2014-15
B.TECH. (V SEMESTER) EXAMINATION
(PETRO-CHEMICAL ENGINEERING)
ENGINEERING CHEMISTRY & MATERIALS SCIENCE
(AC-311)

Maximum Marks: 60 Credits: 04 Duration: Three Hours

Answer all the questions.
All questions carry equal marks.

Q.No. Question M.M.  
1(a) Differentiate between the followings: [6]  
   (i) Crystal structure and interplanar spacing  
   (ii) H.C.P. structure and F.C.C. structure  
   (iii) Frenkel defect and Schottky defect

1(b) What are the important experimental methods to determine the crystal structure by X-ray diffraction? Explain any one method in detail. [4]

OR

1(b)' What do you understand by Miller indices? Explain with the help of an example.

2(a) What are austenitic stainless steels? Give the composition, properties and uses of austenitic stainless steels. [4]

OR

2(a)' What are low alloy steels? Briefly discuss different types of low alloy steels. [2]

2(b) Give detailed classification of steels. [4]

2(c) Give the composition, properties and uses of grey cast iron.

3 Discuss the followings: [5+5]  
   (a) Solid solutions  
   (b) Invariant reactions
3' Write explanatory notes on the followings:
   (a) Phase changes in pure iron
   (b) Tempering
   (c) Annealing

4(a) What are structural clay products? Write any two properties and applications of structural clay products.
(b) Give the preparation, properties and uses of the followings as building material:
   (i) Pig iron
   (ii) Mild steel

5(a) What is the principle of scanning electron microscopy (SEM)? Discuss the sample preparation technique for SEM and applications of SEM.
5(b) Give the principle of differential thermal analysis. How is differential thermal analysis different from differential scanning calorimetry?

6(a) What do you mean by term composite? Explain various constituents of composites with suitable examples.
6(b) Define abrasives. Write the types of natural abrasives and also explain each type in detail.

OR

6(b)' What is adhesion? Write the mechanism of adhesive bonding.
2014-15
B.TECH. (AUTUMN SEMESTER) EXAMINATION
Chemical/ Petrochemical Engg.
Heat Transfer Operations
CH 312/ PK 312N

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

1(a)  Consider two cold canned drinks, one wrapped in a blanket and other placed on a table in the same room. Which drink will warm up faster and why?

1(b)  What do you mean by critical thickness of insulation? Derive its expression for cylindrical wire covered with an insulating material having thermal conductivity $k_{lat}$ and exposed to an environment having convective heat transfer coefficient of 'h'.

1(c)  Draw the electrical analogue of thermal circuit for the following figure and hence find the total thermal equivalent resistance.

![Diagram of thermal circuit](image-url)
1(d) Water flows through a cast steel pipe (thermal conductivity, $k = 50$ W/(m.K)) with an outer diameter of 104 mm and 2 mm wall thickness. Calculate

i. The heat loss per meter length of un-insulated pipe when the water temperature is 15 °C, outside air temp. is -10 °C, water side heat transfer coefficient is 30 k W/(m².K) and the outside heat transfer coefficient is 20 W/(m².K).

ii. the corresponding heat loss when the pipe is lagged with an insulation having outer diameter of 300 mm and thermal conductivity of 0.05 W/(m.K).

OR

1(d') A large vertical plate 4.0 m high is maintained at 64 °C and is exposed to atmospheric air at 10 °C. Calculate the heat transfer by natural convection from the plate if plate is 10 m wide. Apply Churchill and Chu correlation which is given as-

$$h = \frac{k}{L} \left(0.825 + \frac{0.387 Ra^{1/6}}{1 + (0.492/Pr)^{9/16}}\right)^2$$

The properties of air can be used from the table as given below:

<table>
<thead>
<tr>
<th>$T$ (K)</th>
<th>$\rho$ (kg/m³)</th>
<th>$c_p$ (J/kg·K)</th>
<th>$\mu$ (kg/m·s)</th>
<th>$\nu$ (m²/s)</th>
<th>$k$ (W/m·K)</th>
<th>$\alpha$ (m²/s)</th>
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</table>

contd...
2(a) Describe the occurrence of Hysteresis in pool boiling curve.

2(b) Draw the various flow regimes in a film condensation on a vertical plate.

