorine is to be transferred from the existing caustic-chlorine-plant. Assume 330 operating days per year for both plants. **[10]**

OR

Q4) a) Prepare a balance sheet for the financial year 2008-2009 ending on 31st March 2009 when the M/s ABC Petrochemical Corporation Ltd., Pune had the following assets and equities:

Cash	Rs. 20,00,000
Accounts Payable: A Company B Corporation	 Rs. 1,00,000 Rs. 1,60,000
Accounts Receivable	Rs. 3,00,000
Inventories	Rs. 7,50,000
Mortgage Payable	Rs. 2,00,000
Common stock sold	Rs. 2,00,00,000
Machinery and equipment (at present value)	Rs. 9,00,00,000
Furniture and Fixtures (at present value)	Rs. 2,00,000
Government Bonds Surplus	Rs. 1,20,000 Rs. 60,000

[8]

b) Company X is considering the Projects that have the following costs: (All costs are in Rupees)

Item	Project A	Project B
First cost	15,000	18,000
Annual Operating Costs	3,500	3,100
Salvage Value	1000	2000
Life, years	6	9

i) Using a money worth 15% per year, determine which alternative should be selected on the basis of a present-worth analysis.

ii) Company X has a standard practice of evaluating all projects over a 5-year period. If a study period of 5 years is used and the salvage values are expected to be Rs. 1500 and Rs. 4000 for A and B respectively, which project should be selected? **[8]**

Q5) a) An existing plant has been operating in such a way that a large amount of heat is being lost in waste gases. It has been proposed to save money by recovering heat now being lost. Four different heat exchangers have been designed to recover the heat and all prices. Saving has been calculated for each of the design is given in the following table. The plant manager wants at least 16% annual return on initial investment. Which one of the four designs should recommend to the plant manager?

Data:

Item	**Design-I**	**Design-II**	**Design-III**	**Design-IV**
Initial Installed cost (Rs)	2,50,000/-	4,00,000/-	5,00,000/-	6,50,000/-
Operating Cost, Rs.	7,500/-	7,500/-	7,500/-	7,500/-
Fixed Charges, % of initial cost per year	10%	10%	10%	10%
Value of heat saved Rs/year	1,00,000/-	1,40,000/-	1,60,000/-	2,00,000/-

[12]

b) A project expected to have cash flow for five years as follows after all expenses and taxes. The initial fixed capital investment is Rs. 10,00,000 and the working capital investment is 15% of the fixed capital investment.

Time (Years)	Cash Flow (Rs.)
0-1	2,00,000/-
1-2	2,70,000/-
2-3	3,30,000/-
3-4	4,00,000/-
4-5	4,75,000/-

Determine the payout time required for given project. **[4]**

OR

Q6) a) The following data are available for two reactors from a petrochemical plant:

Item	Reactor (Mild Steel)	Reactor (Stainless Steel)
Installed cost	Rs. 5,00,000/-	Rs. 1,50,000/-
Salvage value	0	0
Service life	3	?
Interest rate (i)	12%	12%

If the capitalized cost is same for both the reactors, estimate service life for stainless steel reactor. **[8]**

b) A plant is designed to produce 1.2×10^8 kg/hr of an agrochemical. The estimated fixed capital investment is Rs. 1.5×10^9. The working capital is 2×10^8 and startup cost (only in the first year of commissioning and to be accounted for in the first year) is 1.5×10^8. The following cost data are available:

Raw material: Rs. 0.8/kg product

Labour and Utilities, etc.: Rs. 0.27/kg product

Selling price of product: Rs. 10/kg

Other costs (on year basis) including Maintaince, insurance, etc, @10% of fixed capital.

Indirect cost of administration, R & D, marketing, etc., 20% of sale proceeds. The plant will be fully depreciated over a period of 5 years using the straight-line method.

The rate of income tax is 40%.

