1(a) Define diffusive flux and convective flux of mass transfer. Show that the molar diffusive and convective fluxes are related as

\[ N_i = x_i \sum N_i + J_i \]

Hence show that \( \sum J_i = 0 \)

1(b) At one point in an absorption column the bulk compositions were found to be \( x_A = 0.0 \) and \( y_A = 0.08 \). The corresponding interfacial compositions estimated to be \( x_{AI} = 0.025 \) and \( y_{AI} = 0.04 \). If the overall mass transfer coefficient for the liquid phase is 50 kmol/m²·h·(mole fraction), determine the percentage resistance to mass transfer for gas phase. Assume that the equilibrium relationship for the gas and liquid phases can be described by Henry’s law.

OR

1′(a) Obtain the following relation between the overall gas phase mass transfer coefficient and individual liquid and gas phase mass transfer coefficient

\[ \frac{1}{K_y} = \frac{1}{k_y} + \frac{m'}{k_x} \]

Hence explain the gas phase controlling mass transfer operations.

1′(b) Solute \( A \) is diffusing at unsteady state into a semi-infinite medium of pure \( B \) and undergoes a first-order reaction with \( B \) (reaction rate constant \( k_1 = 1 \times 10^{-5} \text{s}^{-1} \)). Solute

Contd.....2.
$A$ is dilute with an interfacial concentration of $1.0$ kmol/m$^3$. The diffusivity of $A$ in $B$ is $D_{AB} = 1 \times 10^{-9}$ m$^2$/s. Calculate the concentration of $A$ at the point $5$ mm away from the interface and rate of mass transfer at interface after $1$ h of contact of $A$ and $B$. The value of error function is given in the following table.

<table>
<thead>
<tr>
<th>$x$</th>
<th>0.1</th>
<th>0.2</th>
<th>1.0</th>
<th>1.1</th>
<th>1.2</th>
<th>1.3</th>
<th>1.4</th>
<th>1.5</th>
<th>1.6</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{erf}(x)$</td>
<td>0.112</td>
<td>0.222</td>
<td>0.842</td>
<td>0.880</td>
<td>0.910</td>
<td>0.934</td>
<td>0.952</td>
<td>0.966</td>
<td>0.976</td>
</tr>
</tbody>
</table>

2(a) Define the term absorption factor and discuss its physical significance in gas absorption operations.

2(b) Ninety five percent of the acetone vapor in an 85 vol% air stream is to be absorbed by a countercurrent contact with pure water in a valve-tray column with an overall tray efficiency of 50%. The column will operate essentially at 20 °C 101 kPa pressure. Equilibrium data for acetone-water at these conditions are:

<table>
<thead>
<tr>
<th>Mole percent acetone in water</th>
<th>3.30</th>
<th>7.20</th>
<th>11.70</th>
<th>17.10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone partial pressure in air, mm Hg</td>
<td>30.00</td>
<td>62.80</td>
<td>85.40</td>
<td>103.00</td>
</tr>
</tbody>
</table>

Calculate:

(i) Minimum value of $L_s / G_s$

(ii) The number of equilibrium stages required using a water flow rate 1.25 times the minimum

(iii) The concentration of acetone in the exit water

OR

2 (b') Solute $A$ is to be stripped from a liquid stream by contacting with a pure gas. The liquid enters the tower at an $A$-free rate of 2.5 kmol/s and contains $30$ mol% $A$. The gas enters the column counter currently at a rate equals to 1.5 times the minimum. Determine the number of theoretical stages required to reduce the concentration of $A$ in the exiting liquid to $1.0$ mol%. The distribution of $A$ in the gas and liquid is expressed by $y_A = 0.4x_A$.

3(a) Define the terms absolute humidity, relative humidity, and dew point of an unsaturated vapor-gas mixture used in humidification operation.