2(c) Consider a film condensation on a vertical plate. Will the heat flux be higher at the top or at the bottom of the plate and Why?

2(d) What do you mean by evaporator? List down the various processing factors of an evaporator along with its industrial applications.

2(e) A continuous single effect evaporator concentrates 9072 kg/h of a 1.0 wt % salt solution entering at 311.0 K to a final concentration of 1.5 wt %. The vapour space of the evaporator is at 101.325 kPa and the steam supplied is saturated at 143.3 kPa. The overall heat transfer coefficient, U is 1704 W/m²K. Calculate the amount of vapour and liquid produced and heat transfer area required.

Data given:

Heat capacity of the feed = 4.14 kJ/(kg.K)
Latent heat of water at 373.2 K is 2257 kJ/kg
Latent heat of steam at 143.3 kPa (saturation Temperature = 383.2 K) is 2230 kJ/kg

Assume that the solution has same boiling point as water (i.e BPR is zero)

OR

2(e') Water is to be boiled at atmospheric pressure in a mechanically polished stainless steel pan placed on the top of a heating unit. The inner surface of the bottom of the pan is maintained at 108 °C. If the diameter of the bottom of the pan is 30 cm, determine-

a. The rate of heat transfer to the water
b. The rate of evaporation of water

Apply Rohsenow relation for boiling which is as follows-

\[ q_{\text{boiling}} = \mu_1 h_f g \left( \frac{g(p_f - p_T)}{\rho} \right)^{1/2} \left[ \frac{C_p f (T_s - T_{sat})}{C_{fg} h_f p_{sat}} \right]^3 \]

Where, \( C_{ef} = 0.0130 \) and \( n = 1.0 \)

contd...
The properties of water at this condition could be taken as given below:

\[
\begin{align*}
\rho_t &= 957.9 \text{ kg/m}^3 & h_{fg} &= 2507.0 \times 10^3 \text{ J/kg} \\
\rho_v &= 0.6 \text{ kg/m}^3 & \mu_t &= 0.282 \times 10^{-3} \text{ kg \cdot m/s} \\
\rho_f &= 1.75 & C_p &= 4217 \text{ J/kg \cdot °C} \\
\sigma &= 0.0589 \text{ N/m}
\end{align*}
\]

3(a) Draw Temperature profile for 1-1 shell and tube heat exchanger when one of the stream is condensing. What will be the value of correction factor ‘F’ in this case?

3(b) What is meant by active and passive methods of enhancement of heat transfer? List down various techniques for enhancement.

3(c) What is the role of baffle in a shell & Tube heat exchanger? How does the presence of baffles affects heat transfer coefficient and pumping power requirements?

3(d) A 2-4 shell and tube heat exchanger is used to heat glycerine from 20 °C to 50 °C by hot water which enters the thin walled 2 cm diameter tube at 80 °C and leaves at 40 °C. The total effective length of the tubes in the exchanger is 60 m. The convective heat transfer coefficient is 25 W/(m²K) on the glycerine side and 160 W/(m²K) on water side. Determine the rate of heat transfer in the exchanger:

i. before fouling

ii. After fouling, with a fouling factor of .0006 m²°C/W, occurs on the outer surface of the tube

(b) Two-shell passes and 4, 8, 12, etc. (any multiple of 4), tube passes

Contd...
3(d') Deduce the expression for log mean temperature difference (LMTD) for counter current heat exchanger. Mention all the assumptions you have made in the derivation.

4(a) How does agitation in a vessel affects the heat transfer rate?

4(b) What is Wein's displacement law? At what wavelength does a body at 2000 K emit maximum radiation?

4(c) A diffuse gray body of emissivity 0.5 and at a temperature 0 °C, radiates to an ambient at 0 K. What is its radiant heat flux?

4(d) Determine the view factor associated with an enclosure formed by two spheres as shown in figure given below.

Fig: concentric spheres

4(e) A 2.54 cm outer diameter tube is used to transport a cryogenic liquid at -196 °C from a plant to an adjacent unit. The tube is enclosed in an evacuated concentric pipe of 5.25 cm inner diameter and wall temperature of -3 °C. A thin walled radiation shield is placed midway in the annular region between the tube and the pipe. Calculate heat gain by liquid per meter length of the tube.

