2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
PROCESS UTILITIES AND ENERGY MANAGEMENT
PK-422N

Maximum Marks: 60
Credits: 04
Duration: Three Hours

Answer all the questions.
Use of calculator is allowed.

Q.No.   Question                                      M.M.
1(a).   A refrigerator is to be designed to operate between 228 K (-45 °C) and 273 K (0 °C). The selection is to be made out of the refrigerants: R12 and ammonia. From the data provided in the table below, calculate the following: COP, power per ton, compression ratio, working pressure of condenser and evaporator, and compression temperature. Which refrigerant would you prefer to use and why? [08]

<table>
<thead>
<tr>
<th>Refrigerants</th>
<th>Saturated Temperature (°C)</th>
<th>Saturated Pressure (bar)</th>
<th>( h_f ) (kJ/kg)</th>
<th>( h_g ) (kJ/kg)</th>
<th>( s_f ) (kJ/kgK)</th>
<th>( s_g ) (kJ/kgK)</th>
<th>( C_{ps} ) (kJ/kg gK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R12</td>
<td>-45</td>
<td>0.505</td>
<td>-4.4</td>
<td>167.84</td>
<td>0.0190</td>
<td>0.7360</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>3.09</td>
<td>36.15</td>
<td>188.69</td>
<td>0.142</td>
<td>0.7008</td>
<td>0.62</td>
</tr>
<tr>
<td>Ammonia</td>
<td>-40</td>
<td>0.535</td>
<td>-22.4</td>
<td>1378.76</td>
<td>0.0961</td>
<td>6.0475</td>
<td>----</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>4.242</td>
<td>180.88</td>
<td>1443.34</td>
<td>0.7139</td>
<td>5.3368</td>
<td>2.72</td>
</tr>
</tbody>
</table>

OR

1(a'). (i) Explain the working of 2-stage cascade system (for refrigeration) with the help of T-s diagram. [05]

(ii) How sulphur content affects the combustion of fuel oil? [03]

1(b). Classify the different types of burners used for the atomization and combustion of the fuel oil. Explain the working of rotary-cup burner with a proper diagram. [05]

1(c). What do you mean by 'Turn-down ratio' and 'Flow-number'? [02]
2(a). Answer any two of the following:
   (i) Discuss coagulation and flocculation processes for water treatment
   (ii) Working of inverted bucket steam trap with proper diagram
   (iii) Purpose of steam tracing for piping and instruments

2(b). Discuss the effective strategy for segregation of refinery waste water with a neat and clean block diagram. What is the importance of equalization step used in the refinery waste-water treatment?

   OR

2(b') Differentiate fire-tube and water-tube boilers for steam generation. What are their advantages and disadvantages?

2(c). For the efficient utilization of heat content of steam, why the practicable pressure of steam should be at lower value?

3(a). What are the different components in energy management program? Explain each component briefly.

   OR

3(a') (i) Discuss the importance of energy management program.
   (ii) Explain the meaning of the given Fig. when a variable speed drive (VSD) is used to run a standard ac induction motor. What is the correlation of ‘Annual Energy Cost (AEC)’ for induction motor running with VSD and without VSD at different speed reduction?

![Graph]

**Fig.** Average payback periods at different speed reduction

*Contd.....3.*
3(b). A four streams problem is given in the table. Draw hot and cold composite curves for $\Delta T_{\text{min}} = 10$ °C. What are the values of (i) hot and cold pinch temperature (ii) hot and cold utility (iii) heat recovery amount from the process streams. If $\Delta T_{\text{min}}$ increased to 20 °C then calculate the change in hot and cold utility demand.

<table>
<thead>
<tr>
<th>Stream</th>
<th>Supply Temperature $T_s$ (°C)</th>
<th>Target Temperature $T_t$ (°C)</th>
<th>CP (kW/°C)</th>
<th>$\Delta H$ (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot – 1</td>
<td>350</td>
<td>290</td>
<td>3.5</td>
<td>-210</td>
</tr>
<tr>
<td>Hot – 2</td>
<td>400</td>
<td>290</td>
<td>1.8</td>
<td>-198</td>
</tr>
<tr>
<td>Cold – 1</td>
<td>150</td>
<td>350</td>
<td>2</td>
<td>400</td>
</tr>
<tr>
<td>Cold – 2</td>
<td>290</td>
<td>400</td>
<td>2.5</td>
<td>275</td>
</tr>
</tbody>
</table>

4(a). Describe the benefits of waste heat recovery and mention the different sources of waste heat recovery in chemical plants.

4(b). Discuss the working of any two of the following waste heat recovery equipments (with proper diagram)
(i) Recuperator
(ii) Waste heat boiler
(iii) Heat wheel

4(c). A large paper manufacturing company identifies an opportunity to save money by recovering heat from hot wastewater. The discharge of the wastewater from the operation range is 10000 kg/hr at 75 °C. Rather than discharging this water to drain, it was decided to preheat the 10000 kg/hr of cold inlet water having a yearly average temperature of 20 °C, by passing it through a counter flow heat exchanger with automatic back flushing to reduce fouling. Based on a heat recovery factor of 58% and an operation of 5000 hours per year, calculate the annual financial saving if cost of oil = 0.35 US$/litre (Gross calorific value of oil = 10.200 kCal/kg and specific gravity = 0.9 at 20 °C)
2015-16
B.TECH. (WINTER SEMESTER) EXAMINATION
PETROCHEMICAL ENGINEERING
PROCESS INSTRUMENTATION
PK-441A

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)  Explain the following terms with suitable examples;

1(b)  Differentiate between;
(i). Analog and Digital instrument
(ii). Null and Deflection type instruments.

