BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI, K. K. BIRLA GOA CAMPUS
Mid Semester Examination CHE F313 Separation Processes II (Close Book)
1st Semester, 2022-2023 Date: 31-10-2022 Time: 90 minutes Max Marks: 60

PART (A) CLOSED BOOK TOTAL: 10 Marks (Each Question = 1 Mark)

1) What is the full form of the acronym SFE?

2) Define in complete terms SFE

3) Give two practical examples of the use of SFE

4) (a) Which is the most widely used compound in SFE?
(b) State the reason Why in reference to 4a

5) Draw a schematic of a P-T phase diagram and identify the phases. Using the diagram indicate by arrows each of the below:
(a) Critical Point Drying path
(b) Lyophilization path

6) Give two practical examples of the use of critical point drying

7) Name at least two of the different mechanisms of moisture transport within solids

8) In the context of humidity define:
(a) A (b) B

9) (a) Define the term WBT (b)Describe how WBT is determined

10) Name in complete terms a chemistry analytical method that is based on a material in a fluid state

PART (B) CLOSED BOOK TOTAL: 20 Marks (Each Question as marked)

1) In a mixture of benzene (vapor) and carbon dioxide (gas) at a total pressure of 900 mm Hg and a temperature of 60 degrees C the partial pressure of benzene is 100 mm Hg.
Using traditional chemical engineering nomenclature
Calculate and express the following:
(a) Mole fractions of A & B (2 Marks)
(b) Volume fractions of A & B (2 Marks)
(c) Absolute Molal Humidity of A (2 Marks)
(d) Absolute Humidity of A (2 Marks)

2) A gas and benzene (vapor) is saturated at 1 std atmosphere and 60 degrees C.
Using traditional chemical engineering nomenclature & the provided plot
Calculate and express the following:
(a) Absolute Humidity of benzene if the gas is carbon dioxide (2 Marks)
(b) Absolute Humidity of benzene if the gas is methane (2 Marks)

Repeat the above procedure with the temperature as 50 degrees C and all other conditions being the same viz. gas and benzene (vapor) is saturated at 1 std atmosphere
Calculate the following:
(a) Absolute Humidity of benzene if the gas is carbon dioxide (2 Marks)
(b) Absolute Humidity of benzene if the gas is methane (2 Marks)

3) An air-water vapor sample has a dry bulb temperature of 75 degrees C and an absolute humidity of 0.02 kg water/kg dry air at 1 std atm pressure. Using the provided chart determine the following:
(a) The sample's percent humidity (2 Marks)
(b) The sample's dew point (2 Marks)

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PART C (Close Book)) Total: 30 Marks

Q1) Fill in the blanks (1 x 6 = 6 marks)

a) Mesh size means the number of openings per _____.

b) In Bonds law, the_____ is defined as gross energy in kilowatt-hours per ton required to break from infinite size to a product size such that 80% passes a 100 µm screen.

c) A _____ is used to remove cake in rotary drum vacuum filter.

d) The compressibility coefficient of _____ cake is zero.

e) In cyclone separator the size of those particles that are collected with 50% efficiency is called the _____.

f) A large diameter cyclone has a much _____separation factor.

Q2) Laboratory tests on the material being crushed indicate that absorption of 0.98 joules of energy will result in the creation of 175 cm^2 of new surface. **(2+5=7 marks)**

(a) Determine Rittinger's number and report it along with proper units**.**

(b) If hard rock is fed at 5000 kg per hour to the crusher. Estimate power required in Watts for crushing.

Given: $S_P – S_F$ = 121137 cm^2/ kg, where, specific surface of product is S_P and specific surface of feed is S_F.

[Please write formula and show step wise calculation]

Q3(a) Data for filtration of $CaCO_3$ slurry in water are reported as follows at constant pressure (Δp =338 KN/m^2). The filter area of the plate and frame was A = 0.0439 m^2 and the slurry concentration was 23.47 kg / m^3. Construct necessary table and draw graph and hence calculate the constants α and R_m from the experimental data given, where t is time in s and V is filtrate volume in m^3.

Given: viscosity of water is 8.937 x 10^{-4} kg / m. s. **(12 + 5 = 17 marks)**

α is specific cake resistance and R_m is filter medium resistance.

Time, s	3.9	9.5	16.3	24.6	34.7	46.1	59.0	73.6	89.4	107.3
V x 10^3 m^3	0.5	1.0	1.50	2.0	2.5	3.0	3.5	4.0	4.5	5.0

(b) The same slurry used above is to be filtered in a plate and frame press having 20 frames and 0.873 m^2 area per frame. The same pressure will be used in constant pressure filtration. Assuming the same filter cake properties and filter cloth, calculate time (in seconds) to recover 3.37 m^3 of filtrate.

[Hint: Assume c = 23.47 kg / m^3]