The following emissivity data are given:
- Emissivity of the tube wall = 0.05
- Emissivity of the pipe wall = 0.1
- Emissivity of inner surface of radiation shield = 0.02
- Emissivity of outer surface of radiation shield = 0.03

OR
The sun may be considered to be a black body with a surface temperature of 5780 K. Calculate:

i. The fraction of solar radiation that falls in the visible range (0.4 micron to 0.7 micron range)

ii. The fraction of solar radiation that falls on the left of the visible range (wavelength < 0.4 micron)

iii. The fraction of solar radiation that falls to the right of the visible range (wavelength > 0.7 micron)

iv. The wavelength corresponding to maximum spectral emissive power

v. The total hemispherical emissive power

<table>
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<tr>
<th>( \lambda T ), ( \mu m - K )</th>
<th>( f_\lambda )</th>
<th>( \lambda T ), ( \mu m - K )</th>
<th>( f_\lambda )</th>
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</tr>
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1(a) Consider the mass transfer accompanied by the following instantaneous reaction in a homogeneous phase

\[ A + bB \rightarrow \text{products} \]

Sketch the concentration profile of A and B. Write down their respective expressions. Using these profiles show that the mass transfer rate, when accompanied by such reaction, is enhanced by a factor given by

\[ \phi = 1 + \frac{C_{B0}}{bC_{A1}} \frac{D_B}{D_A} \]

where: \( C_{B0} \) is initial concentration of B in solution

\( C_{A1} \) is concentration of A at interface, and

\( D_A, D_B \) are molecular diffusivities of A and B respectively in the reaction product

1(b) Consider a spherical ball of Naphthalene (A) of radius R evaporating in an infinite medium of still gas (B) at a temperature \( T \) and pressure \( P \). The diffusion coefficient of Naphthalene in air and vapor pressure of Naphthalene at the prevailing conditions are \( D_{AB} \) and \( p_A^* \) respectively. Derive an expression for the time required for complete evaporation of Naphthalene ball. Assume that the vapor-gas system follow ideal gas law.

OR

1*(a) Gas A is diffusing from a gas stream at point 1 to a catalyst surface at point 2 and
reacts instantaneously and irreversibly as follows:

$$2A \rightarrow B$$

Gas $B$ diffuses back to gas stream. Derive an expression for the molar flux of $A$ at constant pressure $P$ and steady state in terms of partial pressure

1' (b) Sulfur dioxide is absorbed into water in a packed column. At a certain location, the bulk composition of $\text{SO}_2$ in mole fraction at $50 \, ^\circ\text{C}$ and 2 atm in gas and liquid phase are 0.085 and 0.001 respectively. The equilibrium relation at $50 \, ^\circ\text{C}$ and 2 atm can be approximated as $y_{\text{SO}_2} = 29.74x_{\text{SO}_2} + 6733x_{\text{SO}_2}^2$. The experimental values of mass transfer coefficients for liquid and gas phase are $k_l = 0.18 \, \text{m/h}$ and $k_g = 0.040 \, \text{kmol/h-m}^2\text{-kPa}$. Determine the interfacial composition and fraction of mass transfer resistance that lies in the liquid phase.

2(a) For dilute mixtures and the cases where Henry’s law applies, the number of overall gas transfer unit is given by

$$N_{10G} = \int_{y_2}^{y_1} \frac{dy}{y - y^*}$$

Show that for co-current absorption tower it is given by

$$N_{10G} = \frac{A}{A+1} \ln \frac{y_1 - mx_1}{y_2 - mx_2}$$

where subscript 1 indicate the top (where gas and liquid enter) and subscript 2 indicate the bottom of the tower.

2(b) A gas stream contains 4.0 mol% ammonia and its ammonia content is reduced to 0.5 mol% in a packed absorption tower at 20 °C and 1 atm. The inlet pure water flow is 1.1 kmol/s and the total inlet gas flow is 0.96 kmol/s. The tower diameter is 0.747 m. The film mass transfer coefficients are $k_{fa} = 0.0739 \, \text{kmol/s-m}^2\text{-mol frac.}$ and $k_{ga} = 0.169 \, \text{kmol/s-m}^3\text{-mol frac.}$ Using the design methods for dilute gas mixtures, calculate the tower height using overall gas side mass transfer coefficient. The equilibrium data for ammonia-water system at 20 °C and 1 atm are given below

| $x_A$ | 0.0258 | 0.0405 | 0.0737 | 0.137 | 0.210 | 0.297 |
| $y_A$ | 0.0197 | 0.0328 | 0.0657 | 0.150 | 0.298 | 0.618 |

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 \( y_A = 0.4 x_A \).