3(b) A mixture of nitrogen and acetone vapor at 800 mmHg total pressure, 25 °C, has a
percentage saturation of 80%. Calculate (a) the absolute molal humidity, (b) the absolute humidity, (c) the partial pressure of acetone, (d) the relative humidity, and (e) the dew point. The vapor pressure of acetone in mmHg at any temperature in °C is given by

$$\log p^* = 7.02447 - \frac{1161.0}{t+224}$$

OR

3(b') A horizontal spray chamber with re-circulated water is used for adiabatic humidification and cooling of air. The active part of the chamber is 2 m long and has cross section of 2 m². With an air flow rate 3.5 m³/s at dry bulb temperature 65 °C and humidity 0.017 kg water/kg dry air, the air is cooled and humidified to a dry bulb temperature 42 °C. If a duplicate spray chamber operates in the same manner were to be added in series with the existing chamber, what outlet conditions could be expected for the air?

4(a) Define the following types of the moistures used in the drying operation and show them on an equilibrium diagram
(a) Equilibrium and free moisture
(b) Bound and unbound moisture

4(b) Describe briefly the nucleation and crystal growth processes in the formation of a crystal.

Contd....4.
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
CHEMICAL ENGINEERING
TRANSPORT PHENOMENA
CH323/PK323

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Assume suitable data if missing.
Notations used have their usual meaning.

<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Glycerine at 26 °C is flowing through a horizontal tube 1 ft long and with 0.1 inch inside diameter. For a pressure drop of $2.76 \times 10^6$ dyne/cm², the volumetric flow rate $Q$ is 0.00398 ft³/min. The density of Glycerine at 26 °C is 1.261 g/cm³. From the flow data, find the viscosity of Glycerine in centipoise and PaS. Check whether the flow is laminar and also find the entrance length. Derive the expression used.</td>
<td>10</td>
</tr>
<tr>
<td>OR</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1'(a) | i. The flow field is given by: $\mathbf{V} = 2x \mathbf{i} + 3y \mathbf{j} + z \mathbf{k}$, $\rho = \rho_0 x^2 e^{-t}$. What is the rate of density noticed by an observer moving along with the particle at (1,1,1) at time $t = 2$ s. [2] 
ii. In a gas absorption experiment a viscous fluid flows upward through a small circular tube and then downward in laminar flow outside the tube (figure on next page). Flow is taking place under the action of gravity only. Obtain the velocity distribution in the falling film. Write down the assumptions made in the derivation and also show the balances pictorially on the elemental volume. [8] |      |

Contd.....2.
1(b) Distinguish between the operators $\frac{\partial}{\partial t}$, $\frac{d}{dt}$, $D/Dt$ and write their significance. There are two parallel plates some distance apart. Between the plates, water is used at $24^\circ$C. The lower plate is pulled at a constant velocity, 0.4 m/s faster relative to the top plate. How far apart should the two plates be placed so that the shear stress, $\tau$ is 0.3 N/m$^2$. Also calculate the shear rate.

Given: Viscosity of water, $\mu = 0.9142$ CP

2(a) Liquefied gases are sometimes stored in well insulated spherical containers vented to the atmosphere. Develop an expression for the steady-state heat transfer rate through the walls of such a container, with the radii of the inner and outer walls being $r_0$ and $r_1$, resp. and the temperatures at the inner and outer walls being $T_0$ and $T_1$. Assume that the thermal conductivity of the insulation varies linearly with temperature according to the relation:

$$k = k_0 + (k_1 - k_0)\left(\frac{T - T_0}{T_1 - T_0}\right)$$

OR


Contd.....3.
2(a') A spherical vessel of radius $R_i$ meters is insulated from outside such that the outside surface of the insulated vessel has the radius $R_0$. The temperature of the inside and outside surface of the insulation are $T_i$ and $T_0$ respectively. The ambient temperature is $T_a$, the convective heat transfer coefficient outside the insulation is $h_a$ and the thermal conductivity of the insulating material is $'k'$. Determine the outer radius of the insulation for which the rate of heat transfer will be maximum.

Derive the expression used and state the assumptions made.