Calculate

i) the net profit at the end of first year

ii) the payout period. **[8]**

SECTION - II

Q7) a) Discuss in brief the anatomy of Chemical Manufacturing Process. **[6]**

b) Write a brief note on. "Design constraints and the design process". **[6]**

c) Explain the plant-design project stages with suitable example. **[6]**

OR

Q8) a) Explain the items that should be considered in making a feasibility survey. **[6]**

b) Write a brief note on: "Process Design Codes and Standard sources of information used by Process Engineers". **[6]**

c) Discuss with suitable example(s) the organization of a chemical engineering project. **[6]**

Q9) a) Most process units require consideration of proper materials of construction. The following table gives a relative cost of Metals using carbon steel as a base.

Material	Relative Cost
Carbon Steel	Base Cost (Lowest)
Low Alloy Steel	Low-Moderate
Stainless Steel	Moderate
Aluminium and Aluminium Alloys	Moderate
Copper and Copper Alloys	Moderate
Titanium and Titanium based Alloys	High
Nickel and Nickel based Alloys	High

Why is the selection of the correct material important, and what are some of the constraints one must deal with when making choice. Consider different situations such as for example a crude tower in an oil refinery or a vessel in a vaccine-manufacturing unit. **[8]**

b) Explain Plant shutdown and emergency procedure. **[8]**

OR

Q10) a) What are process utilities? Briefly discuss important utilities required in a typical petrochemical complex/refinery unit. **[8]**

b) What is equipment specification sheet? Give a typical Specification sheet for Shell and Tube Heat Exchanger. **[8]**

Q11) a) Discuss in brief the following safety terms: **[8]**

i) Fault tree analysis.

ii) Flash and Smoke Point.

iii) Trip and interlock system.

iv) HAZOP and HAZAN

b) Discuss in brief the following (**Any Two**): **[8]**

i) Piping Specifications.

ii) Engineering flow diagram and Piping and Instrumentation Diagram.

iii) Plot plan and equipment layout.

OR

Q12) a) Discuss in brief Bar Chart, Milestone chart and Gantt Chart for Petrochemical Engineering project analysis. **[7]**

b) Description of various activities is listed below for a project of laying of pipeline in a refinery in one of the MIDC area near Mumbai.

i) Decide the sequence of operations.

ii) Draw the network and determine the critical path.

iii) Calculate the earliest expected time and latest allowable time to complete the given refinery project.

Date:

Sr. No.	Description of activity	Time duration in weeks
A	Site selection and survey	4
B	Basic Process design	3
C	Preparation of layout and drawing	8
D	Preparation of specification	2
E	Excavating the trench	12
F	Procurement of material related to pipeline and control	12
G	Laying and joining the pipes	10
H	Refilling and compacting	6
I	Inspections and Testing	10

i) Draw a network diagram with given expected time of each activity.

ii) Determine earliest expected time, latest allowable occurrence time and slack time for each path.

iii) Show the critical path. **[9]**

Total No. of Questions : 12] **[Total No. of Pages :5**

P1219

[3564] - 325
B.E. (Petrochemical)
NOVEL SEPARATION PROCESSES
(412405) (Elective)

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

Instructions to the candidates:

1) ***Answer 3 questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables, 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) Compare and contrast on Macroemulsions and Microemulsions with suitable examples.

b) Classify membrane separation processes by giving examples and it's industrial applications.

c) Discuss in brief on: adsorptive bubble separation techniques.

d) Explain the process principles involved in Froth Flotation. Indicate it's Industrial applications.

OR

Q2) a) Explain in brief the selection criteria for chemical engineering separation processes with suitable examples. **[8]**

b) Explain in brief the energy requirement of separation processes with suitable examples. **[10]**

Q3) Classify the models for gas separation by membranes. Develop complete mixing model for membrane separation processes. State the assumption made. **[16]**

OR

P.T.O.