3(a) What is Lewis relation? Show that the systems following the Lewis relation have the wet bulb temperature and adiabatic saturation temperature identical.

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 mass humidity
(b) the relative saturation, and
(c) 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') It is desired to dehumidify 1.2 m³/s of air, available at 38 °C dry bulb, 30 °C wet bulb temperatures, to a wet bulb temperature of 15 °C in a countercurrent tower using water chilled to 10 °C. The packing will be 50-mm Rasching rings. The overall volumetric mass transfer coefficient \( K_{vA} \) is 3.40 kg/m³-s. To keep entrainment minimum, \( G' \) will be 1.25 kg air/m²-s, and a liquid flow rate of 1.5 times the minimum will be used. Determine the temperature of the outlet water and cross section and height of the packed section of the tower.

4(a) A 100 kg batch of granular solids containing 30 per cent moisture is to be dried in a tray drier to 15.5 per cent of moisture by passing a current of air at 350 K tangentially across its surface at a velocity of 1.8 m/s. If the constant rate of drying under these conditions is 0.0007 kg/s m² and the critical moisture content is 15 per cent, calculate the approximate drying time. Assume the drying surface to be 0.03 m²/kg dry mass.

4(b) Describe briefly the nucleation and crystal growth processes in the formation of a crystal.
Psychrometric chart for air-water vapor, 1 atm abs., in SI units.
1. a. What is monopoly? Give examples of some situations where it would be beneficial. Also explain how the price of a product may be determined in a monopoly. 04
b. Explain the Law of Diminishing returns with suitable examples. 04
c. A company 3 years ago borrowed Rs. 40,000 to pay for a new machine tool agreeing to repay the loan in 100 monthly instalments at an annual nominal interest rate of 12% compounded monthly. The company now wants to pay off the loan. How much would this payment be, assuming no penalty cost for early payment? 04

OR

1'. a. What is inflation? What are its causes? How does it affect the economy of a nation? 06
b. Machines that have the following costs are under consideration for a robotized welding process. Using an interest rate of 10% per year, determine which alternative should be selected:

<table>
<thead>
<tr>
<th></th>
<th>Machine X</th>
<th>Machine Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Cost (Rs)</td>
<td>250,000</td>
<td>430,000</td>
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<tr>
<td>Annual operating cost (Rs/year)</td>
<td>60,000</td>
<td>40,000</td>
</tr>
<tr>
<td>Salvage Value (Rs)</td>
<td>70,000</td>
<td>95,000</td>
</tr>
<tr>
<td>Life (Years)</td>
<td>3</td>
<td>6</td>
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</table>

2. a. What is depreciation? What is the need for calculating it? 03
b. Differentiate between defender and challenger. 06

It is proposed to replace a two year old precision measuring instrument immediately. The expected costs and lives of the two instruments are as follows:

<table>
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<th>Current</th>
<th>Proposed</th>
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<tr>
<td>Current market value (Rs.)</td>
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<td>-</td>
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<tr>
<td>Remaining life (years)</td>
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<td>15</td>
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<tr>
<td>Estimated value in 3 years (Rs.)</td>
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<td>Annual operating cost (Rs.)</td>
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</table>

Perform the replacement study for a 3 year replacement period.

c. Five interdependent proposals are under consideration for a particular project. The present worth of capital requirement and benefits for each project are as follows:

<table>
<thead>
<tr>
<th>Alternative</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
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<td>72,000</td>
<td>43,000</td>
<td>81,000</td>
</tr>
<tr>
<td>PW of Benefits (Rs.)</td>
<td>70,000</td>
<td>55,000</td>
<td>76,000</td>
<td>52,000</td>
<td>84,000</td>
</tr>
</tbody>
</table>

Select the best proposal on the basis of an incremental B/C analysis.
3 a. What is the significance of decision making tools? Discuss any one decision making tool with suitable examples.

b. What are the major areas of social responsibility of corporate sector? Discuss the implications of corporate involvement in social causes.

