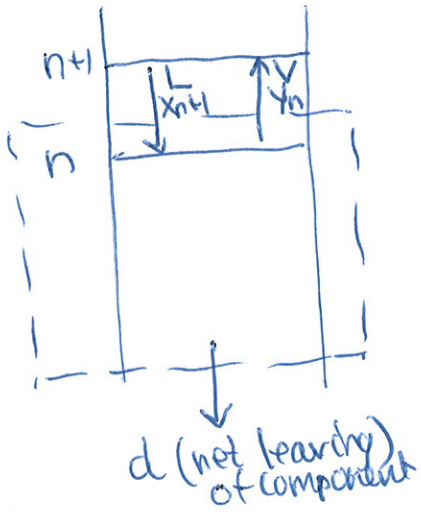
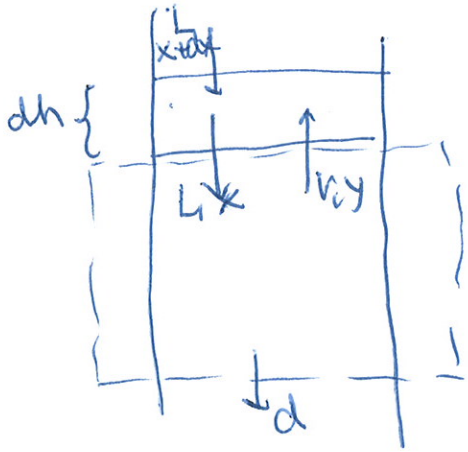
NO! see yellow striker below

SiS
10/8-07
9/11-09

Derivation of equivalence between stage model and rate-based model

STAGE





Mass balance of a given component

$$Lx = Vy + d$$

Mass transfer in liquid phase over differential height dh

$$\underbrace{L(x+dx) - Lx}_{Ldx} = k_y a S \overbrace{dh}^{dV} (y^* - y)$$

assume constant (vapor phase limited)

Get

$$\frac{dx}{dh} = \frac{k_y a S}{L} (y - y^*)$$

or

$$\frac{V}{k_y a S} \frac{dx}{dh} = \frac{V}{L} (y^* - y)$$

dh = H_{OG}

Let H_{OG} be "height of transfer unit" (stage)

and Assume $\frac{dx}{dh}$ is constant over length H_{OG},

Then $\frac{dx}{dh} \approx \frac{x_{n+1} - x_n}{H_{OG}}$

and mass balance becomes

$$x_{n+1} - x_n = \frac{V}{L}(y^* - y) = \frac{V}{L} y^* - x + \frac{d}{L}$$

q.e.d.

Rewrite mass balance

$$x_{n+1} - x_n = \frac{V}{L} y_n^* - x_n + \frac{d}{L}$$

Assume equilibrium

$$y_n = y_n^* \quad (= k(x_n))$$

$$L x_{n+1} = V y_n + d$$

This assumption of piecewise linearity is OK if many stages + OK in high-purity region