

Name:
Enrolment No:



UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2022

Programme Name: M.Tech Chemical Engineering
Course Name : Plant Utility Equipment and Systems
Course Code : CHPD 7017P
Nos. of page(s) : 02
Instructions :

Semester : 2nd
Time : 03 hrs
Max. Marks: 100

SECTION A (5Qx4M=20Marks)

| S. No. | | Marks | CO |
|--------|--|-------|-----|
| 1 | Discuss usage of steam as utility in a chemical process plant. | 4 | CO1 |
| 2 | Discuss the types of steam traps. What is its application? | 4 | CO1 |
| 3 | What do you understand about dew point depression? Discuss its application in an instrument air system | 4 | CO2 |
| 4 | What is affinity law? Describe the characteristics curve of a pump | 4 | CO2 |
| 5 | How do you think the Industry 4.0 is making an industry profitable? | 4 | CO2 |

SECTION B (4Qx10M= 40 Marks)

| | | | |
|---|--|----|-----|
| 6 | What is hardness? Discuss different types hardness associated with water treatment. | 10 | CO3 |
| 7 | Draw a PFD of cooling water system. Provide a conceptual data for the following 1. Pressure profile 2. Temperature profile 3. Mass balance | 10 | CO3 |
| 8 | Discuss with a proper diagram the three-element control philosophy of Boiler System. | 10 | CO4 |
| 9 | Draw the schematic of the pumping system (1x100%, 2x100%, 2x50%, and 3x50%) and discuss the most suitable layout based on the following condition. Consider the below data 1. Flow rate: 400 m ³ /hr 2. Developed head: 200 m 3. Fluid is water 4. Assume any missing data logically | 10 | CO4 |

SECTION-C (2Qx20M=40 Marks)

| | | | |
|----|--|----|--|
| 10 | Design a compressor system including all the necessary equipment like interstage | 20 | |
|----|--|----|--|

separator and cooler for the following data. For coolers and separators mention the applicable design basis only.

Flow rate: 20m³/sec

Inlet pressure / Temp = 2 barg / 25 degC

Discharge pressure /temp = 11 barg

Restrict the outlet temperature to 130 degC maximum

$\gamma = 1.23$, $C_p = 1.2 \text{ J}\cdot\text{g}^{-1}\cdot\text{K}^{-1}$.

Assume any missing data logically

11

A vertical gravity separator (without mist extractor) is required to handle 20m³/sec of 0.65 specific gravity gas (MW=22) at a pressure of 10 barg and a temperature of 30°C. Compressibility is 1, viscosity is 0.012 cp, and liquid specific gravity is 0.87. It is desired to remove all entrainment greater than 150 microns in diameter. No liquid surge is required.

Typical Values of K for Vertical Separators

| Height, feet | K, ft/sec |
|--------------|-------------|
| 5 | 0.12 – 0.24 |
| 10 or taller | 0.18 – 0.35 |

* assumes vessel is equipped with a wire-mesh mist extractor

Mention as the sections present in the vertical separator shown below. Determine the length of the vessel considering the residence time philosophy applicable to various liquid levels.



20

CO5