Liquid - Liquid Extraction

Note Title 11/21/2013

Extraction - Process where one or more solutes are removed from a liquid by transferring the solute to a second liquid

How is the process different with two liquids instead of a gas and a liquid?

- What characteristics must the liquids have?
- How might an extraction process couple with another separation process?
- What about interfacial contact? Why is this important?

Types of equipment (Fig. 13-2)

Equilibrium stages - straightforward
Efficiencies and hydrodynamics more difficult.

"Language"

Solute - material to be moved from one liquid phase to the other.

Diluent - Liquid in which the solute is initially dissolved.

Solvent - 2nd liquid used to extract the solute from the Diluent.

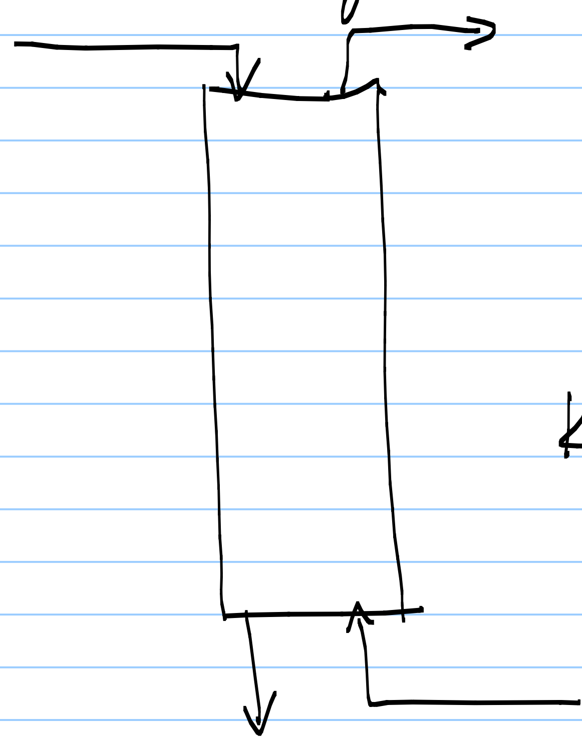
Raffinate - streams with high concentrations of Diluent

Extract - streams with high concentrations of Solvent

x = fraction in Raffinate
y = fraction in solvent

F_D = Diluent flow rate (constant)
F_S = Solvent flow rate (constant)

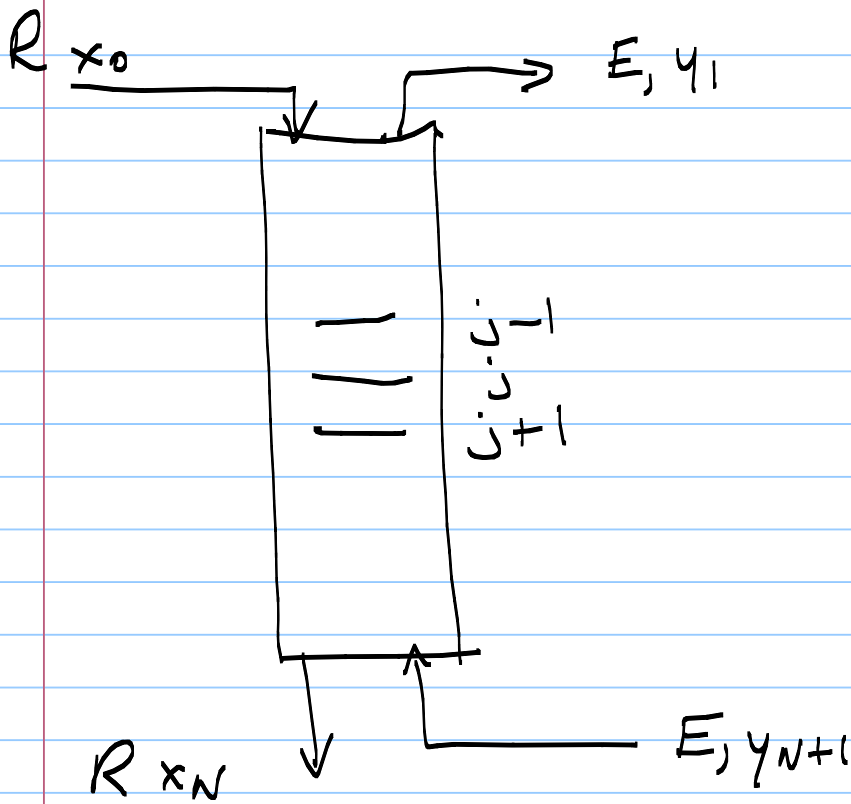
Assume:
- D and S totally immiscible
- Dilute solution
- Const T & P
- ΔH_{mix} not important



Which stream goes up?

E or R?

$$K_d = \frac{y}{x}$$



Write a material balance for y_{j+1} (equilibrium stages)

McCabe Thiele analysis

K_D is often constant for dilute systems.