OR

3' a. Discuss the role of information in the manager's job. Also, state the characteristics of useful information.

b. Discuss the Administrative model of decision making.

4 a. Why are organisational goals important? How are they classified? What are the differences between strategic goals and tactical goals?

b. Differentiate between:
   i. Job enlargement and Job enrichment
   ii. Functional departmentalization and Product departmentalization

OR

4' a. Discuss how control helps the organization. What are the steps involved in the control process?

b. How is authority different form power? Differentiate between line and staff authority with suitable examples.

5 a. Explain the Q/R inventory system.

A company needs 24,000 units/year of a certain component which will be used in its main product. The ordering cost is $150 per order and the carrying cost per unit per year is 18% of the purchase price per unit. The purchase price per unit is $75. Find the economic order quantity.

b. Demand for part number 1012 was 210 in January, 100 in February and 150 in March. The forecast for January was 140 units. With a smoothing constant of 0.30 and using first order exponential smoothing, what is the April forecast? Is 0.30 a good choice as a smoothing constant?

c. Define Quality. Discuss the two aspects of quality. Name some quality control tools and explain any one of them.
<table>
<thead>
<tr>
<th>Q.No.</th>
<th>Question</th>
<th>M.M.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1(a)</td>
<td>Explain in brief thermal conversion processes. Give the advantages of catalytic conversion processes over thermal conversion processes.</td>
<td>[05]</td>
</tr>
<tr>
<td>1(b)</td>
<td>Explain with the help of reactions and neat sketch Dual gasification Flexicoking Process. Also mention the merits of this process.</td>
<td>[10]</td>
</tr>
<tr>
<td></td>
<td><strong>OR</strong></td>
<td></td>
</tr>
<tr>
<td>1(b')</td>
<td>Discuss in detail the Visbreaking process for petroleum residues with special reference to process flowsheet and operating variables. Elaborate the role and significance of furnace and soaker drum in design, operation and economical aspects.</td>
<td>[10]</td>
</tr>
<tr>
<td>2(a)</td>
<td>Discuss the technological aspects and principles of operation of FCC.</td>
<td>[06]</td>
</tr>
<tr>
<td>2(b)</td>
<td>What is the significance of reforming process in a state-of-art refinery in view of increasing demands of high octane gasoline, stringent quality and environmental norms?</td>
<td>[03]</td>
</tr>
<tr>
<td><em>OR</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2(b')</td>
<td>Discuss the need and significance of hydrogen production in petroleum refinery.</td>
<td></td>
</tr>
<tr>
<td>2(c)</td>
<td>Discuss in brief Hydrocracking Process and compare it with catalytic cracking. In Hydrocracking Process employing silica alumina catalyst, why de-nitrogenation of feedstock is necessary?</td>
<td>[06]</td>
</tr>
<tr>
<td>3(a)</td>
<td>Explain with the help of a process flowsheet HF alkylation process with reference to process variables. Mention at least three merits of each HF and Sulfuric acid alkylation.</td>
<td>[08]</td>
</tr>
<tr>
<td>3(b)</td>
<td>Explain in brief any two of the following: a) Catalytic Polymerization b) Hydrotreating Processes c) Catalytic Isomerization</td>
<td>[07]</td>
</tr>
<tr>
<td>4(a)</td>
<td>Mention the importance of each processing step employed for the production of Lube Oil Base Stock (LOBS). Explain with the help of a process flow sheet Propane Deasphalting process with process variables.</td>
<td>[13]</td>
</tr>
</tbody>
</table>
Mention the main process steps involved in wax deoiling operation. Explain the finishing process for Wax with merits and demerits.

What are the limitations of Wax sweating Process?
1(a) Differentiate between:
   a. Homo-polymer and co-polymer.
   b. Thermoplastics and thermoset.
   c. Inhibitor and Chain transfer agent.
   d. Addition and step polymerization.

1(b) Derive the following relationship for step polymerization reaction:

\[ R_p = K.K_o [COOH] [HA] [OH] \]

Also explain the assumptions for above relation.

