2017-18
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
PROCESS UTILITIES AND ENERGY MANAGEMENT IN HC INDUSRY
PK- 422 N

Maximum Marks: 60       Credits: 04       Duration: Two Hours

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

Q.No. Question
1(a) Answer any five of the following questions:

(i) Primary and secondary refrigerants.

(ii) Chemical denomination of R22 and R718 refrigerants.

(iii) Ozone depletion potential.

(iv) Best practices in cooling tower blow down.

(v) Advantages and disadvantages of Fired Tube Boilers.

(vi) Sketch between slip velocity and solid velocity with different regions in fluidized bed combustion boiler.

(vii) Rules that must be obeyed in order to achieve the minimum energy targets for a process in pinch technology.

1(b) Briefly explain the various types of fuel oil used in the industries, with their applications.

1(b') What are the tank bottom draws in the refineries? Describe with the help of diagram.

2 (a) Why the location of equalization system is important in primary treatment of waste water? Write the impact when it is located upstream of the dissolved air floatation unit (DAF).

OR

2(a') Illustrate the working principle of rotating biological contactor which is being used for waste water treatment. How it is different from activated sludge treatment?
2(b) A vapour compression refrigeration system circulates R 134a at rate of 6 Kg/min. The
refrigerant enters the compressor at -10 °C and exit at 7 bar. The isentropic compressor
efficiency is 67%. There are no appreciable pressure drop as the refrigerant flow through
condenser and evaporator. The refrigerant leave the condenser at 7 bar and 24°C. Ignoring
heat transfer between compressor and its surrounding. \( C_p = 3.5 \text{ Kj/Kg.K} \). Other properties of
R134a are given in Table 1

(i) Create a drawing of the refrigeration process described. Include the different unit
operations and known information.

(ii) Calculate Coefficient of performance of the cycle.

(iii) The refrigerating capacity in tons.

(iv) Estimate Power per ton of the refrigeration system.

3(a) What are the different types of burner? Explain the working principle of Pressure jet burner
with neat sketch. Write its merit and demerit.

3(b) Name the different types of steam traps. State the working principle of Inverted bucket Steam
trap.

3(e) A furnace melts 250 tons of copper and raises its temperature to 1600K in 6 hrs. The furnace
consumes 5.2 tons/hr oil. Fuel oil analyses 85% C, 12% H and 3% O and its net calorific value
is 9446 kcal/kg. Combustion air is 20% excess than theoretically required. Heat loss from the
furnace to the surrounding is 50% of the heat that is required to melt copper and raise its
temperature to 1600K. Calculate the inputs and outputs of energy and show them on the energy
flow diagram. \( C_p \) (liquid copper) = 0.6 Kj/Kg.K

OR

3(e') Construct the composite curves from the following pinch analysis thermal data:

<table>
<thead>
<tr>
<th>Stream No</th>
<th>Stream Type</th>
<th>Saturated temperature ( T_s ) (°C)</th>
<th>Target temperature ( T_t ) (°C)</th>
<th>Heat Capacity flow rate ( (C_p) ) (kW/°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hot</td>
<td>200</td>
<td>100</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>Hot</td>
<td>140</td>
<td>50</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>Cold</td>
<td>60</td>
<td>100</td>
<td>80</td>
</tr>
<tr>
<td>4</td>
<td>Cold</td>
<td>30</td>
<td>120</td>
<td>36</td>
</tr>
</tbody>
</table>

Find the minimum hot utility from the curve and potential for energy saving if existing process
energy consumption is 1300 kW.
4(a) Explain the operating principle of Recuperators. Distinguish between Metallic Radiation Recuperator and Convective Recuperator with examples. [05]

4(a') State the working principle of fluidized bed combustion boilers. What are the aspects to be considered in retrofitting fluidized bed combustion boiler to existing boilers? [05]

4(b) Explain the working principle of any Two of the following: [05]

(i) Heat Pipes (ii) Economiser (iii) Waste heat boilers

4(c) What is energy auditing? Write the role of energy manager. Make a preliminary energy audit report for providing air condition facility to all teaching staff of department of petroleum studies. Suggest how annual energy bill can be reduced. [05]

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**R-134a Properties - SI Units**