2(b) A heated sphere of radius ‘R’ is suspended in a large, motionless body of fluid (figure below). It is desired to study the heat conduction in the fluid surrounding the sphere. It is assumed that free convection effects are negligible

i) Obtain the temperature profile using boundary conditions:
   
   BC1 : at $r=R$, $T=T_R$
   
   BC2 : at $r=\infty$, $T=T_\infty$

ii) Develop an expression for the heat flux at the surface. Equate this result to the heat flux given by "Newton's Law of Cooling" and show that dimensionless heat transfer coefficient (known as the Nusselt Number) is given by

   \[ Nu = \frac{hD}{k} = 2 \]

Where 'D' is the diameter of the sphere.

3(a) A sphere of naphthalene of radius 2 mm is suspended in a large volume of still air at 318 K and 1 atmospheric pressure. The surface temperature of naphthalene can be assumed to be at 318 K. Its vapour pressure at 318 K is 0.555 mmHg. The diffusivity of naphthalene- air system at 318 K is $6.92 \times 10^{-6}$ m$^2$/s . Calculate the rate of evaporation of the naphthalene from the surface. Also, derive the equation used.

Given: $R = 8314$ m$^3$Pa/ kg mol K
3(b) Derive the expressions:

\[ \frac{\partial \rho_A}{\partial t} = -\nabla \cdot (\rho_A \nabla) + \nabla \left( \rho D_{AB} \nabla w_A \right) + r_A \]

\[ \frac{\partial c_A}{\partial t} = D_{AB} \nabla^2 c_A \]

OR

3'(b) A Polymerization reaction: \( nA \rightarrow A_n \), occurs instantaneously at the catalytic surface as shown in figure below:

\[ z = 0 \]

\[ z = \delta \]

Catalytic surface, where \( r_A \) takes place.

Product \( A_n \) diffuses back out through the gas film to the main turbulent gas stream.

i. Determine the Fick's Law relationship in terms of compound 'A'.

ii. Obtain the differential equation describing the concentration profile for component 'A'.

4(a) Write down the significance of macroscopic balance.

4(b) i. A cylindrical tank of radius 'R' and its drainpipe of length 'L' and diameter 'D' are completely filled with heavy oil as shown in figure below. At time \( t=0 \) the valve at the bottom of the drainpipe is opened. How long will it take to drain the tank if the flow in the drainpipe is laminar?

![Figure 4](image)

ii. A cylindrical tank of inside diameter 2 m and with a water level of 4 m is to be emptied by draining through drainpipe of length 4 m and diameter 5 cm. How long it will take to remove one-half of the contents? How long will it take to empty the tank?
### Question 1

1(a) Discuss any two of the following three categories of Natural Gas sources:

- i. Non-associated Gas
- ii. Associated Gas
- iii. Continuous/Unconventional Gas

1(a') Discuss the following mechanisms of formation of Natural Gas:

- i. Biogenic
- ii. Thermogenic

1(b) Discuss any three of the following properties of Natural Gas:

- i. Colour and odour
- ii. Composition and Calorific value
- iii. Flammability limits and autoignition temperature
- iv. Pollutants and contaminants

1(c) Find the density and formation volume factor (FVF) of a gas with the following properties:

\[ \gamma = 0.75, \quad H_2S = 5\%, \quad CO_2 = 8\%, \quad p = 2000 \text{ psia}, \quad T = 10^\circ C, \quad z = 0.78 \]

### Question 2

2(a) Discuss the following three principles of achieving physical separation of gas and liquids:

- i. Momentum
- ii. Gravity settling
- iii. Coalescing

---

*Contd.....2.*
2(b) With the help of diagrams discuss the following separation equipment:
   i. Slug catchers
   ii. Liquid-liquid coalescer

2(e) Discuss the applications of Liquid/Gas coalescer.

   OR

2(c') Discuss the applications of Liquid/Liquid coalescer.

3(a) What are gas hydrates? How is it affected by presence of Nitrogen, CO₂ and H₂S

3(b) What is absorption dehydration? What are the desirable properties of a dehydrating agent?

3(c) Describe Glycol dehydration process using block diagram along with its significant features.