Q4) a) A heart-lung machine uses a 0.175 mm silicone rubber membrane with a permeability of 6×10^{-7} cm^3 O_2 (STP) mm/s.cm^2cmHg. The machine is to supply 350 cm^3/min of oxygen to a patient, where the partial pressure of oxygen in the blood is the equivalent of 40 mmHg. The machine is supplied with pure oxygen at 720 mmHg, so gas film resistance can be neglected. If the resistance on the blood side were neglected also, how large would the membrane need to be? **[6]**

b) A 9-micron tubular membrane is used to recover salt A from a dilute solution. The solutions to either side are at 0.025 and 0.004 kmol/m^3, with mass transfer coefficients of 3.5×10^{-5} and 2.2×10^{-5} m/s respectively. The distribution coefficient is 0.79 and the diffusivity of A in the membrane is 2.96×10^{-11} m^2/s.

i) Calculate the percentage of total resistance to mass transfer contributed by the membrane.

ii) Calculate the membrane area needed to allow recovery at 0.01 kmol/hr.

iii) Flow inside the tube is turbulent and mass transfer follows the Gilliland, Sherwood & Linton correlation. If the velocities of both solutions are doubled, what will the membrane resistance now be? **[10]**

Q5) A liquid containing dilute solute A at a concentration 3×10^{-2} kgmol/m^3 is flowing rapidly by a membrane of thickness, 3×10^{-5} m. The solute diffuses through the membrane and its concentration on the other side is 0.5×10^{-2} kgmol/m^3. The mass transfer coefficient k_{c1} is large and can be considered as infinite and $k_{c2} = 2.02 \times 10^{-5}$ m/s.

Data: Distribution coefficient = K′ = 1.5

Diffusivity, $D_{AB} = 7 \times 10^{-11}$ m^2/sec in the membrane.

i) Derive the equation to calculate the steady state flux, NA and make a sketch.

ii) Calculate the flux and concentration at the membrane interfaces. **[16]**

OR

Q6) a) Discuss with neat sketches various membrane modules available for membrane separation processes. **[10]**

b) Reverse osmosis of salt solution at 25ºC is tested with a 5.2×10^{-3} m^2 cellulose acetate membrane. On one side of the membrane is 1 mol NaCl/kg H_2O solution at 60 atmospheres (abs.) pressure, on the other is 0.01 mol NaCl/kg H_2O at atmospheric pressure. The permeation rate is 96.12 ml/hour. Find the solvent permeability and the rejection rate.**[6]**

SECTION - II

Q7) a) Answer Any Three from the following : **[12]**

i) Show why the Langmuir or Freundlich isotherm parameters are found by plotting (1/q) against (1/C), or by plotting (log q) against (log C).

ii) Name five of the most important commercial adsorbents? What is the distinguishing feature of the molecular-sieve zeolites?

iii) What is a mass-transfer zone (MTZ) and what causes it? Is it desirable? If not, why not?

iv) Describe a typical thermal-swing adsorption cycle.

b) A 45cm high bed of adsorbate, when processing 0.25 m^3 per hour of a fluid, gives a 560 second break-through time, with 75% of the bed height fully spent. If more adsorbate were added to the bed so as to give 880 seconds before breakthrough at the same flow rate, how much higher will it be? **[6]**

OR

Q8) Activated carbon is used to adsorb ethanol vapor from an airstreams. The laboratory experiment to investigate this has a bed 4 cm in diameter and 15 cm high. Exit data for an input of 0.754 liter/second are as follows:

Time (hours)	0	3	3.5	4	4.5	5	5.5	6.0	6.2	6.5	6.8
C/C_0	0	0	0.002	0.030	0.155	0.396	0.658	0.903	0.946	0.978	0.993

Do as follows:

i) Determine breakthrough time if break point is $C/C_0 = 0.05$.

ii) Calculate the height of a new column of the same diameter that has breakthrough at 8.5 hours.

iii) Calculate the diameter of this new column if it is to process 3 liter/min. **[18]**

