

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(END SEMESTER EXAMINATION)**

**CLASS: BPHARM  
BRANCH: PHARMACY**

**SUBJECT: BP304T PHARMACEUTICAL ENGINEERING**

**SEMESTER: III  
SESSION: MO/2023**

**TIME: 3.00 Hours**

**FULL MARK: 75**

**INSTRUCTIONS:**

1. The missing data, if any, may be assumed suitably.
2. Before attempting the question paper, be sure that you have got the correct question paper.
3. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
4. This question paper consists of (03) three parts. Read the part wise instructions before attempting the questions.

**PART-I**

**Objective types questions (Instruction: Answer all questions)**

Q1.

(10 x 2 = 20 Marks)

- A. The dimension of power is .....
- B. Frictional loss is measured as the ratio of .....
- C. Calculate the critical speed in rpm of a ball mill (diameter = 300 mm) loaded with 5 mm balls.
- D. Convert the value of overall heat transfer coefficient 250 kilocalorie/hour/square meter/°C to watt/square meter/°F
- E. Define the terminal velocity as per the general laws of settling.
- F. If the reflux ratio is 2.8, what will be the slope of operating line of the rectifying section in a distillation process?
- G. Write down the two streams which are in equilibrium at ideal plate in a rectification column.
- H. A solution of organic colloids is to be concentrated from 14 % to 68 % solids in a vertical tube evaporator. If the evaporator must evaporate 42000 kg of water per hour, what will be feed rate and thick liquor rate?
- I. If the ratio of outer radius and inner radius of a cylindrical pipe is 4, calculate the ratio of logarithmic mean radius and arithmetic mean radius.
- J. In which condition(s) the slope of the feedline will be negative in distillation process?

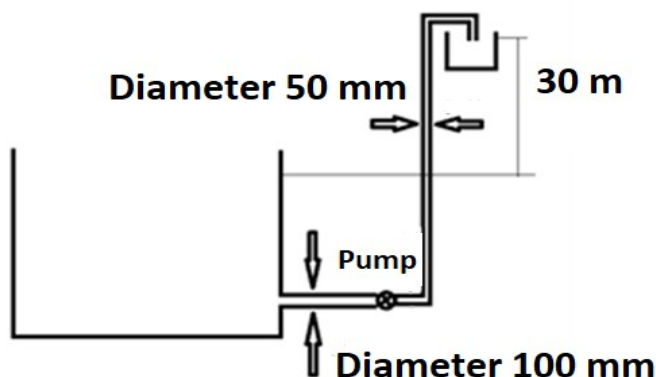
**PART-II**

**Short Answers**

**(Instruction: Answer seven out of nine questions)**

(7 x 5 = 35 Marks)

- Q2. Derive Bernoulli's equation for incompressible fluid flowing through a circular pipe.
- Q3. In the equipment shown below, a pump draws a solution of specific gravity 1.86 from a storage tank through schedule 40 steel pipe as per the dimension given in the figure. The velocity in the suction line is 0.694 m/s. The end of the discharge pipe is 30 m above the level of the solution in the feed tank. Friction losses in the entire piping system are 75 J/kg. What pressure must the pump develop? What is the power delivered to the fluid by the pump?



- Q4. A crushing roll has rolls of 135 cm diameter and they are set so that the crushing surfaces are 12 cm apart at the narrowest point. If the angle of nip is  $32^\circ$ , calculate the feed diameter.
- Q5. Determine the mass flow rate of a fluid by Orifice meter.
- Q6. Discuss the integration over total surface and concept of logarithmic mean temperature difference (LMTD).
- Q7. Establish the material and energy balance equation in a single effect evaporator.
- Q8. Describe the various types of feeding in multiple effect evaporator.
- Q9. Derive the equation for feed line in a distillation process.
- Q10. Discuss the various factors affecting the economy of a single effect evaporator.

### PART-III

#### Long Answers

(Instruction: Answer two out of three questions)

(2 x 10 = 20 marks)

- Q11. A solution of organic colloids is to be concentrated from 12 to 72 % solids in a vertical tube evaporator. The solution has a negligible elevation in boiling point, and the specific heat of the feed is  $0.93 \text{ J/g}^\circ\text{C}$ . Saturated steam is available at 0.8 atm abs ( $95^\circ\text{C}$ ), and the pressure in the condenser is 100 mm Hg abs ( $45^\circ\text{C}$ ). The feed enters at  $32^\circ\text{C}$ . The overall heat transfer coefficient is  $1985 \text{ W/m}^2\text{C}$ . The evaporator must evaporate 25000 kg of water per hour. The heat of vaporization of steam  $\lambda_s$  at 0.8 atm abs is 2273 KJ/Kg. The enthalpy of superheated water vapour at 100 mm Hg abs ( $H_v$ ) is 2378 KJ/Kg.
- What is the feed rate in kg/h?
  - What is the steam consumption in kg/h?
  - What is the economy of the evaporator?
- Q12. A continuous fractionating column is to be designed to separate 45000 kg/h of a mixture of 55% benzene and 45% toluene into an overhead product containing 99% benzene and a bottom product containing 97% toluene. The percentages are by weight. A reflux ratio of 2.65 to 1 mole of product is to be used. The molal latent of benzene and toluene are 7360 and 7960 cal/g mole, respectively. Benzene and toluene form a nearly ideal system with a relative volatility of about 2.5. The feed has a boiling point of about  $95^\circ\text{C}$  at 760 mm Hg pressure. a) Calculate the moles of overhead product and bottom product per hour.; b) Determine the number of ideal plates and the position of feed plate if the feed is liquid and at its boiling point. (Graph paper will be provided). The equilibrium curve data is given as follows.
- |   |      |      |      |      |      |      |      |      |      |      |
|---|------|------|------|------|------|------|------|------|------|------|
| x | 0.10 | 0.20 | 0.30 | 0.40 | 0.50 | 0.60 | 0.70 | 0.80 | 0.90 | 0.95 |
| y | 0.21 | 0.37 | 0.51 | 0.64 | 0.72 | 0.79 | 0.86 | 0.91 | 0.96 | 0.98 |
- Q13. Derive the equation for operating line for rectifying section in a rectification column.

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