   OR

3(c') Describe Adsorption dehydration process using block diagram along with its significant features. Give the name of atleast four commercially available adsorbents.

4(a) Outline the sweetening processes of natural gas. List down the various processing constraints for selection of a sweetening process.

4(b) What is the relative reactivity order of mono, di and tri ethanol amines (MEA, DEA and TEA)? Describe the process flow diagram of a typical Amine process for gas treatment.

   OR

4(b') Describe Iron Sponge process of gas treatment using block diagram along with its significant features.

4(c) Write a short note on any two of the followings-
   i. Natural Gas Liquid (NGL) processing
   ii. Transportation by Marine CNG
   iii. Depleted gas/oil reservoirs for storage of Natural Gas
Q No 1

(a) What is the significance of atmospheric and vacuum distillation unit in any typical refinery configuration? 5.0

(b) What is the need of various types of average boiling point? Explain with suitable example. 5.0

(c) Convert the TBP curve of crude oil, given in figure 1, into ASTM curve. Conversion equations are given below; 5.0

\[ Y_{\text{ASTM slop}} = 0.8334 X_{\text{TBP slop}} - 0.0452 - - - - - - - - - - - - - 1 \]

\[ \text{ASTM}_{T50} = 1.05 \times \text{TBP}_{T50} - - - - - - - - - - - - - - 2 \]

OR

(c') Find out the Gap for the D1-D2 & D2-D3 only. All the details are given below. Crude oil curve is given as figure 1;

<table>
<thead>
<tr>
<th>Separation Di-Di+1</th>
<th>No of trys (N)</th>
<th>Reflux (R)</th>
<th>Cut Name</th>
<th>Cut Range, Di+1 (Vol%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4-D5</td>
<td>8</td>
<td>4</td>
<td>D5</td>
<td>0-10</td>
</tr>
<tr>
<td>D3-D4</td>
<td>8</td>
<td>3</td>
<td>D4</td>
<td>10-16</td>
</tr>
<tr>
<td>D2-D3</td>
<td>6</td>
<td>1</td>
<td>D3</td>
<td>16-28</td>
</tr>
<tr>
<td>D1-D2</td>
<td>6</td>
<td>7</td>
<td>D2</td>
<td>28-40</td>
</tr>
<tr>
<td>W-D1</td>
<td>3</td>
<td>-</td>
<td>D1</td>
<td>40-50</td>
</tr>
</tbody>
</table>

Conversion for TBP in to ASTM is given below;

\[ \text{ASTM}_{T50} = 1.05 \times \text{TBP}_{T50} \]
Q No 2
(a) What do you understand about overflash? Why it is necessary in atmospheric distillation column? OR

(a’) What do you mean by Gap (5-95)? Discuss its significance also.

(b) What are the various refluxes for atmospheric tower? Explain with neat sketch OR

(b’) Describe following terminology with the help of neat sketch.
- TBP cut volume
- TBP cut point
- TBP overlap

(c) Find out the yield of distillates produced from atmospheric distillation column with the help of following parameters. TBP data of the crude oil is given in figure 1.

<table>
<thead>
<tr>
<th>Product</th>
<th>ASTM End Point, °F</th>
<th>Gap, ASTM (5-95) °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Light Naphtha (LN)</td>
<td>275</td>
<td>-</td>
</tr>
<tr>
<td>Heavy Naphtha (HN)</td>
<td>380</td>
<td>+25</td>
</tr>
<tr>
<td>Light Distillate (LD)</td>
<td>560</td>
<td>+35</td>
</tr>
<tr>
<td>Heavy Distillate (HD)</td>
<td>650</td>
<td>+15</td>
</tr>
</tbody>
</table>

Equation used for converting TBP into ASTM is given as:

\[ TBP_{FBP} = 1.04 \times ASTM_{FBP} + 4 \]

Q No 3
(a) Discuss the Vacuum Distillation products with reference to metal content and carbon residue. OR

(b) Discuss the significance of steam in vacuum distillation tower? How it can be optimized? Also derive steam requirement in the vacuum distillation tower.