Q9) a) Discuss the process principles involved in PSA and TSA by giving suitable examples? **[8]**

b) From Darcy's Law, the velocity through a packed bed for a given pressure drop (P) is given by:

$$u = \frac{\varphi P d_p^{\,2}}{1\eta}$$

Where,

φ = Darcy's constant

P = Pressure drop

d_p = Particle diameter

l = Length of column

η = Viscosity of the mobile phase

Also, from the analysis of the Van Deemter equation, for a well packed column and for a highly retained solute, it is found that:

$$H_{min} = 2.48 d_p$$

and the velocity at H_{min} is equal to

$$1.62\, D_m / d_p$$

Where D_m is the diffusivity of the solute in the mobile phase.
From the above informations, derive an analytical expression for the maximum efficiency obtainable for a column in terms of these parameters, if the maximum allowable pressure drop is P. **[8]**

OR

Q10) a) Suggest one or more types of chromatography to separate each of the following mixture: **[6]**

i) α and β pinenes

ii) Blood serum proteins

iii) Hexane Isomers

iv) Purification of Cefonicid-a synthetic antibiotic

b) You are working as Separation technologist in one of the chemical complex near Mumbai. Your company has been contracted to purify a new peptide mixture, which has been produced by ABC company. Your research department has optimized the separation on two exiting columns and the production department needs to know which column can operate at the higher volumetric flow rates. Since the stationary phase chemistries are slightly different, each column is operated at different mobile phase mixture so you will need to take this consideration for your calculations.

Data:

Column-I	Column-II
Mobile Phase 50/50 MeOH/H_2O by weight d_{col} = 0.5 cm L_{col} = 25 cm ε_c = 0.4888 $d_p = 10\mu m$	Mobile Phase 70/30 MeOH/H_2O by weight d_{col} = 1 cm L_{col} = 50 cm ε_c = 0.5330 $d_p = 10\mu m$

[10]

Q11) a) Discuss the process principles involved in elution chromatography and derive the retention equation. **[8]**

b) Discuss in brief the process principles and operational fundamentals involved in Ion Exchange separations. **[8]**

OR

Q12) Write Short notes on (Any Three) : **[16]**

a) Isoelectric Focusing.

b) Bioseparation.

c) Ultra and Nano filtration.

d) Biofiltration-Principles and applications.

e) Batch Adsorption.

Total No. of Questions : 6] **[Total No. of Pages : 2**

P1269

[3564]-332

B.E. (Petrochemical Engineering)

PETROLEUM EXPLORATION & PRODUCTION OPERATIONS

(Elective)

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

Instructions :

1) ***All questions are compulsory.***
2) ***Answers to the two sections should be written in separate answer books.***
3) ***Neat diagrams must be drawn wherever necessary.***

SECTION - I

Q1) Describe in brief the history of development of petroleum industry in India. What are the likely effects of financial crisis all over world on the development of petroleum industry in general. **[16]**

OR

a) Why oil and gas are preferred fuels? Comment on their availability and application areas in twenty first century. **[8]**

b) Give the 'Standard Geological Timescale' in a tabular form and the major events in each division. **[8]**

Q2) What are sedimentary rocks? How are they formed? Give a classification of sedimentary rocks. Why are they important to petroleum industry? **[16]**

OR

Write short notes on **any four** of the following: **[16]**

a) Calorific value of hydrocarbon fuels.

b) Geophysical Exploration.

c) High sulfur crudes.

d) Migration of oil and gas.

e) Types of reservoir traps.

f) Rock cycle.

Q3) Describe reflection seismic method of exploration for oil in brief with the help of neat sketches. **[18]**

P.T.O.

OR

Write notes on **any three** of the following: **[18]**

a) Physical properties of crude oil.

b) Origin of hydrocarbons.

c) Migration of hydrocarbons.

d) Geochemistry in petroleum exploration.

