

KATHMANDU UNIVERSITY
End Semester Examination
February, 2025

Marks Scored:

Level : B.E.

Year : III

Exam Roll No. :

Registration No.:

February, 2025

18 FEB 2025

Time: 30 mins.

Course : CHEG 310

Semester : II

F. M. : 10

Date :

SECTION "A"

[20 Q. × 0.5 = 10 marks]

Choose and encircle the most appropriate option from each set of choices

1. What is the primary characteristic of a propeller in liquid agitation?
 - a. It generates radial-flow currents
 - b. It is most effective for high-viscosity liquids
 - c. It operates at high speed and creates axial-flow currents
 - d. It moves liquid with no turbulence

2. In a standard turbine impeller, where is the radial velocity of the liquid at its maximum?
 - a. At the upper and lower edges of the blade
 - b. In the plane of the middle of the blade
 - c. Near the shaft of the impeller
 - d. Equally distributed across the entire blade

3. What factor is used to estimate the power requirement of an impeller in a turbulent flow system?
 - a. The viscosity of the fluid
 - b. The density of the fluid alone
 - c. The product of flow rate and kinetic energy per unit volume
 - d. The temperature of the solution

4. What is the primary function of baffles in a shell-and-tube heat exchanger?
 - a. To reduce the velocity of the tube-side fluid.
 - b. To increase the surface area for heat transfer.
 - c. To promote crossflow and increase shell-side fluid velocity.
 - d. To eliminate the need for turbulence in the shell-side fluid.

5. Why can't the shell-side heat transfer coefficient in a shell-and-tube exchanger be calculated as easily as the tube-side coefficient?
 - a. The shell-side fluid always flows in a completely parallel direction to the tubes.
 - b. The shell-side flow is affected by varying cross-sectional areas and leakage between baffles and tubes.
 - c. The shell-side fluid velocity remains constant throughout the exchanger.
 - d. The shell-side coefficient depends only on the temperature difference between the fluids.

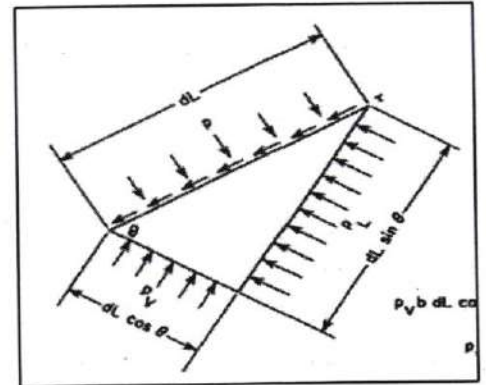
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6. Why has the use of air-cooled exchangers increased in recent years?
 - a. They require less maintenance compared to shell-and-tube exchangers.
 - b. They can cool fluids to temperatures below the ambient air temperature.
 - c. Air-cooled exchangers are more compact than water-cooled exchangers.
 - d. Cooling water has become scarcer, and pollution controls have become stricter.
7. What is a primary limitation of heat-transfer coefficient in practical applications?
 - a. It does not consider material properties.
 - b. Accurate temperature differences are difficult to estimate.
 - c. It is only applicable to liquid-phase heat transfer.
 - d. Heat-transfer coefficients are constant under all conditions.
8. Which of the following is the most significant component of heat duty in a dryer?
 - a. Heating the feed (solids and liquid) to the vaporization temperature
 - b. Vaporizing the liquid
 - c. Heating the solids to their final temperature
 - d. Heating the vapor to its final temperature
9. The energy required per unit mass to grind limestone particles of very large size to $100\ \mu\text{m}$ is $12.7\ \text{kWh/ton}$. An estimate (using Bond's law) of the energy to grind the particles from very large size to $50\ \mu\text{m}$.
 - a. $6.35\ \text{kWh/ton}$
 - b. $9.0\ \text{kWh/ton}$
 - c. $18\ \text{kWh/ton}$
 - d. $25.4\ \text{kWh/ton}$
10. Which of the following is **NOT** an objective of comminution?
 - a. Reduction of large lumps into smaller sizes.
 - b. Liberation of valuable minerals from gangue.
 - c. Increasing the moisture content of the ore.
 - d. Preparation of feed material for different ore processing techniques.
11. Which of the following best describes Kick's Law in comminution?
 - a. The energy required for crushing is proportional to the square of the reduction ratio.
 - b. The work required for crushing a given mass of material is constant for the same reduction ratio.
 - c. The energy required for size reduction is inversely proportional to the final particle size.
 - d. The energy required depends only on the hardness of the material and not on the size reduction ratio.
12. The sphericity of a solid particle of cylindrical shape whose length equals to diameter is
 - a. $(\pi/6)^{1/3}$
 - b. $(6/\pi)^{1/3}$
 - c. $(1/3)^{2/3}$
 - d. $(2/3)^{1/3}$
13. Overall pressure drop in cake filtration is:
 - a. The sum of pressure drops over medium and cake.
 - b. Pressure drop over filtering medium.
 - c. Pressure drop over cake.
 - d. The total resistance encountered by the fluid during filtration.