<table>
<thead>
<tr>
<th>Temperature (°C)</th>
<th>Absolute Pressure (bar)</th>
<th>Density Liquid (kg/m³)</th>
<th>Density Vapor (kg/m³)</th>
<th>Enthalpy Liquid (kJ/kg)</th>
<th>Enthalpy Vapor (kJ/kg)</th>
<th>Entropy Liquid (kJ/KgK)</th>
<th>Entropy Vapor (kJ/KgK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-60</td>
<td>0.15935</td>
<td>1472.0</td>
<td>0.9265</td>
<td>24.491</td>
<td>261.491</td>
<td>0.68772</td>
<td>1.8014</td>
</tr>
<tr>
<td>-50</td>
<td>0.29477</td>
<td>1444.9</td>
<td>1.6526</td>
<td>36.302</td>
<td>267.779</td>
<td>0.74358</td>
<td>1.7609</td>
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<tr>
<td>-40</td>
<td>0.51225</td>
<td>1417.0</td>
<td>2.773</td>
<td>48.931</td>
<td>274.068</td>
<td>0.79756</td>
<td>1.76448</td>
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<tr>
<td>-30</td>
<td>0.84379</td>
<td>1388.2</td>
<td>4.4397</td>
<td>61.139</td>
<td>280.324</td>
<td>0.84985</td>
<td>1.75142</td>
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<tr>
<td>-20</td>
<td>1.32719</td>
<td>1358.4</td>
<td>6.7903</td>
<td>73.833</td>
<td>286.513</td>
<td>0.901</td>
<td>1.74113</td>
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<tr>
<td>-10</td>
<td>2.00575</td>
<td>1327.4</td>
<td>10.047</td>
<td>86.777</td>
<td>292.598</td>
<td>0.96095</td>
<td>1.73309</td>
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<tr>
<td>0</td>
<td>2.92769</td>
<td>1295.1</td>
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<td>100.0</td>
<td>298.536</td>
<td>1</td>
<td>1.72584</td>
</tr>
<tr>
<td>10</td>
<td>4.14571</td>
<td>1261.2</td>
<td>20.226</td>
<td>113.549</td>
<td>304.270</td>
<td>1.04834</td>
<td>1.71219</td>
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<tr>
<td>20</td>
<td>5.71665</td>
<td>1225.5</td>
<td>27.773</td>
<td>127.437</td>
<td>309.750</td>
<td>1.09613</td>
<td>1.71106</td>
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<tr>
<td>30</td>
<td>7.70132</td>
<td>1187.5</td>
<td>37.517</td>
<td>141.736</td>
<td>314.892</td>
<td>1.14534</td>
<td>1.71473</td>
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<tr>
<td>40</td>
<td>10.1048</td>
<td>1146.7</td>
<td>50.055</td>
<td>156.491</td>
<td>319.575</td>
<td>1.19073</td>
<td>1.71512</td>
</tr>
<tr>
<td>50</td>
<td>13.1773</td>
<td>1102.2</td>
<td>65.234</td>
<td>171.778</td>
<td>323.652</td>
<td>1.23794</td>
<td>1.70792</td>
</tr>
<tr>
<td>60</td>
<td>18.8156</td>
<td>1052.9</td>
<td>87.346</td>
<td>187.715</td>
<td>326.899</td>
<td>1.28548</td>
<td>1.70325</td>
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<tr>
<td>70</td>
<td>21.1688</td>
<td>996.49</td>
<td>115.064</td>
<td>204.515</td>
<td>328.941</td>
<td>1.3339</td>
<td>1.6995</td>
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<tr>
<td>80</td>
<td>25.3396</td>
<td>938.78</td>
<td>155.130</td>
<td>222.615</td>
<td>329.095</td>
<td>1.38434</td>
<td>1.68585</td>
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<tr>
<td>90</td>
<td>32.4469</td>
<td>838.51</td>
<td>216.936</td>
<td>243.168</td>
<td>325.655</td>
<td>1.43978</td>
<td>1.66692</td>
</tr>
<tr>
<td>100</td>
<td>39.7264</td>
<td>649.71</td>
<td>297.054</td>
<td>273.641</td>
<td>309.037</td>
<td>1.5196</td>
<td>1.61466</td>
</tr>
</tbody>
</table>
Maximum Marks: 60  
Credits: 04  
Duration: Two Hours

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

Q.No.  |  Question  |  M.M.  
---|---|---
1(a)  |  Match the followings;  |  [9]  

<table>
<thead>
<tr>
<th>Name</th>
<th>Photographs/ symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Differential Transducer (DPT)</td>
</tr>
<tr>
<td>2</td>
<td>Pressure sensor</td>
</tr>
<tr>
<td>3</td>
<td>Motor actuated control valve</td>
</tr>
<tr>
<td>4</td>
<td>Level Switch</td>
</tr>
</tbody>
</table>
1(b) Drive the expression for flow rate in Venturimeter.

OR

1(b)' In a flow control loop flow is sensed by a venturimeter having cross sectional area of throat and upstream line as 2.5 and 10 cm². The differential pressure transducer (DPT) converts the pressure differential to electrical signal as per the calibration chart:

<table>
<thead>
<tr>
<th>Q (m³/s)</th>
<th>0.0</th>
<th>0.2</th>
<th>0.4</th>
<th>0.6</th>
<th>0.8</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 (mA)</td>
<td>4</td>
<td>8</td>
<td>12</td>
<td>16</td>
<td>20</td>
</tr>
</tbody>
</table>

Find out the change in differential pressure across venturi for change in corresponding electrical current of 10 to 15 mA.

