Birla Institute of Technology and Science, Pilani
Semester I   Session: 2022-2023
CHE F313   Separation Process-II
Mid-Semester Test

Date: 05/11/2022   Full Marks: 90
Time: 2.00 pm-3.30 pm

                                        Part A-Closed Book   Full Marks: 50
                                        (Time: 50 Minutes)

Instructions: *Answer all parts of a question together. *State and justify if you make any assumptions. *Clearly write the nomenclature used. *Your answers must include appropriate units. *Clearly mention the question number. * Be to the point and specific. * Textbook is only allowed as a reference material in open book part. *No other printed material is allowed. * No exchange of calculator is allowed.*

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1. Define following terms with suitable schematic: (a) Ferret's Diameter; (b) Shear Diameter; (c) Wire Diameter and (d) Pitch **[2×5=10]**

2. Starting from a generalized differential expression, derive the expressions for Bond's Law, Kick's Law and Rittinger's Law. What is the major difference between closed circuit and open circuit operation. **[8+2=10]**

3. A ball mill usually runs at about 65-80% of its critical speed. In such a case, what range of rotational speed can you prefer for a ball mill that is 2000 mm in diameter and charged with 80 mm balls? Assume g=10 m/s^2. Define the term "clarifier" and "classifier"? **[8+2=10]**

4. Let F, D, and B are the mass flow rates of the feed, overflow, and underflow, respectively, through a screen. x_F, x_D and x_B are the mass fraction of oversize particles in these three streams. With the help of a neat schematic, derive an expression for the screen effectiveness based on oversize (E_A) and undersize (E_B) particles. Following this, derive an expression for overall screen effectiveness as a function of these mass fractions only (E). **[6+4=10]**
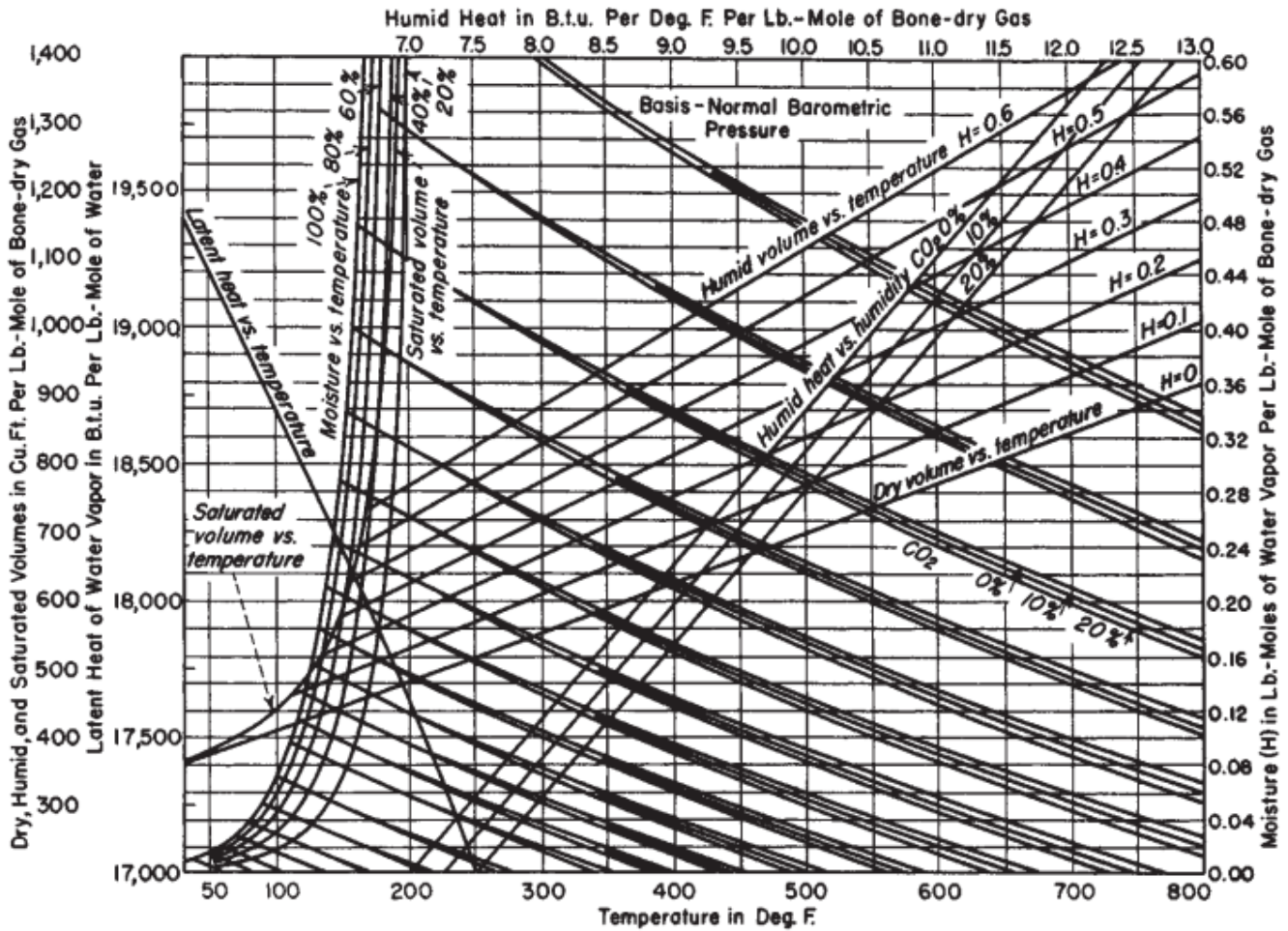
5. What is a "bone dry" solid? Estimate the sphericity of a cuboid which have the same value of length, breadth and height. Air in a room is measured to be at a dry bulb temperature of 25^{0}C and contains water vapor at a partial pressure of 3 kPa. Vapor pressure of water at this temperature is 4.5 kPa, while total pressure is 102 kPa. Evaluate the following quantities for the air inside the room: (a) humidity, (b) Saturation humidity, (c) percentage humidity, (d) percentage relative humidity, (e) humid volume (cc/g) and (f) saturated humid volume (cc/g). **[2+2+6=10]**