SECTION - II

Q4) With the help of neat figures show various systems of a typical oil well drilling rig and explain. **[16]**

OR

a) What are well logs? How are they recorded? How are they useful in locating hydrocarbons? **[6]**

b) Explain important **[10]**

i) surface or

ii) subsurface production equipment.

Q5) Write notes on **any two** of the following: **[16]**

a) Impact of petroleum industry on global environment.

b) Nonconventional petroleum resources.

c) Hydrocarbon potential of India.

d) Carbon credits.

Q6) Write notes on **any three** of the following: **[18]**

a) Borehole environment.

b) Drilling bit.

c) Functions of drilling fluids.

d) Importance and types of casings.

e) Types of inclined wells and tools used to deviate trajectory.

f) Enhanced Oil Recovery.

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Total No. of Questions : 8] **[Total No. of Pages : 2**

P1295

[3564]-328
B.E. (Petrochemical)
NATURAL GAS TECHNOLOGY
(2003 Course)

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 books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.***

SECTION - I

Q1) a) Elaborate on 'Associated and Nonassociated Gas'. **[5]**

b) Write a note on 'Origin of components of natural gas'. **[5]**

c) With the help of diagrams, describe basic methods for production of gas from hydrate deposits. **[8]**

Q2) a) Give Indian scenario of natural gas with respect to production and utilization. **[6]**

b) Give the typical compositions of a dry gas and a wet gas or a condensate gas. **[4]**

c) Discuss the measurements taken during sampling of natural gas. **[6]**

Q3) a) Elaborate on 'Hydrate Structures'. (Diagrams are not necessary.) **[6]**

b) With the help of phase diagram, explain retrograde condensation of natural gas. **[6]**

c) Draw phase diagrams of a dry gas and a wet gas showing conditions in the reservoir as well as at the surface and describe the same in brief. **[4]**

Q4) Write short notes on following (Any 4): **[16]**

a) Sweet and sour natural gas.

b) Compressibility of a dry gas.

c) Hydrate Formation.

d) Surface and interfacial tension.

e) Coal bed methane.

f) Hydrate prevention.

P.T.O.

SECTION - II

Q5) a) Enlist the four major parts of a gas/liquid separator and describe the vertical separator in detail. (Diagram is necessary.) **[10]**

b) Write a note on 'Adsorbents for Dehydration of Natural Gas'. **[6]**

c) What do you mean by 'Natural Gas Liquids'? **[2]**

Q6) a) Enlist the different components of natural gas pipeline and discuss the safety precautions associated with the same. **[10]**

b) Elaborate on 'Preparation of feed gas to LNG plant'. **[6]**

Q7) a) Elaborate on 'Existing LNG Terminals in India'. **[8]**

b) Give the significance of natural gas storage and explain the cryogenic storage method in detail. **[8]**

Q8) Write short notes on following (Any 4): **[16]**

a) Heat exchangers and compressors in LNG liquefaction plant.

b) LNG Importers.

c) Corrosion protection for natural gas pipeline.

d) Chemical conversion of natural gas.

e) Proposed LNG terminals in India.

f) Natural gas dehydration by gas permeation.

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Total No. of Questions : 8] **[Total No. of Pages : 2**

P1315

[3564] - 327

B.E. (Petrochemical)

REFINERY PROCESS DESIGN

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

Instructions to the candidates:

1) ***Answer any 3 questions from each section.***
2) ***Answers to the two sections should be written in separate books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of De Priester charts, electronic pocket calculator and steam tables is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) Feed to the condenser of a multi component distillation column is saturated vapor of the following composition : C_2H_4 20%, C_2H_6 20%, C_3H_8 40%, C_4H_{10} 20%. Calculate the operating pressure of the condenser if the vapours are to be totally condensed at 27°C. Also calculate the temperature of the condenser feed at this pressure. **[16]**