Kremser?

Example 1:

A feed of 100 kg/min of a 1.2 wt % mixture of acetic acid in water is to be extracted with 1-butanol at 1 atm and 26.7 °C. Desired outlet stream = 0.1 wt % acetic acid.

Assume dilute.

$$K_D = \frac{y}{x} = 1.613 \quad \text{(Table 13-3)}$$

Determine

1) Minimum Extract flow rate

2) Number of equilibrium stages at $\left(\frac{R}{E}\right) = 0.8\left(\frac{R}{E}\right)_{max}$

(Does this act like absorption or stripping column?

$R = 100$ kg/min $\qquad x_0 = 0.012$ wt

$D = 98.80$ kg/min

$E = ?$ $\qquad x_N = 0.001$ wt

$y_{N+1} = 0$

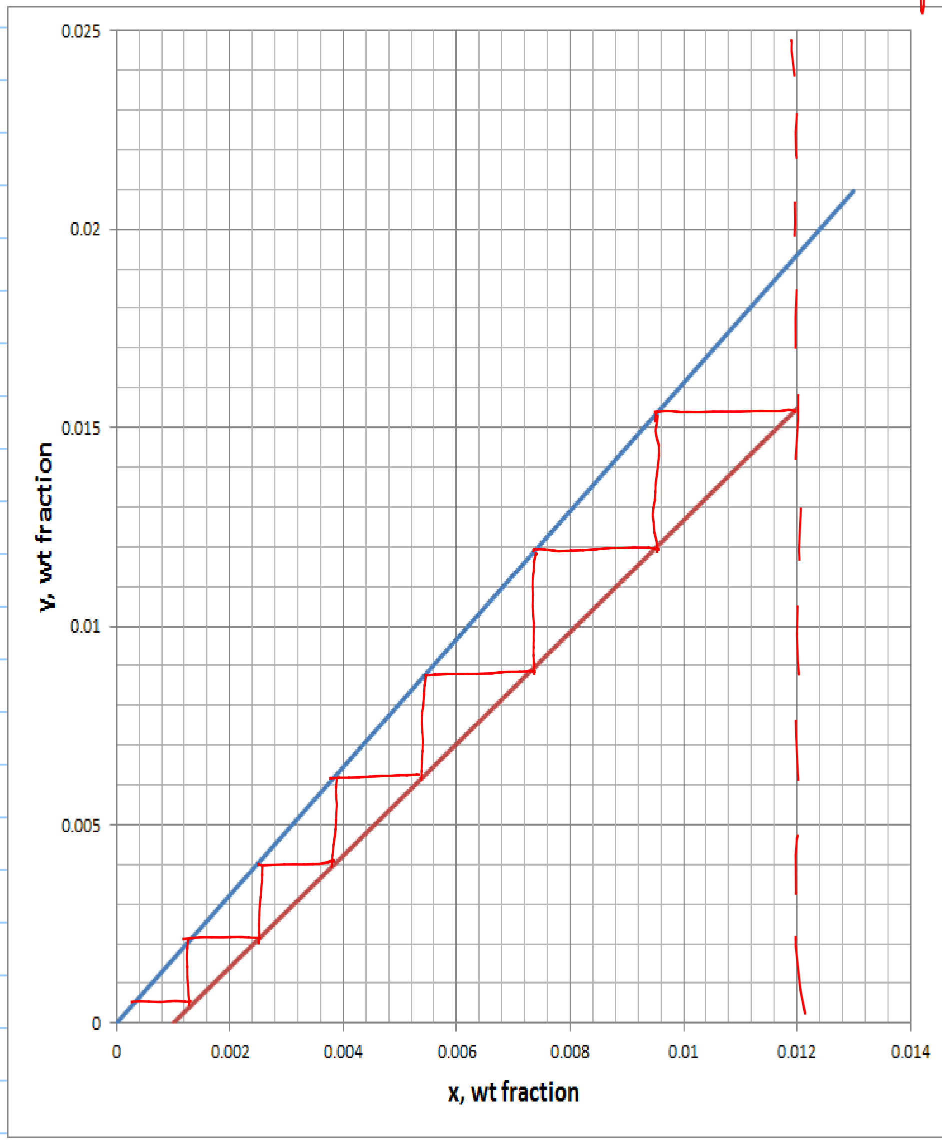
For minimum flow

$y = 1.613\,x \qquad y_{1,eq} = 0.019356$

$$\left(\frac{R}{E}\right)_{max} = \frac{0.019356 - 0}{0.012 - 0.001} = 1.760$$

$$\left(\frac{R}{E}\right) = .8(1.760) = 1.41$$

Look at end point



$E_{min} = 56.8$ kg/min

$E = 71.0$ kg/min

$\left(\frac{R}{E}\right) = 1.41 = \frac{y_1 - 0}{0.012 - 0.001}$ $\quad y_1 = 0.0155$

Trays?