2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
(PETROCHEMICAL ENGINEERING)
REFINERY ENGINEERING CALCULATIONS
PK-413N
Credits: 04

Maximum Marks: 60
Duration: Three Hours.

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

Q No 1
(a) What do you understand by crude assay? Explain its significance in designing of distillation tower.

(b) Define Gas Modulus? Manufacture gas is used in a furnace as a fuel having Wobbe Number 27.5 and supply pressure of fuel is 6.0 Mbar. What will be the supply pressure if the manufactured gas has been replaced by natural gas having Wobbe Number 55.

(c) Why study of phase behavior of hydrocarbon is necessary? How phase behavior can be constructed with the help of k values.

OR

(c') What do you understand by retrograde phenomena? Explain with the help of neat sketch.

Q No 2
(a) Derive the following equation. Notation have their usual meaning.

\[ V' = (100 + L_2) - \left[ \frac{W}{1 - 5R} \right] \]

(b) 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>260</td>
<td>-</td>
</tr>
<tr>
<td>Heavy Naphtha (HN)</td>
<td>410</td>
<td>+25</td>
</tr>
<tr>
<td>Light Distillate (LD)</td>
<td>550</td>
<td>+35</td>
</tr>
<tr>
<td>Heavy Distillate (HD)</td>
<td>650</td>
<td>+15</td>
</tr>
</tbody>
</table>

(contd-2)
(b') Find out the Gap for the D1-D2 & D2-D3. Also Calculate the critical Gap of the above fractions, keeping other parameters constant.

<table>
<thead>
<tr>
<th>Separation</th>
<th>No of trays (N)</th>
<th>Reflux (R)</th>
<th>Cut Range, D1 (Vol%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>D4-D5</td>
<td>8</td>
<td>4</td>
<td>0-8</td>
</tr>
<tr>
<td>D3-D4</td>
<td>8</td>
<td>3</td>
<td>8-12</td>
</tr>
<tr>
<td>D2-D3</td>
<td>6</td>
<td>1</td>
<td>12-30</td>
</tr>
<tr>
<td>D1-D2</td>
<td>6</td>
<td>7</td>
<td>30-45</td>
</tr>
<tr>
<td>W-D1</td>
<td>3</td>
<td>-</td>
<td>45-51</td>
</tr>
</tbody>
</table>

Q No 3
(a) Compare the vacuum tower distillation operation with atmospheric distillation column.

(b') Discuss the residue mode operation in vacuum tower.

(b) Explain the economic consideration for vacuum distillation column

(c) It is planned to design lube-asphalt type vacuum distillation tower with following product specifications. Carry out the material balance (in lb/hr) around this column.

- Feedstock flow rate = 50,000 BPSD
- Range of vacuum tower feed is 50-100 volume% on whole crude basis.
- Asphalt with 70 penetration index @ 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 200 SSU @ 100°F and yield on whole crude of 4.0 volume %.

Q No 4
(a) Describe the different sections and their functions of the furnaces.

(b) Discuss the tubes/pipes used in furnaces for heating of process fluid.

(b') What are the steps in Lobo-Evans method?

(e) Explain different types of draft induced in the furnaces with neat sketch.
Figure 1: TBP curve of Crude Oil
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
PROCESS UTILITIES AND ENERGY MANAGEMENT
PK-422N

Maximum Marks: 60
Credits: 04
Duration: Three Hours

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

Q.No. Question M.M.

1(a) What is meant by the term Process Utility? List out various process utilities used in process industries. Discuss water as utility in the process industry [06]

OR

1(a') What is Refrigerant? Discuss the classification of refrigerant on the basis of Toxicity and Flammability? [05]

1(b) Discuss the classification of burners. Explain the working of twin fluid atomizer. What is the purpose of splitting primary air and secondary air in burner operation? [06]

1(c) Write chemical formula of R134a, R717, R616, R290, and R600a. Also mention the steps involved in deducing the formula? [03]

2(a) Discuss internal water treatment for boiler feed water. Also discuss the effective utilization of steam. [10]

2(b) What is the importance of steam trap? Discuss inverted bucket steam trap. Also mention the category in which it falls. [05]

OR

2(b') List out the advantages of condensate recovery. Why it is undesirable to use superheated steam for process heating? [05]

3(a) What do you understand by the term Energy Management? Discuss its significance. Discuss the two approaches that lead to the realization for the need of energy management. [10]

OR

Contd....2.
3(a') What is Energy Audit? Discuss the procedure for performing Energy Audit. [10]

3(b) Discuss Energy conservation in various pieces of process equipment. [5]

4 Explain the working of any three of the following: [15]
   i. Direct contact heat exchanger
   ii. Recuperator
   iii. Waste heat exchanger
   iv. Heat pipe
   v. Heat pump
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
STRUCTURE PROPERTY RELATIONSHIP
PK-42D

Maximum Marks: 60 Credits: 04 Duration: Three Hours

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

Q.No. Question M.M.

1(a) Differentiate between:
   a. Homopolymer and co-polymer.
   b. Thermoplastics and thermoset.
   c. Initiator and Chain transfer agent.
   d. Addition and step polymerization.

1(b) What do you mean by mechanical properties of polymers? Explain the following terms with their units in MKS system.
   (a). True stress,
   (b). Modulus of Elasticity,

OR

1' Differentiate between the stress-strain curve for metals and polymers. Also explain the effect of temperature, elongation and moisture on SSC of polymers.

