

1) A separation apparatus consists of a still pot, one theoretical plate, and a total condenser. The feed to this apparatus is a saturated-liquid mixture of A and B at a pressure of 1 bar. The relative volatility of A to B is 2.5. Equilibrium is achieved in the still and its distillate composition is 75 mol % A. For each of the following situations, where possible, calculate the ratio of the molar flow rates of feed to the distillate. For each case, assume an initial feed of 100 moles/hour and equimolar composition.

- The feed is to the still pot and no reflux is used.
- The feed is to the still pot and a reflux ratio of 3 is used.
- The feed is to the still pot and the minimum reflux ratio is used.
- The feed is to the plate and a reflux ratio of 3 is used.
- Repeat case b) after rust has destroyed the theoretical plate.

2) The feed to a continuously operating distillation column is a mixture of carbon disulfide (mole fraction 0.4) in carbon tetrachloride which is 50% vaporized. The total condenser yields a top product having a carbon disulfide mole fraction of 0.95. The partial reboiler produces a bottoms product having a carbon disulfide mole fraction of 0.05. VLE is achieved at each stage.

Graphically calculate the minimum reflux, the minimum boilup ratio from the reboiler, and minimum number of stages required.

For the pressure at which the column operates, the VLE data given in terms of the mole fractions of carbon disulfide is given in the table below:

x	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
y	0.135	0.245	0.42	0.545	0.64	0.725	0.79	0.85	0.905	0.955

3) Concentrates of fruit juices are produced feeding juice into an evaporator. The heat added to the evaporator produces a gaseous stream consisting mostly of water vapor. Additionally, the most desirable flavor component of the juice also leaves the evaporator. In apple juice, one of the most important flavor components is the “fruity” ester, ethyl 2-methyl butyrate. It leaves the evaporator at a mole fraction of 10^{-7} in the vapor stream. The remaining concentrated juice leaves the evaporator as a liquid stream. To avoid loss of the most important volatile aromatic flavor component, the vapor leaving the evaporator is sent to a distillation column as a feed stream. The condensed top product from the distillation column, the so-called “essence”, is recombined with the juice concentrate from the evaporator to yield the final commercial product. The relative

volatility of the flavor component to water at 100 °C is 4.0. It is desired that the essence have at least 90% of the flavor component which enters the column and no more than 1% of the water entering the column.

a) Calculate the minimum ratio of steam required to be produced by the column's reboiler to the steam which enters the column as the feed.

b) If the column is to be operated at a vapor generation rate of the reboiler which is 50% greater than the minimum value, determine the number of equilibrium stages required.