CH3030 Tutorial 2- 21 August 2020

1. A gas mixture containing 10 mol% SO_2 and 90 mol% air at 1 atm pressure and 30°C is to be scrubbed with water to remove 97% of SO_2 in a tower packed with 25mm ceramic Raschig rings. The feed gas rate is 1500 kg/h. Calculate

a) The minimum liquid flow rate

b) If the tower operates as 1.25 times the minimum liquid flow rate, the packed height of the tower.

The liquid can be assumed to have properties like water. The volumetric mass transfer coefficients at the given conditions are k_xa=1.25 kmol/m^{3}sΔx, k_ya = 0.075 kmol/m^{3}sΔy. Assume MTCs determined under UMD and EMD conditions are nearly the same. Cross sectional area of the tower is 0.781 m^2.

Equilibrium data in mole fraction unit at 30°C and 1 atm total pressure is

10^4x	0	0.562	1.403	2.8	4.22	8.42	14.03	19.65	27.9
10^3y	0	0.792	2.23	6.19	10.65	25.9	47.3	68.5	104

2. A CS_2-N_2 mixture is to be scrubbed with an absorbent hydrocarbon oil which will be subsequently steam stripped to recover the CS_2. The CS_2-N_2 mixture has a partial pressure of CS_2 of 50 mm Hg at 24°C and is to be blown into the absorber at atmospheric pressure at the flow rate of 0.4 m^3/s. The CS_2 content of the gas is to be reduced to 0.5%. The absorbent oil has an average molecular weight of 180 and viscosity 2cP, specific gravity 0.81 at 24°C. The oil enters the absorber, stripped of all the CS_2 and the solution of CS_2 and oil follows Raoult's law. The vapour pressure of CS_2 at 24°C =346 mmHg. Assume isothermal operation.
   a) Determine minimum liquid/gas ratio
   b) For liquid/gas ratio of 1.5 times the minimum, determine the kg/h oil flow rate to enter the absorber.
   c) Determine the number of theoretical trays required both graphically and analytically.
   d) Determine the overall tray efficiency of the bubble cap tray absorber using the plot below and the real number of trays required for this efficiency.

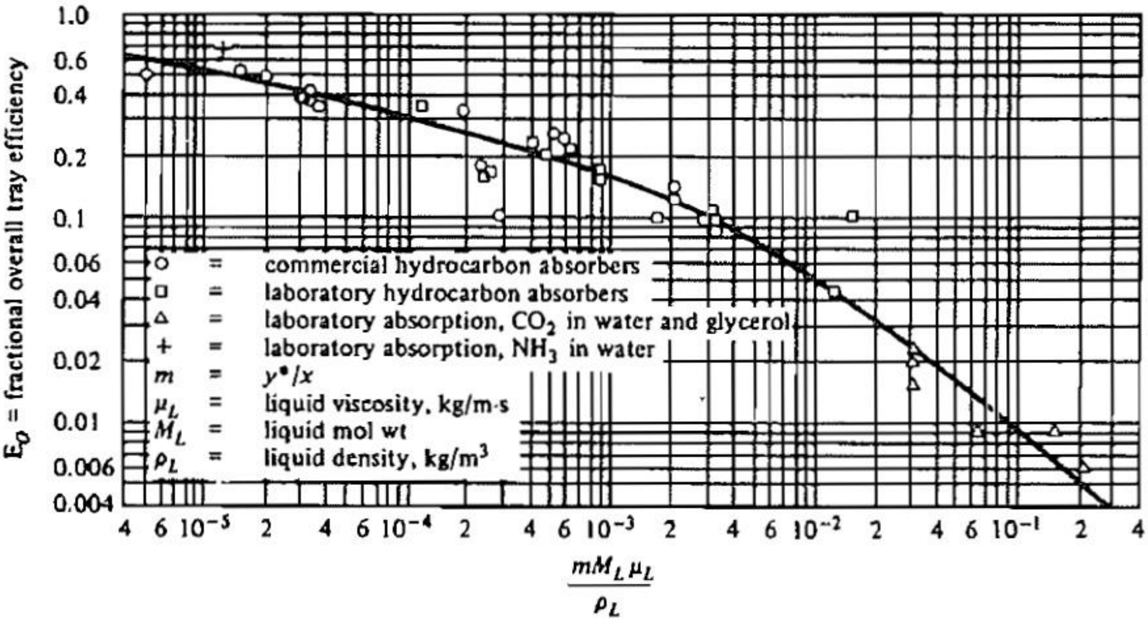

Figure 6.24 Overall tray efficiencies of bubble-cap tray absorbers. For μ_L in centipoises and ρ_L in lb/ft^3, use as abscissa $6.243 \times 10^{-5}\ mM_L\mu_L/\rho_L$. (*After O'Connell* [*90*].)