                                        Part B-Open Book   Full Marks: 40
                                        (Time: 40 Minutes)

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6. Consider a clarifying centrifuge operating under the following conditions: Diameter of bowl=800 mm; Thickness of liquid layer=80 mm; Depth of bowl=500 mm; Speed=1000 r/min; Specific gravity of liquid=1.1; Specific gravity of solid=1.8; Viscosity of liquid=3 cP; Cut size diameter of particles=50 μm. Estimate the capacity of the centrifuge in cubic meters per hour. **[20]**

7. A direct-heat, countercurrent-flow rotary dryer with a 6-ft diameter and 60-ft length is available to dry titanium dioxide particles at 70^0F and 1 atm with a moisture content of 30% (dry basis) to a moisture content of 2% (dry basis). Hot air is available at 400^0F with a humidity of 0.015 lb/lb dry air. Experiments show that an airmass velocity of 500 lb/h-ft^2 will not cause serious dusting. The specific heat of solid titanium dioxide is 0.165 Btu/lb-^{0}F, and its true density is 240 lb/ft^3. Specific heat of liquid water, water vapor and air are 1 Btu/lb-^{0}F, 0.45 Btu/lb-^{0}F and 0.24 Btu/lb-^{0}F, respectively. Determine: (a) production rate in lb/h of dry titanium dioxide (dry basis); (b) heat-transfer rate in Btu/h; (c) air flow rate in lb/h (dry basis); (d) exit-air and exit-solids temperatures. *{Hint: Locate the wet bulb temperature from the high temperature humidity chart and then point out the heat of vaporization from Appendix 7 of textbook; Take number of transfer units to be 2}* **[5×4=20]**

All the Best ✌