Chemical Engineering 476

Fall 2014

1. Review of stage stepping for absorption columns
2. Stripping Columns (dilute systems)
    a. Known: inlet liquid, outlet liquid (target), inlet gas
    b. Location of equilibrium line
    c. Find gas flow rate and number of stages or, alternatively, compositions if number of stages is given
    d. Text recommends stepping off stages from top of column
3. Analytical solution for dilute absorbing and stripping systems
    a. In situations where both the operating and equilibrium curves are linear, an analytical solution is possible! Why?
    b. Absorption Factor (L/mV); Guideline: $(L/V)_{op} \approx m/0.7$
    c. Stripping Factor (mV/L); Guideline: $(L/V)_{op} \approx m/1.4$
    d. Kremser Equations
    e. Example- Use Kremser equation to calculate number of trays for Example 12-1

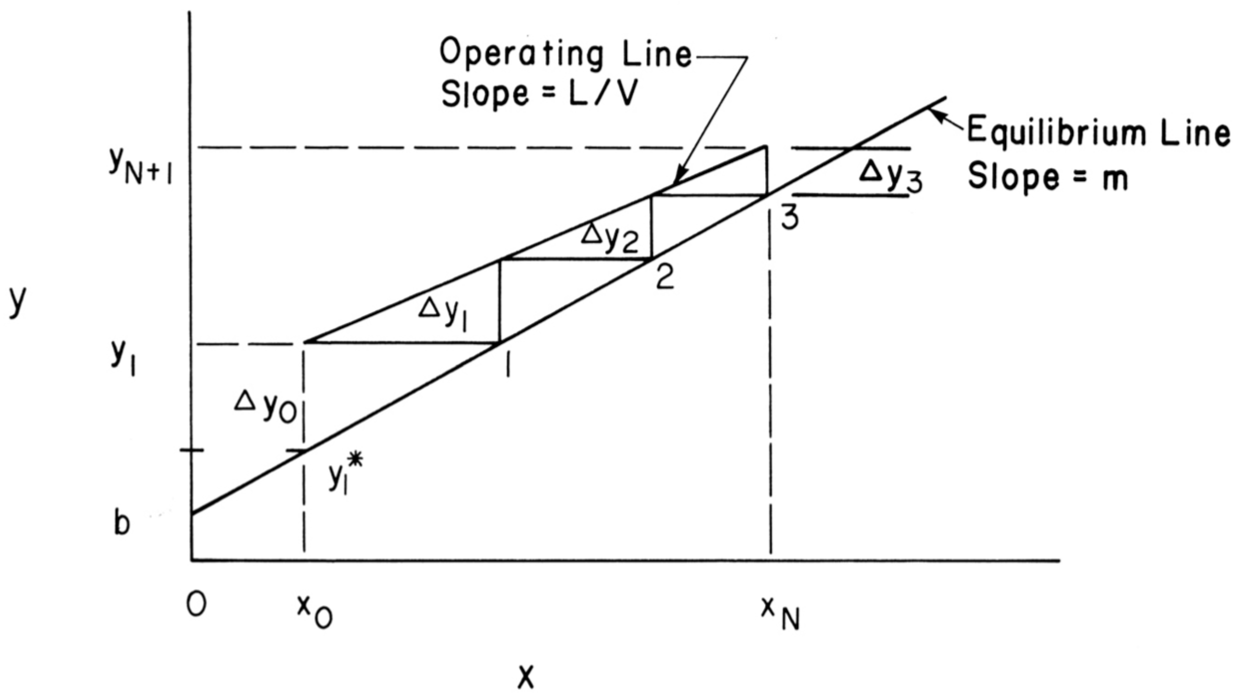


Figure 12-7 McCabe-Thiele diagram for dilute absorber. (L/V) < m

Result: Kremser Equations

Absorber Form

y_{N+1} = Composition of entering gas
y_1 = Composition of exiting gas (target)
$y^*{}_1$ = Gas composition that would be in equilibrium with the entering liquid
m = Slope of the equilibrium curve
L/V = Slope of the operating curve
N = Number of equilibrium stages

$$\frac{y_{N+1} - y^*{}_1}{y_1 - y^*{}_1} = \frac{1 - \left(\frac{L}{mV}\right)^{N+1}}{1 - \frac{L}{mV}} \quad Eq. 12-21$$

$$N = \frac{\ln\left[\left(1 - \frac{mV}{L}\right)\left(\frac{y_{N+1} - y^*{}_1}{y_1 - y^*{}_1}\right) + \frac{mV}{L}\right]}{\ln\left(\frac{L}{mV}\right)} \quad Eq. 12-22$$

$$N_{actual} = -\frac{\ln\{[1 - mV/L]\left[(y_{N+1} - y^*{}_1)/(y_1 - y^*{}_1)\right] + mV/L\}}{\ln[1 + E_{MV}(mV/L - 1)]} \quad Eq. 12-34$$