OR

1' Explain the reaction kinetics involve in self catalyzed polyestorification reaction. Also give brief justification for non linearity at lower and higher conversions.

2(a) Explain the classification of polymers as per (i). Physical State, (ii). Thermal Behavior, (iii). Polymerization reaction.

2(b) Explain the relationship of polymer rheology with polymer melt processing. Give suitable examples to strengthen your explanation.

OR
2'(a) Explain the phenomenon of auto-acceleration in bulk polymerization system. How can the chances of such a hazardous condition be minimized at industrial level? [7.5]

2'(b) Drive the Maxwell's equation of viscoelastic materials. Explain the significance of relaxation time in polymer processing. [7.5]

3 What do you mean by injection molding of polymers? Explain various steps of injection molding. [15]

4(a) What do you mean by crystallization of polymers? Does it change or remain as it is during polymer processing? [7.5]

4(b) Explain the structural factors affecting the glass transition temperature of polymer. [7.5]
Q No 1
(a) What do you understand by refinery configuration? Explain with suitable example. 5.0
(b) Why distillation curves are required in design of distillation column? Explain with suitable example. 5.0

OR

(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. 5.0
Conversion equations are given below:

\[ Y_{ASTM \ \text{slop}} = 0.8334 X_{TBP \ \text{slop}} - 0.0452 \]
\[ ATSM_{T50} = 1.05 \times TBP_{T50} \]

Q No 2
(a) Describe following terminology with the help of neat sketch. 5.0
- TBP cut volume
- TBP cut point
- TBP overlap

(b) 100,000 BPSD Crude oil is being charged in atmospheric distillation column (ADC), at flash zone, after passing through furnace. If 40 volume % of feed is vaporized at flash zone, then what will be the temperature & pressure at flash zone? Maximum temperature at the
outlet of furnace is 650 °F.

OR

(b') Light Distillate (Range = 25 - 40 vol % of crude oil) is desired as side stream product from atmospheric distillation column. Four tray steam stripper is used to remove lighter fractions associated with Light Distillate. Find out the outlet temperature of Light Distillate from stripper. The conditions is given below;
Steam rate = 10 lb/lb! of stripped product@500 °F
Enthalpy of steam (for all temperature) = 1050 btu/lb
Draw tray temperature of LD = 450 °F
Take initial temperature guess, AT = 30 °F for stripper

Q No.3
(a) Explain how vacuum distillation column will operate under dry mode?

(b) Discuss, in brief, different types of vacuum operations? Why lube based vacuum tower have more stringent operating conditions than fuel based vacuum tower?

(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 %.

OR

(c') It is planned to yield two VGO cuts (LVGO & HVGO) from the bottom of atmospheric tower in the vacuum tower which is operated as fuel pitch mode. Carry out the material balance (moles/hr) of each stream recovered from vacuum tower for the following conditions.
Feedstock = 48900 BPSD @ 17.4 °API & range = 51.1-100 vol % of whole crude,
Over flash = 2.0 vol% of vacuum feed treated as separate product,
TBP cut point between VGO & vacuum residue = 1100 °F,
LVGO = 33% VGO

Contd. 3.
Mol wt = 0.005 V^3 - 0.2 V^2 + 5.4 V + 68
where V = mid volume % of vapor

Q No 4

(a) Why negative pressure is kept inside the furnaces? 5.0
(b) Discuss the methods of designing of different sections of the furnaces. 5.0

OR

(b') Discuss, in brief, different parameters considered for design of radiant section of furnace. 5.0

(c) A petroleum stock at a rate of 1500 bbl/hr of specific gravity 0.800 is passed through a train of heat exchangers and is allowed to enter directly the radiant section of box type heater at 220°C. The heater is designed to burn 3000 kgs per hour of refinery off gases as fuel. The net heating value of fuel is 4.5×10^4 KJ/kg. The radiant section contains 175 sq. meters of projected area of one row of tubes (10.5 cm OD, 12 m long and spaced at 2 OD). Find the outlet temperature of the petroleum stock.

Data
α=0.88, Air fuel ratio=25
Average. Specific heat of stock= 2.268 KJ/Kg°C
Figure 1: TBP curve of Crude Oil