OR

(b’) Write down energy balance expression for fuel type operation with neat sketch.

(c) It is planned to design lube-asphalt type vacuum distillation tower with following product specifications. Calculate the products range & yields on vacuum feed basis.
- Range of Vacuum tower feed is 53-100 volume% on whole crude basis.
- Asphalt with 90 penetration @ 77°F
- Heavy lube cut mid volume viscosity of 800 SSU @ 100°F and yield on whole crude of 6.0 volume %.
- Light lube cut mid volume viscosity of 150 SSU @ 100°F and yield on whole crude of 4.0 volume %.

Contd…..3.
Q No 4

(a) What are the important sections of the fired heaters? How heat transfer can be enhanced in these sections?

(b) Describe any two types of furnaces with neat sketch.
   - Vertical cylindrical furnace
   - Box type furnace with vertical tubes
   - Cabin furnace with horizontal tubes
   - Radiant wall furnace

(c) Why draft is required in furnaces. Explain the types of draft used in furnaces with neat sketch.

OR

(c') Discuss the important considerations for designing the radiant section of fired heaters.
Figure - Fractionation between adjacent side-stream products, atmospheric crude tower, level with permission of American Institute of Chemical Engineers.)
Figure. Relationships between TBP (100-) overlap and ASTM (5-98) gap—typical atmospheric tower streams.

Figure. Crude assay data. Asphalt yield versus penetration.
Figure Crude assay data, viscosities of vacuum gas oils.
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
HETEROGENEOUS REACTION ENGINEERING
PK-341A

Maximum Marks: 60  Credits: 04  Duration: Three Hours

Answer all the questions.
Use of calculator is allowed.

Q.No.  Question  M.M.
1(a).  What are the main components of a solid catalyst and briefly explain their  [06]
function.

1(b).  Answer any one of the following:  [05]
(i) Describe these terms relevant to solid catalyst: turn-over frequency and
    dispersion. In the selection of active agent, why so much interest on
    thermodynamic characteristics of adsorption?
(ii) Write the basic unit operations involved in preparation of solid catalyst and
     describe the sol-gel method.

1(c).  Why the characterization of the solid catalyst is necessary? Name any three
        characterization techniques and their purpose.  [04]

2(a).  Differentiate the Langmuir-Hinshelwood and Eley-Rideal mechanism for surface
        reaction over the solid catalyst.  [04]

2(b).  Benzene (B) and methane (M) were produced from hydrodemethylation of
        toluene (T) [i.e., \( H_2 + T \leftrightarrow B + M \)] using a solid mineral catalyst, and the reaction
        mechanism was found to be as follows:

        \[ T(g) + S \underset{k_{-a}}{\overset{k_a}{\rightleftharpoons}} T.S \]

        \[ H_2(g) + T.S \underset{k_{-s}}{\overset{k_s}{\rightarrow}} B.S + M(g) \]

        Contd.....2.
\[ B.S \xleftarrow{\frac{k_d}{k_{-d}}} B(g) + S \]

Identify the various steps. Assume the surface reaction step is the rate limiting step and derive the rate expression for this mechanism. The values of overall rate constant (k), adsorption constants \( K_T \) and \( K_B \) were \( 1.45 \times 10^{-8} \text{ mol. (g cat)}^{-1} \text{ s}^{-1} \text{ atm}^{-2} \), 1.39, and 1.038, respectively. Calculate the ratio of sites occupied by toluene to the sites occupied by benzene at 40% conversion of toluene.