Stripping Form

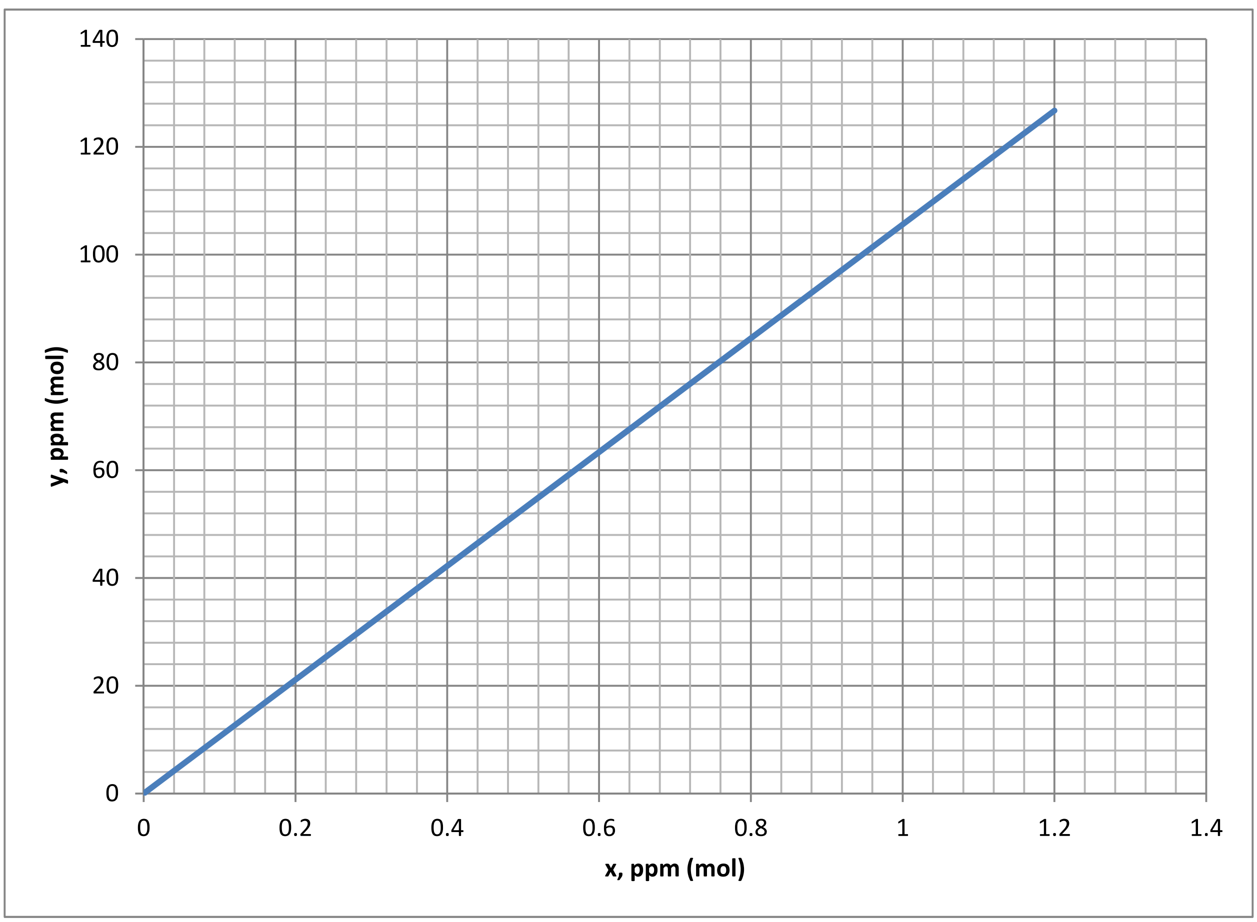
x_N = Composition of exiting liquid (target)
x_0 = Composition of entering liquid
$x^*{}_N$ = Liquid composition that would be in equilibrium with the entering gas
m = Slope of the equilibrium curve
L/V = Slope of the operating curve
N = Number of equilibrium stages

$$\frac{x_N - x^*{}_N}{x_0 - x^*{}_N} = \frac{1 - (mV/L)}{1 - (mV/L)^{N+1}} \quad Eq. 12-31$$

$$N = \frac{\ln\left[\left(1 - \frac{L}{mV}\right)\left(\frac{x_0 - x^*{}_n}{x_N - x^*{}_N}\right) + \frac{L}{mV}\right]}{\ln(mV/L)} \quad Eq. 12-28$$

Example (12-1 from your text)

1000 kmol/h of air containing 100 ppm (mol) of chloroform at 25C and 2 atm is to be processed. We will absorb the chloroform into pure water to reduce the amount in the gas to 10ppm. The Henry's Law constant is 211.19 atm/mol. frac. L/V for this problem is 133 (see example problem in text). The exiting liquid composition, from an overall material balance, is $x_N = 0.677$ ppm.



Same chemistry as Example 12-1, Stripping Column

Suppose that you have a liquid flow rate of 10,000 kmol/h containing 1.16 ppm (mol) of chloroform at 25 C and 2 atm. We want to remove the chloroform with a gas stream to reduce the liquid concentration to 0.2 ppm. The flow rate of the gas is 126.3 kmol/h. The chloroform concentration in the gas inlet stream is 4ppm.

Plot the operating line for the stripping column and determine the number of equilibrium stages required. Start stepping from the top of the column.