14. The expression of stress from the figure is:

- a. $\tau = (P_V - P_L)\cos\theta\sin\theta$ b. $\tau = (P_V + P_L)\cos\theta\sin\theta$
 c. $\tau = (P_V P_L)\cos\theta\sin\theta$ d. $\tau = (P_V/P_L)\cos\theta\sin\theta$

Where, τ : Shear stress, P_V : Pressure on base,
 P_L : Pressure on the side



15. What does the rate of filtration refer to?

- a. The total amount (mass) of filtrate collected over time.
 b. The volume of filtrate collected per unit time.
 c. The pressure applied during filtration.
 d. The size of particles retained by the filter.

16. Which of the following is a defining characteristic of a crystal?

- a. Random arrangement of constituent particles.
 b. An organized three-dimensional space lattice.
 c. Irregular shape with undefined angles.
 d. Inability to form polyhedral shapes.

17. Which of the following correctly defines supersaturation in terms of molar concentration?

- a. The difference between the molar concentration of solute in a supersaturated solution and that in an equilibrium solution.
 b. The total molar concentration of the solute in the solution.
 c. The ratio of solute concentration to solvent concentration.
 d. The concentration of solute in a fully saturated solution.

18. In the ideal stages in countercurrent leaching:

- a. It is assumed that the solute free solid is soluble in the solvent and that the flow rate of this solid is constant throughout the cascade.
 b. It is assumed that the solute free solid is insoluble in the solvent and that the flow rate of this solid is constant throughout the cascade.
 c. It is assumed that the solute free solid is insoluble in the solvent and that the flow rate of this solid is not constant throughout the cascade.
 d. It is assumed that the solute free solid is soluble in the solvent and that the flow rate of this solid is not constant throughout the cascade.

19. What is the condition called when the mass of solution retained by the solid remains constant regardless of concentration?

- a. Variable solution underflow b. Constant solution underflow
 c. Variable overflow condition d. Saturated solution equilibrium

20. The Power number for a stirred tank becomes constant at high Reynolds number. In this limit, the variation of power input with impeller rotational speed (N) is proportional to

- a. N b. N^{-1} c. N^3 d. N^5

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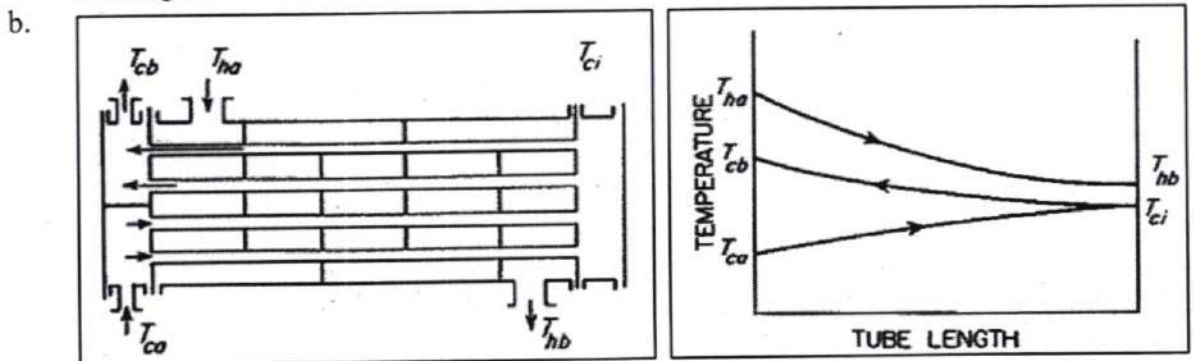
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Course : CHEG 310
Semester : II
F. M. : 40

SECTION "B"

Attempt **ANY FOUR** questions.

1.
 - a. Differentiate between axial-flow and radial-flow agitators in terms of their flow patterns. Discuss the mixing mechanism in an agitator. [2+3]
 - b. A flat-blade turbine with six blades is installed centrally in a vertical tank. The tank is 6 ft in diameter; the turbine is 2 ft in diameter and is positioned 2 ft from the bottom of the tank. The turbine blades are 5 in. wide. The tank is used to mix rubber-latex compound which is filled to a depth of 6 ft and the rubber-latex compound have a viscosity of 1200 P and a density of 70 lb/ft³ (1120 kg/m³). What power will be required? An agitated vessel 6 ft (1.83 m) in diameter contains a six-blade straight-blade turbine 2 ft (0.61 m) in diameter, set one impeller diameter above the vessel floor, and rotating at 80 r/min. It is proposed to use this vessel for neutralizing a dilute aqueous solution of NaOH at 70 °F with a stoichiometrically equivalent quantity of concentrated nitric acid (HNO₃). The final depth of liquid in the vessel is to be 6 ft (1.83 m). Assuming that all the acid is added to the vessel at one time, how long will it take for the neutralization to be complete? Density of liquid: $\rho = 62.3 \text{ lb/ft}^3$, Viscosity of liquid: $\mu = 6.6 \times 10^{-4} \text{ lb/ft-s}$. [2.5+2.5]
2.
 - a. Explain the working principle of a multi-pass heat exchanger. Discuss challenges in calculating the shell-side heat transfer coefficient in a shell-and-tube heat exchanger and how the Donohue equation addresses these challenges. [2+3]

