

Register No.: Name:

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

THIRD SEMESTER B.TECH DEGREE EXAMINATION (Regular), DECEMBER 2022 CHEMICAL ENGINEERING (2020 SCHEME)

Course Code : 20CHT203

Course Name: Chemical Process Principles

Max. Marks : 100

Duration: 3 Hours

Assume all missed data suitably. Attested copy of Psychrometric Chart can be permitted.

PART A

(Answer all questions. Each question carries 3 marks)

1. Convert the flow rate of water from 15 cubic feet per minute to mass flow rate in kg/s. Taking density of water as 1 g/cm^3 .
2. Differentiate fundamental quantities from derived quantities.
3. Mention Antoine equation and its application.
4. Highlight Raoult's law and its significance.
5. Draw a schematic representation of recycle in a process with chemical reaction.
6. Inspect the working of an evaporator and its applications.
7. Identify the significance of limiting reagent in a chemical reaction.
8. Differentiate proximate analysis from ultimate analysis.
9. Analyze the relationship between Kistyakowsky equation and Trouton's ratio.
10. State Hess's law of constant heat summation and its importance.

PART B

(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. 250 kg wet ammonium sulphate containing 50 kg moisture is sent to a dryer in order to remove 90% of the moisture in the feed. Calculate the weight fraction of water, weight ratio of water, weight percentage of moisture on a wet basis and weight percentage of moisture on a dry basis for the entrance and exit to the dryer. (14)

OR

12. Natural gas containing 93% methane, 4.5% ethane and the rest nitrogen is transported from a well at 300 K and 400 kPa. Calculate (14)
(a) The partial pressure of nitrogen

- (b) The pure-component volume of ethane in 10 m^3 of the gas
- (c) The density at standard conditions in kg/m^3
- (d) The density of the gas as piped in kg/m^3

MODULE II

13. Explain the following. (14)
- a) Absolute humidity
 - b) Molal humidity
 - c) Relative humidity
 - d) Percentage humidity
 - e) Dew point
 - f) Dry bulb temperature
 - g) Wet bulb temperature

OR

14. Describe the dew point line, bubble point line, two phase region, and tie line with the help of a neat T - x,y phase diagram of a binary mixture. (14)

MODULE III

15. a) A crystallizer is charged with 100 kg of a solution containing 25% $\text{Ba}(\text{NO}_3)_2$ in water. On cooling 10% of the original water present evaporates. Calculate the yield of crystals when the solution is cooled to 283 K. The solubility at 283 K is 7.0 kg $\text{Ba}(\text{NO}_3)_2/100$ kg total water. (7)
- b) Coal contains 85% carbon and 15% ash. The cinder formed in the combustion of coal contains 80% ash and 20% carbon. Determine the weight of cinder formed by the combustion of 100 kg of coal and the percent of fuel value that is lost. (7)

OR

16. a) A drier is fed with wet solid to reduce the moisture content from 80% to 15%. The product leaving the drier is admitted to an oven which further brings down the moisture to 2%. If the drier can handle 1000 kg of wet solid per day, calculate (7)
- (a) The weight of products leaving the drier and the oven per day
 - (b) The percentage of the original water that is removed in the drier and the oven
- b) 1000 kg of mixed acid of composition 40% H_2SO_4 , 45% HNO_3 and 15% H_2O is to be produced by mixing waste acid of composition 30% H_2SO_4 , 36% HNO_3 and 34% H_2O by weight. Concentrated sulphuric acid of strength 95% and concentrated nitric acid containing 80% are available for this purpose. Calculate the weight of spent acid and concentrated acids in kg to be mixed together for this operation. (7)

MODULE IV

17. Hydrogen-free coke containing 85% (weight) carbon and the rest inert materials is burned in a furnace. It is found that during combustion 5% of the coke charged is lost unburned. The flue gas analysis shows 14.84% CO₂, 1.65% CO, 5.16% O₂ and 78.35% N₂. The flue gas leaves the furnace at 500 K and 100 kPa. Calculate the following: (14)
- (a) The percent excess air on the basis of complete combustion of coke
 - (b) The weight of air supplied per kg of coke charged
 - (c) The volume of flue gas per kg of coke charged
 - (d) The composition of the refuse from the furnace

OR

18. A producer gas contains 9.2% CO₂, 21.3% CO, 18% H₂, 2.5% CH₄, and the rest N₂. It is burned with an excess supply of air. The flue gas analyzed 9.05% CO₂, 1.34% CO, 9.98% O₂ and 79.63% N₂. Determine the following: (14)
- (a) The volumetric ratio of air supplied to the fuel burned
 - (b) The percent excess air supplied
 - (c) The percent of nitrogen in the flue gas that came from the fuel.

MODULE V

19. Calculate the standard heat of formation of liquid methanol, given the standard heat of combustion of liquid methanol is -726.55 kJ/mol and the standard heat of formation of gaseous CO₂ and liquid water are, respectively, -393.51 and 285.84 kJ/mol. (14)

OR

20. a) The heat of combustion of methane, carbon and hydrogen are -890.4 kJ/mol, -393.51 kJ/mol and -285.84 kJ/mol respectively. Calculate the heat of formation of methane. (7)
- b) Calculate the heat of reaction for the esterification of ethyl alcohol with acetic acid if the standard heats of combustion are: ethyl alcohol (liq.), -1366.91 kJ/mol; acetic acid (liq.), -871.69 kJ/mol; ethyl acetate (liq.), -2274.48 kJ/mol. (7)