Q2) a) Differentiate between adiabatic and isothermal flash. **[4]**

b) Overhead vapor from a fractionating column has the following composition : Ethane 15%, Propane 20%, Isobutane 60%, n-Butane 5%. It is desired to condense 75% of this vapor at the condenser temperature of 30°C. What pressure is required? Also report the compositions of vapor and liquid streams leaving the condenser. **[12]**

Q3) a) Discusss important steps involved in atmospheric distillation column design based on Packie's method. **[8]**

b) Discuss important steps involved in the design of multicomponent distillation column using Fenske-Underwood-Gillitand method. **[8]**

Q4) Write notes : **[18]**

a) Importance of overflash.
b) Flash zone calculations to determine coil outlet temperature.
c) Pumpback Vs Pumparound reflux.
d) Products of ATU and their boiling ranges.
e) Pressure profiles of ATU and VDU.

P.T.O.

SECTION - II

Q5) Discuss the difference between Rating and Design of a shell and Tube Heat Exchanger. State the important steps involved in rating of an existing heat exchanger for a specified duty. Base your answer on Kern's methodology. **[16]**

Q6) Elaborate in detail the Lobo and Evan's method used in design of refinery furnaces. **[16]**

Q7) a) Write a note on importance of flooding curves in design and operation of packed columns. **[6]**

b) Hydrocarbon feed gas of following description is fed to an existing five tray absorber so as to remove butane and heavier components. Butane recovery is specified at 85%.

Estimate the liquid-to-gas ratio needed for this operation. Also report the exit gas composition. **[10]**

Component	Feed mol%	K for solvent used
Methane	70	74.0
Ethane	12	12.0
Propane	8	3.5
Butane	6	0.8
Pentane	6	0.2
C_6 plus	2	0.1

Q8) Write notes: **[18]**

a) Types of refinery furnaces.

b) Optimum utility calculations using Pinch Analysis.

c) Optimum L/V or L/G ratio in vapor-liquid or gas-liquid columns.

Total No. of Questions : 8] **[Total No. of Pages : 2**

P1314

[3564]-323
B.E. (Petrochemical Engineering)
PROCESS DYNAMICS AND CONTROL
(2003 Course)

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 books.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam table is allowed.***
6) ***Assume suitable data, if necessary.***

SECTION - I

Q1) a) What are the elements of a control system - explain all of them briefly? **[6]**

b) Discuss the objectives of process control and highlight its benefits. **[6]**

c) Define first order system and provide three examples of it. **[4]**

Q2) a) Discuss the dynamics of two interacting tanks placed in series. **[8]**

b) Define followings with help of neat diagram: **[8]**

Overshoot, Decay Ratio, Response Time, Under-damped response.

Q3) a) Discuss the effects of K_c, τ_I and τ_D on closed loop response of a PID controlled process. **[6]**

b) With help of neat diagram highlight strengths and weaknesses of feedback control system. **[6]**

c) Why do you think a system with inverse response is difficult to control? **[4]**

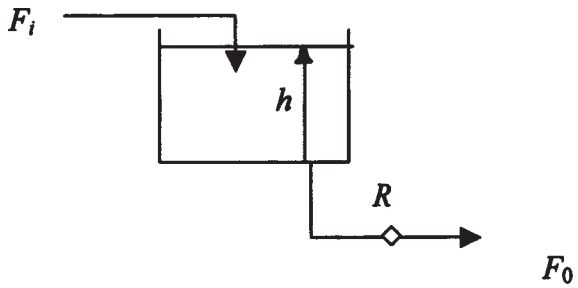
Q4) a) Solve following differential equations with help of Laplace transform. **[12]**

i) $\frac{d^2y}{dt^2}+3\frac{dy}{dt}-y-5t=0$ with y'(0) = 0 and y(0) = 2.

ii) $\frac{d^2y}{dt^2}=2$ with y'(0) = y(0) = 0.