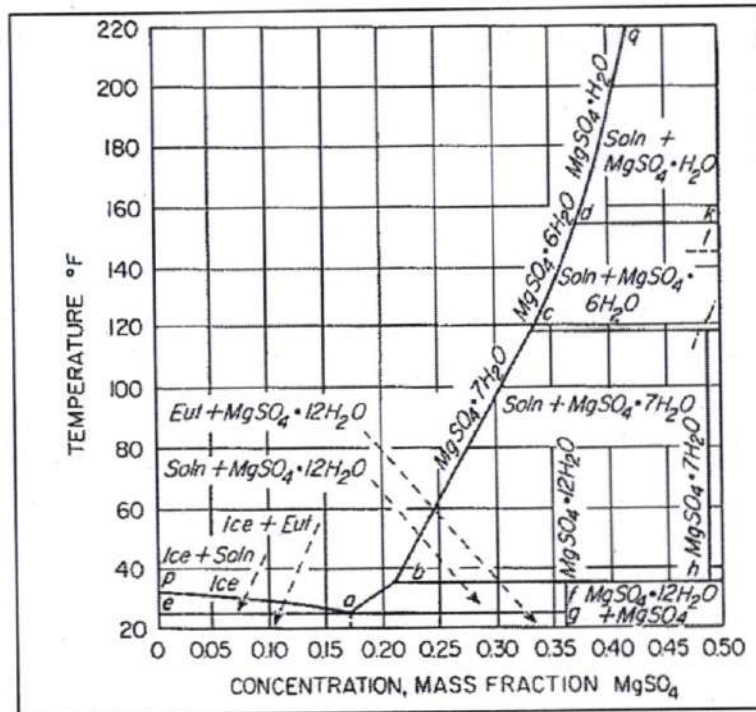


In the 1-2 exchanger sketched in Figure, the values of the temperatures are $T_{ca} = 70 \text{ }^\circ\text{C}$; $T_{cb} = 130 \text{ }^\circ\text{C}$; $T_{ha} = 240 \text{ }^\circ\text{C}$; $T_{hb} = 120 \text{ }^\circ\text{C}$. What is the correct mean temperature drop in this exchanger? What is the correct mean temperature difference in a 2-4 exchanger operating with the same inlet and outlet temperatures as in the 1-2 exchanger? Give; F_G for 1-2 and 2-4 exchangers are 0.735 and 0.9345, respectively.

[5]

P.T.O.

3. a. Explain the importance of heat-transfer coefficients in dryer design and describe heat duty in dryers. What do you mean by equilibrium moisture, bound moisture, unbound moisture and free moisture? [3+2]
- b. Explain the concept of supersaturation and its role in crystallization. A solution consisting of 30 percent $MgSO_4$ and 70 percent H_2O is cooled to 60 °F. During cooling, 5 percent of the total water in the system evaporates. How many kilograms of crystals are obtained per 1,000 kg of original mixture? (Take the data from the figure below). [2+3]



4. Discuss the followings: [2+2+2+2+2]
- Filtration mechanism
 - Plate and frame filter
 - Continuous counter current leaching
 - McCabe-Thiele diagram
 - Bulk storage and bin storage

5. a.

Mesh	Screen opening D_{pi} , mm	Mass fraction retained, x_i	Average particle diameter in increment, \bar{D}_{pi} , mm	Cumulative fraction smaller than D_{pi}
4	4.699	0.0000	—	1.0000
6	3.327	0.0251	4.013	0.9749
8	2.362	0.1250	2.845	0.8499
10	1.651	0.3207	2.007	0.5292
14	1.168	0.2570	1.409	0.2722
20	0.833	0.1590	1.001	0.1132
28	0.589	0.0538	0.711	0.0594
35	0.417	0.0210	0.503	0.0384
48	0.295	0.0102	0.356	0.0282
65	0.208	0.0077	0.252	0.0205
100	0.147	0.0058	0.178	0.0147
150	0.104	0.0041	0.126	0.0106
200	0.074	0.0031	0.089	0.0075
Pan	—	0.0075	0.037	0.0000

What do you mean by screen analysis? The screen analysis shown in Table applies to a sample of crushed quartz. The density of the particles is 2650 kg/m^3 (0.00265 g/mm^3), and the shape factors are $a = 2$ and $\Phi_s = 0.571$. For the material between 4-mesh and 200-mesh in particle size, calculate (a) Specific surface area of particles (A_w), in square millimeters per gram and N_w in particles per gram, (b) volume mean diameter (\bar{D}_v) and (c) mean volume-surface diameter (\bar{D}_s). [1+4]

b. Please elaborate Bond's law, Kick's law and Von Rittinger's Law. Discuss working principle of simple ball mill. [2+3]