2(a) Calculate the relaxation time for given Maxwell model. Also calculate the residual stresses in material after 10 seconds of loading. Initial stress developed due to constant strain loading is 100 MPa, (G = 15 GPa; v = 60 GPa).

2(b) Explain the phenomenon of stretching induced crystallization with the help of stress-strain curve of a polymer.

OR

2'(a) What do you mean by thermal properties of polymers? Explain the various transitions observed in polymers.

Cont'd
2*(b) Explain the basic principle of differential Scanning Calorimeter (DSC) with the help of a basic DSC plot. Also mention the name of parameters that can be determined with the help of DSC.

3. Give the expression for electrical field acting on an atom/molecule. Explain the phenomenon of and how electrical relaxation time it depends upon the radius of molecule and viscosity of system according to Debye?

4(a) What will happen to a dielectric (polymer) subjected to a varying electrical field? Differentiate between dielectric dissipation factor ($\tan \delta$) and dielectric loss factor ($\varepsilon''$).

4(b) What do you mean by chemical properties of polymer? Explain the Hansen solubility map and its application in formulation of polymer composition.
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
PETROCHEMICAL TECHNOLOGY II
PK-432

Maximum Marks: 69
Credits: 04
Duration: Three Hours

Answer all the questions.

Q.No. Question

1(a) Draw flow sheet for the production of phenol from toluene oxidation. Explain why phenol enters both bottom and top product.

OR

1(a') Draw flow sheet for the production of Maleic Anhydride and write down steps involved.

1(b) Answer the following questions:
(i) What is the basic advantage of emulsification during production of phenol from currents.
(ii) Explain how azeotropic distillation unit functions to convert wet benzene to dry benzene during production of styrene.
(iii) How do switch condensers assist in generating the crude maleic anhydride solid product?
(iv) In production of maleic anhydride explain how the usage of centrifuge is justified from process technology perspective.

2(a) Give chemical properties and uses of Acrylic Acid and UMT.

OR

2(a') Give reactions involved in AMCO process.

2(b) Give various routes for production of Terphthalic Acid or Methyl methacrylate.

2(c) Give flow sheet for the production of polyester from Purified Terphthalic Acid.

cont'd 2.
3(a) What are the various uses and properties of LDPE and HDPE. Discuss technological developments in the production of polyethylene from high pressure to low pressure processes and name any two types of catalyst which are used for the production of HDPE by low pressure processes.

3(b) What properties allow polypropylene to be used as an engineering plastics and why it is not suitable for high temperature moulding? Discuss the reaction mechanism and production of PVC with the help of suitable process flow sheet.

OR

3(b') Although polystyrene is an aromatic compound but it is used to make container for chemicals, Solvents and fluid, why? Draw a detailed process flow sheet for the production of polystyrene with its important uses.

4(a) What are the properties and uses of Epoxy resin? Write down the names of at least five types of synthetic rubber? Discuss various factors leading to Synthetic Rubber production.

OR

4(a') What is the effect of moulding temperature on the properties of Acrylonitrile Butadiene Styrene (ABS)? How Impact resistance of ABS can be amplified? Which polymer has the highest impact of any thermoplastic?

4(b) What features of Nylon make them good Fibre and which property makes Nylon thermo plastic so tough? Draw an integrated process flow sheet for the production of Nylon 6 by taking Hydroxylamine sulphate and cyclo hexane as feed stock.
1(a) Differentiate between:
   i. Cis and trans polymers.
   ii. Linear, branched and network polymer structures.
   iii. Photo-degradation and Photo-Polymerization.
   iv. Condensation and step polymerization.
   v. Injection blow molding and Extrusion blow molding.

1(b) Calculate the change in crystallinity of PET sample containing 0.5% voids by volume. [5]
Sample density is 1.395 g/cc. \( \rho_c = 1.455 \text{ g/cc} \) and \( \rho_n = 1.335 \text{ g/cc} \)

OR

1* Quantitatively compare the open and close system of polymerization and its effect on the molecular weight of polymer with the help of reaction kinetics involved. Also calculate the feed ratio \( r \) of adipic acid (AA) and hexamethylene diamine (HMD) that should be used to get polyamides 6,6 of molecular weight 35000 at \( r = 99.5 \) and 100% conversion.

contd...
2(a) Why average molecular weight is needed in case of polymer? Explain the difference between $M_n$ and $M_w$, also describe the polydispersity curve in polymer.

2(b) What would be the number average and weight average molecular weight of a sample of polypropylene oligomer that consists of 5 mol of pentamer and 10 mol of hexamer?

OR

2'(a) Qualitatively compare the suspension and emulsion polymerization system along with merits and demerits of each.

2'(b) Explain the GEL Effect in bulk polymerization. Suggest method to avoid this situation.

3. Explain the construction, working and governing equations for capillary rheometer. Also elaborate the viscometric plot for shear thinning polymer and the effect of various processing parameter over viscosity of polymer melt.

4(a) What do you mean by Rotational Molding of Polymer? With the help of neat and clean diagram explain the construction and working of 3 arm rotational molding machine. Also mention the applications of blow molded products.

4(b) Differentiate between:

(i). Rotational molding and Blow Molding

(ii). Injection Molding and Extrusion process

(iii). Compounding and Molding.