\( \rho_{\text{water}} = 1000 \text{kg/m}^3 \)

2(a). Explain the "fail open" and "fail close" mode of valve failure with the help of a suitable P&ID.

2(b). A process flow diagram (PFD) for a distillation column is given in figure-1. Draw and explain the P&I diagram (P&ID) for this.
2(b'). Draw the P&ID for the following control task that are needed for a reactor as shown in figure-2;

i. Temperature control in Polymerizer

ii. Residence time control in Polymerizer.

3(a). As per Fig. 3, it is required to maintain hydrostatic head of 25 ft of water in the tank. The maximum expected flow rate for this valve is 470 GPM. What should the maximum (Cv) rating be for this valve?
3(b). Explain the working of following with the help of neat and clean figures.
   (i) Needle valve
   (ii) Globe valve
   (iii) Port guided valve

3(b)'. Draw the instrumentation & control symbols for followings:
   (i) Pressure controller and recorder (ii) Flanged pipe line (iii) Main control panel – Front mounted – shared instrument (iv) Pressure control valve (v) Flow nozzle (vi) Temperature Transmitter.

4(a). Explain the need of A/D and D/A converters required in modern instrumentation techniques? Explain the physical significance of following terms;

4(b). Discuss in detail the importance of Distributed Control System (DCS) in large scale Petrochemical plants. Compare the DSC system with dedicated PLC system.

OR

4(b)'. Explain any three terms of the following;
2017 – 2018
B.TECH. (WINTER SEMESTER) EXAMINATION
(PETROCHEMICAL ENGINEERING) (FERTILIZER TECHNOLOGY)
(PK – 442 A)
(CREDITS – 04)

Maximum Marks: 60

Duration : Two Hours

Note: Answer all questions.
All questions carry equal marks.

1. (a) Describe the commercial process for the manufacture of Ammonium Phosphate Surfate with the help of a process flow sheet with reference to chemical reactions involved, role of sulfuric acid and recycle ration. [08]

(b) (i) Define what is bio-fertilizer? [05]
(ii) What are the advantages of bio-fertilizers and the benefits of using bio-fertilizers?
(iii) What are the probable reasons for not getting proper response from the application of bio fertilizers?

(c) Write the chemical relation involved in the manufacture of sodium phosphate and the consumption pattern. [02]

OR

(c') Write the chemical reaction involved in the manufacture of Nitro phosphates from carbonitric process and the merits of this process over the other processes employed in the manufacture of Nitro phosphates. [02]

2. (a) List the major products of a fully developed phosphate industry in our country. [1.5]
(b) Materials of construction for the phosphoric acid for
(i) Reaction tanks
(ii) air rent & systems, filter
(iii) and storage tanks.

(c) Merits and demerits of dry and wet process in the manufacture of phosphoric acid. [1.5]
(d) Describe the manufacture of phosphoric acid (commercial process) from wet process using sulfuric acid with special reference to chemical reactions involved, rate of cooling air, particle size and temperature. [10]

OR

(d') (i) List chemical reactions involved in the manufacture of phosphoric acid from dry process. [01]
(ii) Mention merits and demerits in employing H₂SO₄ and HCl in the wet process. [01]

Contd…..2
(iii) Why the content of $P_2O_5$ is three times in triple super phosphate over superphosphate though the chemical structure of phosphate rock is same? [01]

(iv) Describe the commercial process for the manufacture of Triple Super phosphate will reference to process flow sheet and chemical reactions involved. [07]

3. (a) Describe the manufacture of synthetic ammonia with the help of a process flow sheet with special reference to guard converter (Chemical reactions involved) catalysts and the removal of diluent (what is the important diluent to be necessary to be removed) and conditions in the storage tank of Ammonia. [08]

OR

(a') Describe the manufacture of Commercial Nitric acid with reference to process flow sheet chemical reactions involved particularly with special reference to absorption system types of processes (merits & demerits) and the corrosion problem. [08]

(b) Describe the manufacture of Urea with special reference to chemical reactions precautions, pressure and temperature condition and their effect on conversion. [07]

OR

(b') Describe the commercial process for the manufacture of Ammonium sulfate with reference to chemical reactions and the purification system. Ammonium sulfate is best fertilizer for which crop. Why the multiple reactors are not used in the manufacture of synthetic Ammonia. [07]

4. (a) List the various micro and macro nutrients employed in the fertilizer. What is the source of C & H in the fertilizer? [2.5]

(b) What are the various feedstocks available in our country (India) for the manufacture of synthetic fertilizer? [2.5]

(c) Why steam reforming process is not employed for heavier hydrocarbons? [01]

(d) Though the pressure helps in the conversion of $SO_2$ to $SO_3$ but the advantage is not taken industrially. [01]

(e) Mention the chemical reactions involved in the manufacture of $H_2SO_4$ from Gypsum. [02]

(f) Manufacture of Syngas from heavy hydrocarbon such as fuel oil with the help of process flow sheet and chemical reactions involved. Why the catalysts is not used in this process. [06]

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