P.T.O.

b) For the figure given below, volumetric flow rate is F_i and outlet flowrate is F_0. At outlet there is a resistance to flow in form of a valve. Considering F_0 is related linearly to hydrostatic pressure of liquid level h, through the resistance R by $F_0 = \frac{h}{R}$. Obtain the transfer function of the process. **[6]**



SECTION - II

Q5) a) With help of neat diagram explain feed forward and feed back control loops and differentiate between them. **[6]**

b) Define cascade control and explain it with help of suitable example. **[6]**

c) Write a short note on applications of split range control action. **[4]**

Q6) a) What is meant by controller tuning? **[4]**

b) Can you design a controller that minimizes overshoot and settling time simultaneously? Explain. **[4]**

c) With help of suitable example explain liberalization. **[4]**

d) When a system is to be termed stable? Explain briefly. **[4]**

Q7) a) Define poles and zeros of transfer functions and indicate significances. **[4]**

b) Draw Bode-plot for a 1st order system. **[6]**

c) Define Gain and Phase Margins. How do they affect tuning of a controller? **[6]**

Q8) a) Consider a second order process having following transfer function : **[10]**

$$G(s) = \frac{1}{s^2 + 2s + 2}$$

Comment on stability of the system.

If the system is now connected with a PI controller having $K_c = 100$ and $\tau_1 = 0.1$, check the stability of the system.

b) What are the applications of Z-transform in process control? **[4]**

c) Write a short note on Programmable Logic Control (PLC). **[4]**

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Total No. of Questions : 6] **[Total No. of Pages : 4**

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B.E. (Petroleum Engineering)

PETROLEUM ECONOMICS

(2003 Course)

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

Instructions :

1) ***Solve any two questions from Section-I and Section-II.***
2) ***Answers to the two sections should be written in separate answer books.***
3) ***Use graph paper and semi log graph paper wherever necessary.***
4) ***Assume additional data, if required.***

SECTION - I

Q1) a) Following is the production history of a field, which is under consideration for redevelopment. The initial recovery of 20% is expected to increase up to 30% after redevelopment. Draw the production profile and by using same decline, calculate the time taken to reach desired recovery rate. What may be the breakeven price if an amount of 125 million dollars is used for redevelopment? How much is the OOIP? **[9]**

Year	Oil Production / year MMbbl	CAPEX $MM	OPEX $MM
1		150	
2		130	
3	2.432		9.728
4	1.749		6.996
5	1.438		5.752
6	1.321		5.284
7	1.189		4.756
8	1.174		4.696
9	0.985		3.94
10	0.912		3.648
11	0.818		3.272
12	0.741		2.964
	12.759	280	51.036

Table 1 : for Q.1 and also for Q.6

P.T.O.

b) Write notes on **any two** of the following : **[16]**

i) Decline curves in the calculation of reserves of hydrocarbons.

ii) Errors in calculation of reserves.

iii) Hubert curve.

Q2) a) Prepare a forecast of future oil prices using following equation for the next eight years with the first year price determined on the basis of the market price of a designated marker crude and escalated at the rate of 2% per year. **[5]**

Oil Price = (marker crude oil price @ 0° API) + 0.19 (°API) – 0.77 (% sulfur)

Given,

i) Current Market Price of Marker Crude (40° API) = $ 45.00.

ii) Current Market Price of Marker Crude (0° API) = $ 21.00.

iii) Quality of oil to be produced.

Gravity = 36°

Sulfur = 1.0%

b) Write notes on **any two** of the following : **[20]**

i) Marketing and trading of crude oil.

ii) Crude oil pricing mechanism and factors controlling oil price.

iii) Reserves auditing.

iv) Gas Economy.

