Department of Chemical Engineering, Indian Institute of Technology Delhi
CHL351: Mass Transfer Operations
Semester II, 2013-2014

Minor-I

Date: 22/03/14 | Closed Book & Notes | Marks: 16

1. A 300 kmol/h stream of aqueous methanol at having 45 mol% methanol is to separated into a top product having 96 mol% methanol and a bottom liquid with 4 mol% methanol. The feed entering column is 50% vaporized. A reflux ratio of 2.25 is used. Total condenser and open steam are used (instead of a reboiler). Determine
   a. [1 Mark] Slope of q-line.
   b. [4 Marks] Equation of stripping section operating line.
   c. [2 Marks] Number of theoretical stages required for this separation.
   d. [2 Marks] The steam rate.
   e. [2 Marks] The condenser heat load. Given following data for 96 mol% methanol: saturated vapor enthalpy (H_V) = 9725 kcal/mol, saturated liquid enthalpy (H_L) = 1260 kcal/mol

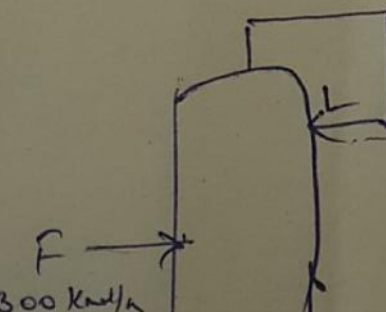
Equilibrium data

x	0	0.05	0.07	0.10	0.15	0.2	0.25	0.3	0.35	0.4	0.5	0.6	0.7	0.8	0.9	1
y	0	0.07	0.1	0.14	0.205	0.29	0.39	0.55	0.67	0.75	0.86	0.93	0.96	0.98	0.99	1

2. Answer the following in a word or a sentence. For long answer only the first two lines will be evaluated.
   a. [1 Mark] For a given distillation column, without changing number of trays and feed location, how can the distillate purity be increased?
   b. [1 Mark] Which parameters of the distillation column get affected by the measure of part (a)?
   c. [1 Mark] When do enthalpy concentration diagram become straight line(s).
   d. [2 Marks] What conditions/assumptions about enthalpy/latent heat allow equimolar liquid overflow and equal vaporization in a distillation column?

END

q-line = $y = \left(\frac{q}{1-q}\right)x - \left(\frac{1}{1-q}\right)z_F$



$x_D = 0.96$

$\frac{L}{D} = 2.25$

$F + S = B + D$

$\frac{F}{2} + S = L + D$