OR

2(b'). Benzene (B) and methane (M) were produced from hydrodemethylation of toluene (T) [i.e., \( H_2 + T \leftrightarrow B + M \)] using a solid mineral catalyst. Deduce a plausible rate law from the experimental data obtained from a differential reactor as shown below:

<table>
<thead>
<tr>
<th>Run</th>
<th>( r_T \times 10^{10} ) (g mol toluene/g cat.\cdot s)</th>
<th>Partial Pressure (atm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Toluene, ( P_T )</td>
<td>Hydrogen (H(_2)),(^*)</td>
</tr>
<tr>
<td>Set A</td>
<td>1</td>
<td>71.0</td>
</tr>
<tr>
<td>2</td>
<td>71.3</td>
<td>1</td>
</tr>
<tr>
<td>Set B</td>
<td>3</td>
<td>41.6</td>
</tr>
<tr>
<td>4</td>
<td>19.7</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>42.0</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>17.1</td>
<td>1</td>
</tr>
<tr>
<td>Set C</td>
<td>7</td>
<td>71.8</td>
</tr>
<tr>
<td>8</td>
<td>142.0</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>284.0</td>
<td>1</td>
</tr>
<tr>
<td>Set D</td>
<td>10</td>
<td>47.0</td>
</tr>
<tr>
<td>11</td>
<td>71.3</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>117.5</td>
<td>1</td>
</tr>
<tr>
<td>13</td>
<td>127.0</td>
<td>1</td>
</tr>
<tr>
<td>14</td>
<td>131.0</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>133.0</td>
<td>20</td>
</tr>
<tr>
<td>16</td>
<td>41.8</td>
<td>1</td>
</tr>
</tbody>
</table>

\(^*\)\( P_H = P_{H_2} \).

2(c). What is catalyst deactivation? The first-order isomerisation, \( A \rightarrow B \), is being carried out isothermally in a batch reactor on a catalyst that is decaying as a result
of ageing. Derive an equation for conversion as a function of time.
Given: activity of the catalyst: \( a(t) = \frac{1}{1 + k_d t} \)

3(a). Define and discuss the significance of any two of the following: [03]
(i) Thiele modulus (\( \Phi \))
(ii) Internal effectiveness factor (\( \eta \))
(iii) Overall effectiveness factor (\( \Omega \))

3(b) The catalyst regeneration process to reactivate the catalyst by burning off the carbon can be described by shrinking core model. Explain the model with suitable diagram and derive the expression for molar flux of \( O_2 \) to the gas-carbon interface (i.e., \( r = R \) where \( R \) is the distance of gas-carbon interface from the centre of the catalyst pellet) for a porous catalyst of radius \( R_0 \). [07]

3(c) Often flux to or from the outer surface of the catalyst is written in terms of an effective transport coefficient \( k_{eff} = \frac{k_c k_r}{k_c + k_r} \) where \( k_c \) is mass transfer coefficient and \( k_r \) is surface reaction rate constant. Suppose the overall kinetics of a reaction is controlled by external mass transfer of the reactants from the bulk fluid to the surface of the catalyst. What are the important variables which can affect \( k_c \) and consequently control the reaction rate? [Hint: Relation between Sherwood and Schmidt number] [05]

OR

3(c'). The first-order reaction \( A \rightarrow B \) was carried out over two different-sized pellets. [05]
The pellets were contained in the spinning basket reactor that was operated at sufficiently high rotation speeds such that the external mass transfer resistance was negligible. The results of two experimental runs made under identical conditions are given in Table below. Estimate the Thiele modulus (\( \Phi \)) and internal effectiveness factor (\( \eta \)) for each pellet and explain the results by comparing values. [Given for 1st order reaction: \( \eta \Phi_1^2 = 3(\Phi_1 \coth \Phi_1 - 1) \)]

Contd.....4.
<table>
<thead>
<tr>
<th></th>
<th>Measured Rate (obs) (mol/g cat · s) × 10^5</th>
<th>Pellet Radius (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>3.0</td>
<td>0.01</td>
</tr>
<tr>
<td>Run 2</td>
<td>15.0</td>
<td>0.001</td>
</tr>
</tbody>
</table>

4(a). Answer any one of the following:

(i) Usefulness of RTD function (i.e., E(t))

(ii) Limitations of pulse or step experiment

4(b). Derive the expression of E(t) for pulse input in a laminar flow reactor (LFR). In the absence of dispersion across the boundaries and for constant volumetric flow rate, prove 'Mean Residence Time t_m' is equal to space time (τ).

OR

4(b'). E(t) and F(t) functions for a pulse-input (tracer) in CSTR and PFR for the following cases: perfect operation (P), bypassing (BP), and dead volume (DV).