OR

1(b)' Describe the selection criteria and precautions that must be taken into account while installing a pressure transducer in a process line.  [5]

2(a). Explain the “fail open” and “fail close” mode of valve failure with the help of a suitable P&ID.  [5]

2(b). A process flow diagram (PFD) for an evaporator and knock out drum is given in figure-1. Draw and explain the P&I diagram (P&ID) for this.  [5]

Contd.....2.
2(b). Draw the P&ID for the following control task that are needed for a reactor as shown in figure-2:
   i. Rate of catalyst feed to reactor.
   ii. Control of agitator.

3(a). As per figure-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 \( C_v \) rating be for this valve?

Contd....3.
Fig-3. P&ID of tank level.

3(a'). Explain the construction and working of Double Ported Sliding Stem Globe Valve with diaphragm actuator with the help of neat and clean cross-sectional diagram.

3(b). Drive the equation for fluid resistance in a control valve. Also state the name of factors on which resistance of control valve depends.

4(a). What is the role of a PLC in modern instrumentation? What do you mean by modular PLCs?

4(b). What do you mean by Distributed Control System (DCS)? Why it is important for large scale petrochemical plants?

5. What is virtual instrumentation? Draw the block diagram in Labview graphical programming language to measure and data-log the temperature of a heated vessel.

5'. Explain the functions of following blocks in Labview;
   (i). Graph (ii). Knob (iii). DAQ Assistant (iv). Signal Simulator (v). While loop

6. In a pharmaceutical plant the temperature control of reactor is very critical for the quality of drugs. You have to choose the suitable temperature sensor among the followings; justify your selection by comparing the inherent characteristics of each of them.
2015-2016
B. Tech. (WINTER SEMESTER) EXAMINATION
(PETROCHEMICAL ENGINEERING)
(FERTILIZER TECHNOLOGY)
(PK – 442 A)
CREDITS - 04

Max Marks: 60
Duration: Three Hours

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

1. (a) Explain the significance of Nitrogen phosphorous and potassium in the growth of the plants. [1.5]

(b) List the major macro and micro nutrients employed in a fertilizer industry. [2.5]

(c) List the major problems associated with the fertilizer industry. [2.0]

(d) List the alternative sources available in India for the manufacture of sulfuric acid. [1.5]

(e) Mention the various feedstocks/raw materials available in our country for the manufacture of nitrogenous fertilizer and describe with the help of a process flow, chemical reactions involved for the manufacture of Hydrogen either with natural gas or fuel oil. [7.5]

OR

(e') A concentrated H₂S stream is available from the refinery which is to be utilized for the manufacture of elemental sulfur. Describe with the help of a process flow sheet, chemical reactions involved and major engineering problems encountered in the process of manufacture of sulfur from H₂S. [7.5]

2. (a) Explain the various processes available for the manufacture of ammonia with reference to operating temperature, pressure and conversion. [02]

(b) Describe the manufacture of Ammonia with the help of a process flow sheet from a stream containing Nitrogen and Hydrogen in 1:3 ratio. Explain why in the synthesis of Ammonia, the temperature of the reactor is kept less than or equal to 550°C though in-crease in temperature helps the reaction. [07]

OR

(b') Describe the manufacture of Urea with the help of a process flow sheet, chemical reactions involved from a stream containing CO₂ and NH₃ with reference to effect of temperature and pressure on the yield. [07]

(c) Describe the manufacture of Ammonium Sulfate with the help of a process flow sheet from the Mergburg process. [06]

Contd.....2
(c') Describe the manufacture of Calcium Ammonium Nitrate/Nitrolime either from vapor phase or liquid phase process. Mention the important precaution involved in the process. [06]

3. (a) Merits and demerits of dry and wet process in the manufacture of phosphoric acid. [02]

(b) Though the chemical structure of super phosphate and triple super phosphate, is same but content of \( P_2O_5 \) is three times in triple Superphos them the superphospate. [1.5]

(c) Discuss briefly the handling and storage of phosphoric acid and mention the material of construction of storage tank of phosphoric acid. [3.5]

(d) Describe with the help of a process flow sheet the manufacture of phosphoric acid from wet process with special reference to effect of particle size on conversion and control of temperature in reactor. [08]

4. (a) Define the term biofertilizer and explain the significance of biofertilizer over synthesis fertilizer. [03]

(b) Describe the manufacture of Ammonium phosphate Sulfate with the help of a process flow sheet with special reference to chemical reactions involved, role of sulfuric acid and material of construction. [08]

(c) List the various reactions involved in the manufacture of Nitro phosphate and the role of nitric acid. [04]

OR

(c') List the reactions desirable & undesirable involved in the manufacture of Nitric acid. What are the advantages if the processes carried out at higher pressure. Material of construction for 60% Nitric acid at 95\(^{0}\)C & 140\(^{0}\)C. [04]

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