Distillation
Question Bank

1. Explain the terms (a) Boiling Point (b) Vapor Pressure (c) Equilibrium (d) Driving Force (d) Equilibrium stage (e) Vapor-Liquid equilibrium (f) Constant pressure vapor liquid equilibria (g) Boiling point diagram (h) Bubble point and Dew point (i) Raoult's law (j) Dalton's law (k) Relative volatility
2. Explain relative volatility. Show that for ideal systems obeying Raoult's law, the vapour liquid equilibrium data for a binary system may be represented by the equation, $y = \frac{\alpha x}{1+(\alpha-1)x}$, Where $\alpha =$ relative volatility.
3. Define distillation with neat flow diagram.
4. Explain T-x,y boiling point diagram.
5. Methods or classification of distillation.
6. Explain differential or Simple distillation with neat flow diagram.
7. Explain Flash or Equilibrium distillation with neat flow diagram.
8. Explain Rectification or Fractionation distillation with neat flow diagram.
9. Prove that $ln\frac{Fx_F}{Wx_W} = \alpha \ln \frac{F(1-x_F)}{W(1-x_W)}$ (Assume constant relative volatility)
10. Explain terms feed plate and Feed Line with neat diagrams and expressions.
11. Explain the terms using material balance diagrams for (a) Total condenser and (b) Partial condenser (c) Reboilers.
12. Explains the following terms
    (a) Reflux ratio (b) Infinite or total reflux ratio (c) Minimum reflux ratio (d) Optimum reflux ratio
13. Explain the calculation procedure of minimum reflux ratio
14. Discuss about the McCabe-Thiele method for obtaining theoretical plates. (Including Assumptions, stepwise procedure and Limitations)
15. Discuss about the Ponchen-Savarit method for obtaining theoretical plates. (Including Assumptions, stepwise procedure and Limitations)
16. Azeotropes (a) Minimum boiling azeotropes (b) Maximum boiling azeotropes
17. Discuss about (a) Extractive distillation with neat diagram (b) Steam distillation with neat diagram
18. Types of plate efficiency (a) Overall efficiency or Overall plate efficiency (b) Murphree efficiency (c) Murphree local or point efficiency
19. Discuss briefly the simple distillation process and state its applications.
20. Derive Rayleigh's equation and explain its usefulness of distillation calculations.
21. A liquid mixture of 20 mole percent acetone and 80 mole percent methanol is to be continuously flash vaporized at the 1 atm pressure to vaporize 40 mole percent feed. Calculate composition of the products. x and y are mole fractions of acetone in liquid and vapour respectively. Equilibrium data

x	0	0.1	0.2	0.4	0.6	0.8	1.0
y	0	0.19	0.32	0.51	0.66	0.8	1.0

22. Describe in detail about azeotropic distillation with a neat sketch.
23. A mixture containing benzene and toluene with 40% benzene and 60% toluene is to be separated in a fractionating column to give product containing 96% benzene and bottom product containing 95% toluene. Feed is a mixture of two-third vapor and one-third liquid.

Find the number of theoretical stages required if the reflux ratio of 1.5 times the minimum is used. (Relative volatility = 2.5)

24. write the equation for feed plate line (q line) and draw the q-line for various conditions of feed.
25. Define the terms minimum reflux, total reflux and optimum reflux ratio, how to determine the optimum reflux ratio.
26. A continuous fractionating column is to be designed for separating 10,000 kg per hour of a liquid mixture containing 40 mole percent methanol and 60 mole percent water into an overhead product containing 97 mole percent methanol and a bottom product having 98 mole percent water. A mole reflux ratio of 3 is used. Calculate (i) moles of overhead product obtained per hour and (ii) number of ideal plates and location of the feed plate if the feed is at its bubble point. Equilibrium data:

x	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.417	0.579	0.669	0.729	0.78	0.825	0.871	0.915	0.959

Where, x = mole fraction of methanol in liquid and y = mole fraction of methanol in vapor

27. A reboiler is considered as a theoretical plate but a total condenser is not. Justify.
28. Compare azeotropic and extractive distillation. Which is the most preferred one among two?
29. Under what circumstances vacuum distillation is preferred over normal distillation.
30. Why reflux stream is necessary for a continuous distillation column?
31. Define plate, Murphree and point efficiency with respect to plate columns.
32. State and explain the assumptions of McCabe Thiele method.
33. Explain the concept of optimum reflux ratio with a graph.
34. In a particular binary distillation, calculating the operating line equation in rectifying section is given by $y = 0.715\ x + 0.28$, where y and x are the mole fractions of more volatile component in vapor and liquid phase respectively. Now if the liquid coming out from the third plate counted from the top have the composition $x_3 = 0.72$. Calculate the composition of the vapor entering the fourth plate, i.e., y_5. The alpha (α) of the system may be taken as 3.0.
35. Match the following

1	Sub – cooled liquid	A	$q < 0$
2	Saturated liquid	B	$q = L / F$
3	Mixture of liquid and vapour	C	$q = 0$
4	Saturated vapour	D	$q > 1$
5	Superheated vapour	E	$q = 1$

36. Match the following

1	Batch Distillation	A	Equilibrium
2	Mc Cabe Thiele method	B	Entrainer
3	Flash Distillation	C	No. of plates

	4	Azeotropic Distillation	D	Relative Volatility
	5	Distillation	E	Rayleigh's equation

37. Tabulate different conditions of feed along with their q values (or) formula. Represent q lines for different feed conditions on the equilibrium diagram.

38. Draw a continuous distillation column. Indicate the parts and sections in the continuous distillation column. Explain the constructional features, working principle and application of it.

39. A feed containing 50mol% benzene and 50 mol% toluene is to be distilled in a fractionating column to produce a distillate containing 90 mol% benzene and bottoms containing 90 mol% toluene. Feed rate to the column is 10000 kg/h and feed is at its bubble point. The operating reflux ratio is 1.5 times the minimum and the overall plate efficiency is 0.75. Determine the actual number of plates required. The relative volatility is 2.28.

40. A stream of aqueous methanol having 45 mol% methanol is to be separated into a top product having 96 mol% methanol and a bottom product containing 4 mol% methanol. The feed is at its bubble point and the operating pressure is 101.3 kPa. A reflux ratio of 1.5 is suggested. (i) Determine the number of ideal trays. (ii) Find the actual number of trays if the overall tray efficiency is 40% (iii) Find the feed plate location.

VLE data:

x	0	0.02	0.06	0.08	0.10	0.2	0.4	0.6	0.8	1.0
y	0	0.134	0.304	0.365	0.418	0.579	0.729	0.825	0.915	1.0

41. Define relative volatility and reflux ratio. What should be the value of relative volatility for better separation?

42. How reflux ratio effect on number of theoretical stage?

43. How constant boiling mixture be formed? What is the possible way to separate such mixture?

44. What is azeotrope? Give an example of azeotropic system. How azeotrope mixture can be separated?