4(c). Differentiate between the segregation and maximum mixedness model. Derive the equation for first-order reaction using the segregation model when the RTD is equivalent to an ideal CSTR.
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
PETROCHEMICAL TECHNOLOGY - I
PK 342

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer all the questions. Assume suitable data if missing. All questions, and parts thereof, be started on a fresh page of the answer book(s).

Q.No. Question M.M.

1. Describe, in detail, the process of steam cracking of hydrocarbons for the preparation of olefins as petrochemical feedstock. Also discuss the changes to be made in feed selection and/or process conditions if the production of BTX is also desired, along with the role of water/steam with the feed. [15]

OR

1.' (a) Discuss the history and growth of Petrochemical industry in India. [08]

1.' (b) Describe, in detail, the uses of petrochemicals in our daily life. [07]

2. (a) Describe the manufacture of synthesis gas with the help of a process flow sheet with reference to chemical reactions involved. Also mention major petrochemical derivatives of synthesis gas. [07]

2. (b) Discuss, in detail, the main pathways of converting primary petrochemicals - \( \text{C}_1, \text{C}_2, \text{C}_3 \) and \( \text{C}_4 \) - to major end products, through intermediate petrochemicals. [08]

3. Discuss the manufacture of any TWO of the following, with reference to consumption pattern, reactions involved, process flowsheet and major engineering problems:
   (a) Methanol
   (b) Formaldehyde
   (c) Ethylene Oxide
   (d) Vinyl Chloride [15]

4. (a) Describe with the help of a process flowsheet the manufacture of acetone from isopropenol. [05]

4. (b) Describe and develop as suitable process flowsheet for the manufacture of Linear Alkyl Benzene (LAB). Discuss each step involved in detail, along with the catalyst(s) employed for the production of LAB. [10]

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2015-16
B.TECH. WINTER SEMESTER EXAMINATION
PETROCHEMICAL ENGINEERING
HEALTH, SAFETY AND ENVIRONMENT IN HYDROCARBON INDUSTRIES
PK-343

Maximum Marks: 60 Credits: 04 Duration: 3 Hour

Answer all the four questions.
Assume suitable data if missing.
Notations used have their usual meaning.

Q.No. Question
1. (a) Comment on the following statement:
"Failure in large plants is not due to size of equipment or use of high technology. Yet
in case of failure, the potential for loss is much greater"
(b) Discuss any one of the following:
i. major process hazards
ii. factors that determine the scale of hazards
(c) Discuss any two of the following in regards to fire in process plants:
i. pump fires
ii. flange fires
iii. storage tank fires
(d) Discuss any one of the following:
i. Extinguishment and control of fire using water
ii. Fire protection using foam
2. (a) Enumerate the types of explosion in process industries
(b) Explain Detonation and Deflagration processes.
(c) Explain any two of the following:
i. Vapour cloud explosions
ii. Boiling liquid expanding vapour explosions
iii. Dust explosions
(d) Describe any two of the following related to process plant explosions:
i. Explosion of aerosols
ii. Superheated liquid explosions
iii. Air system explosions

Contd.....2.
3. (a) Discuss on the modes of toxic exposure and their effects in general. [3]

(b) Discuss on the hygiene standards for exposure over a working lifetime and for emergency exposure. [4]

(c) In regards to carcinogens in process industries, discuss any two of the following: [4]
   i. Benzene
   ii. Vinyl chloride
   iii. Acrylonitrile

(d) Discuss on any two of the following industrial toxic gases [4]
   i. Chlorine
   ii. Hydrogen sulphide
   iii. Methyl isocyanate

4. (a) Discuss on the classification of air and water pollutants [6]

(b) Discuss on the effluent treatment on any one of the following industries: [3]
   i. Oil refinery
   ii. Food industry

(c) Discuss on control and treatment of air pollution in relation to any two of the following: [6]
   i. Control of SOx
   ii. Control of VOC and Hydrocarbons
   iii. Particulate matter Control