

CH3030 Tutorial 1

14.8.2020

1. Flue gas from a process plant contains 15% CO₂, 6% O₂ and 79% N₂. This gas is to be treated in a tray column absorber operating at 25°C and 1.2 atm pressure with 30% (wt) aqueous ethanolamine (C₂H₄OHNH₂) solution as the solvent (absorbent) which enters the column at 25°C. The solvent is recycled from a stripper and contains 0.058 mol of CO₂/mol of solution. The gas leaving the absorption column is to contain only 2% CO₂. Assume isothermal operation and that only CO₂ gets absorbed in the solution.
 - a) Determine the minimum liquid to gas ratio (mol/mol)
 - b) Determine the number of kilograms of liquid solution to enter the absorber per cubic metre of entering gas for a liquid to gas ratio of 1.2 times the minimum.
 - c) Determine the number of theoretical trays for the condition defined in part 2 (round off to nearest higher integer).

Equilibrium partial pressure of CO₂ over 30% (wt) aqueous solution of ethanolamine at 25°C is given below.

Mol CO ₂ /mol solution	Partial pressure of CO ₂ (mmHg)
0.058	5.6
0.060	12.8
0.062	29
0.064	56
0.066	98.7
0.068	155
0.070	232

2. In a bioprocess, molasses is fermented to produce a liquor containing ethyl alcohol. A CO₂-rich vapor with a small amount of ethyl alcohol is evolved. The alcohol is recovered by absorption with water in a sieve-tray tower. Determine the number of equilibrium stages required for counter current flow of liquid and gas, assuming isothermal, isobaric conditions and that only alcohol is absorbed. Entering gas is 180 kmol/h; 98% CO₂, 2% ethyl alcohol; 30°C, 110 kPa. Entering liquid absorbent is 100% water; 30°C, 110 kPa. Required recovery (absorption) of ethyl alcohol is 97%. The gaseous mixture can be assumed to be ideal, but the ethyl alcohol-water mixture is not. Vapour pressure of ethyl alcohol at 30°C is 10.5 kPa and the liquid phase activity coefficient of ethyl alcohol is 6. (Hint: modified Raoult's law may be used to estimate the vapour liquid equilibrium distribution constant).