Q3) a) An investment of $ 25,000 for a new sucker rod string is estimated to generate a cash flow of $ 10,000, $ 8,000, $ 6,000, $ 5,000, $ 4,250, $ 6,000 and $ 5,000 over the tenure of the project. What is the DCFROR for the cash flow generated? **[10]**

OR

Operating costs are estimated to be $ 200,000 per year, which will remain constant during the life span of a project, i.e. 10 years. A capital investment of $ 1 MM is anticipated for year one and an additional investment of $ 100,000 in seventh year. Inflation is forecast to be 7% for first half of the project and then drop to 6% for the remaining period. Prepare a cash flow diagram and calculate the PV of the cash flow.

b) Explain, how can sensitivity analysis help in handling uncertainty. **[10]**

c) Explain with the help of cumulative cash flow diagram, various parameters used in the mathematical methods for Profitability Evaluation. **[5]**

SECTION - II

Q4) a) A choice must be made between three alternatives, to drill, drop acreage and farm out on an expiring lease. Following conditions exist: **[15]**

Sr. No.	Description	Value
1	Discovery	30 %
2	Dry hole cost	$ 750,000
3	Completion cost	$ 500,000
4	Surface facilities	$ 50,000
5	Lease cost	$ 200,000

If this lease is dropped, a tax credit of $ 50,000 is available.

Farm out is available on 25% WI with the condition that the farmer will pay a maximum of $ 125,000 for surface facilities.

Two situations are possible in case of discovery:

Description	Probability	Value
Commercial well	0.8	$ 10 MM
Marginal Well	0.2	$ 3 MM

This is excluding drilling, completion and facilities.

Construct a suitable decision tree and give decision on maximizing EMV with proper justification.

b) Write a detailed account on Petroleum Accounting system. **[10]**

Q5) a) Initial cost of the completely installed reactor is $ 90,000 and its salvage value towards the completion of useful life is $ 12,000. Service life of the reactor is 6 years. Calculate its depreciation using Straight Line (SLD), Declining Balance (DBD) and Double Declining Balance (DDB) methods. Prepare a plot of book value against number of years and compare the results obtained with different methods. **[10]**

OR

Conduct a critical path study to develop a medium size field reserve in an offshore area based on following:

Facts: The field has been delineated satisfactorily. All resources that are needed will be available.

i) Thirty development wells ($ 10 MM each)-One third will be injectors.
ii) Three platforms-two for wells, the other for production / injection equipment and pipeline terminus. ($ 310 MM each).
iii) Wells take about one month to drill. Upto two rigs / platform.
iv) Platforms manufactured in one and a half years-tow out time one month during weather window in Summer. (Tow out costs $ 10 MM).

Setup time is three months for drilling / well platform, and five months for production platform.

v) Pipeline lay time is about 14 months (Cost $ 180 MM).

vi) Production "commissioning" and final permit take two months. ($ 5 MM).

vii) Overhead and other ongoing costs = $ 1 MM/Month.

Do the following:

i) Draw a critical path diagram for this project. Assume a starting date of Jan, 1, 2009.

ii) Determine the time length of the critical path. Identify this path on the diagram.

iii) Determine slack times for each activity.

iv) Plot cumulative costs as a function of time.

b) Write notes on **any two** of the following: **[15]**

i) Depreciation and depletion,

ii) Reserves to Production Ratio,

iii) Decision analysis in petroleum exploration,

iv) Fiscal parameters and field size.

Q6) a) Use production data given in Table 1 for this calculation. Following are the assumptions for the analysis: **[20]**

i) Oil price is $ 50 and is constant.

ii) Royalty is 10% on annual production, which has to deducted from gross revenue.

iii) Rate of return is 10%.

iv) Cost recovery is 70% and is allowed to deduce with the commencement of commercial production. The unrecovered cost is allowed to carry forward to next year.

v) Profit petroleum is to shared between government and contractor @ 60% and 40% respectively.

vi) Contractor is entitled to pay 30% income tax on profit.

Prepare a tabular form giving details of cumulative production, gross cash flow, royalty, net cash flow, cost recovery, recovered cost, profit petroleum, government share and contractor share, NPV for contractor BFIT and AFIT. How is one barrel distributed?

b) Write a short note on: **[5]**

Production sharing contract in India.

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