CBCS SCHEME

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18BT33

Third Semester B.E. Degree Examination, June/July 2023
Unit Operations

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. Explain about the Rheological behaviour of various types of fluids by using shear stress Vs velocity gradient. **(08 Marks)**

b. In A manometer, used to measure the pressure drop across an orifice. Liquid A is mercury (density – 13,590 Kg/m^3) and fluid B, flowing through the orifice and filling the manometer leads, is brine (density 1260 Kg/m^3) when the pressure at the taps are equal the level of the mercury in the manometer is 0.9m below the orifice taps. Under operating conditions, the gauge pressure at the upstream tap is 0.14 bar ; the pressure at the downstream tap is 250mmHg below atmospheric. What is the reading of the manometer in millimeters? **(12 Marks)**

OR

2 a. Explain about the shear – stress distribution for a flow of incompressible fluids in cylindrical tubes. **(10 Marks)**

b. Crude oil, specific gravity at 60°F/60°F = 0.887, flow through the Fig Q2(b). Pipe A is 2-in (50mm) schedule 40, pipe B is 3 – in (75mm) schedule 40, and each of pipes C is 1½ in (38mm) schedule 40. An equal quantity of liquid flows through each of the pipes C. The flow through pipe A is 30gel/mm (6.65 m^3/h). Calculate: i) The mass flow rate in each pipe ii) The average linear velocity iii) The mass velocity in each pipe.

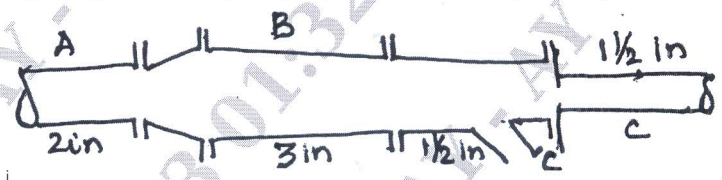

Fig Q2(b) **(10 Marks)**

Module-2

3 a. Enumerate the mathematical equation to determine the mass flow rate and volumetric flow rates for venture meter. **(10 Marks)**

b. Explain about the working process of positive displacement pumps i) Reciprocating pump ii) Centrifugal pump. **(10 Marks)**

OR

4 a. Explain about the different types of crushers and its advantages with neat diagram. **(10 Marks)**

b. Give the graphical representation between product size, mm Vs Energy consumed, kwh/ton for various size reduction equipment. **(05 Marks)**

c. What is the power required to crush 100 ton/h of limestone if so percent of the feed passes a 2 – in screen and so percent of product a 1/8 in screen? Note : work index for limestone is 12.74. **(05 Marks)**

Module-3

5 a. A flat furnace wall is constructed of a 4.5 in (114 – mm) layer of sil – o – cel brick, with a thermal conductivity of 0.08btu/ft-h- °F (0.138 W/m°C) backed by a 9 in (229mm) layer of common brick, of conductivity 0.8Btu/ft-h °F (1.38 W/m°C). The temperature of the inner face of the wall is 1400 °F (760°C), and the outer face is 170°F (76.6°C).
Evaluate :
i) What is the heat loss through the wall?
ii) What is the temperature of the interface between the refractory brick and the common brick?
iii) Supposing that the contact between the two brick layers is poor and that a "contact resistance of 0.50 °F-h-ft^2/Btu (0.088 °C – m^2/W) is present, what would be heat loss.
(15 Marks)

b. Derive the expression for evaluating flow of heat through a thick – walled cylinder with neat diagram. **(05 Marks)**

OR

6 a. Delineate the graphical representation of temperature profile for parallel flow and counter flow in a cooling process in shell and tube heat exchanger. **(08 Marks)**

b. Benzene is cooled from 141 to 79°F (60.6 to 21.1°C) in the inner pipe of a double pipe exchanger. Cooling water flow counter currently to the benzene, entering the jacket at 65°F (18.3 °C)and leaving at 75°F (23.9°C). The exchanger consist of an inner pipe of 7/8 inch (22.2mm) BWG (16) copper tubing jacketed with 1½ in (38.1mm) schedule 40 steel pipe. The linear velocity of the benzene is 5ft/s (1.52m/s). Neglecting the resistance of the wall and scale films and assuming L/D > 150 for both pipes, compute the film co-efficient of the benzene and water and the overall coefficient based on the outside area of the inner pipe.
Data for Benzene and water value at average fluid temperature

Property	Benzene	Water
Density ρ, ℔b/ft^3	53.1	62.3
Viscosity μ, ℔b/ft-h	1.16	2.34
Thermal conductivity R, Btu/ft-h-°F	0.089	0.346
Specific heat C_p, Btu/ ℔b-°F	0.435	1
The viscosities of the liquids at T_w are		
Viscosity correction factor	μ_w = 1.45 ℔b/ft-h . . . Benzene = 2.0.6 ℔b/ft-h . . . Water ϕ_u = 0.969 . . . . . Benzene = 1.018 . . . . Water	

(12 Marks)

Module-4

7 a. Elucidate the flux equation for steady state
i) Diffusion of A through non-diffusing of B
ii) Steady state equimolal counter diffusion. **(15 Marks)**

b. Calculate the rate of diffusion of acetic acid A) across a film of non-diffusing water B) solution 1mm think at 17°C, when the concentrations on opposite sides of the film are respectively, 9 and 3wt% acid. The diffusivity of acetic acid in the solution is 0.95×10^{-9}m^2/s.
Where z = 0.001m, M_A = 60.03, M_B = 18.02 at 17°C.
ρ (9% solution = 1012 Kg/m^3 **(05 Marks)**
ρ (3% solution = 100 3.2 Kg/m^3)

OR

8 a. Oxygen (A) is diffusing through Carbon – monoxide (B) under steady state conditions, with the carbon monoxide diffusing. The total pressure is 1×10^5 N/m^2, and the temperature 0°C. The partial pressure of oxygen at two planes 2.0mm apart is respectively, 13600 and 6500 N/m^2. The diffusivity for the mixture is 1.87×10^{-5} m^2/s. Calculate the rate of diffusion of oxygen in Kmol/s through each square meter of the two phases. **(10 Marks)**

b. Explain about i) Film theory ii) Penetration theory iii) Surface renewal theories to evaluate the mass transfer coefficients. **(10 Marks)**

Module-5

9 a. Explain about the quantities has to be considered on choice of solvents for extraction process. **(10 Marks)**

b. Explain about the stage type equipments and its major types used for contacting liquid phases in extraction process. **(10 Marks)**

OR

10 a. Explain about vapour liquid equilibrium phase diagram for Binary mixture with neat graphical representation. **(10 Marks)**

b. A mixture of benzene and toluene containing 60% mole of benzene is to be separated to give a product of 95 mole% benzene and bottom product containing 10 mole % benzene. The feed enters a column at its bubble point. It is proposed to operate the column with reflux ratio of 2.5. It is required to find the number of theoretical plates needed and the position of feed plate. Equilibrium data.

X	0	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0
Y	0	0.13	0.21	0.37	0.5	0.6	0.7	0.83	0.9	0.95	1.0

(10 Marks)

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