Dilute solutions obeying Henry's law:

Tray Towers:

Dalton's law: $p = y\ p_t$

Henry's law : $p = \mathcal{H}\ x$ (Raoult's law: $p = p^s\ x$)

$$y = \frac{\mathcal{H}}{p_t}\ x$$

$y = m\ x$ $\qquad\qquad$ $y = \frac{p}{p_t}\ x$

Where m is a constant

This is a straight line equation using mole fractions

For dilute solutions

$y \cong Y \qquad and \qquad x \cong X$

$G \cong G_s \qquad\qquad L \cong L_s$

$\therefore$ any concentration unit will give straight lines: operating and equilibrium

In these cases the number of theoretical plates can be determined using the Kremser equations

	Absorption	Stripping
$A \neq 1$	$N_p = \dfrac{\left[\dfrac{N_{N_p+1} - mx_o}{y_1 - mx_o}\left(1 - \dfrac{1}{A}\right) + \dfrac{1}{A}\right]}{\log A}$	$N_p = \dfrac{\log\left[\dfrac{x_o - N_{N_p+1}/m}{y_1 - N_{N_p+1}/m}\left(1 - \dfrac{1}{S}\right) + \dfrac{1}{S}\right]}{\log S}$
$A = 1$	$N_p = \dfrac{y_{N_p+1} - y_1}{y_1 - mx_o}$	$N_p = \dfrac{x_o - x_{N_p}}{x_{N_p} - {y_{N_p+1}}/{m}}$

$$A = {L}/{mG}\ , \qquad and \qquad S = {mG}/{L}$$

Notes:

- These relations can also be used with mole ratios since $y \cong Y\ and\ x \cong X$
- If A top is not the same as A bottom, a geometric average can be used $A_{average} = \sqrt[2]{A_{top} \cdot A_{bottom}}$

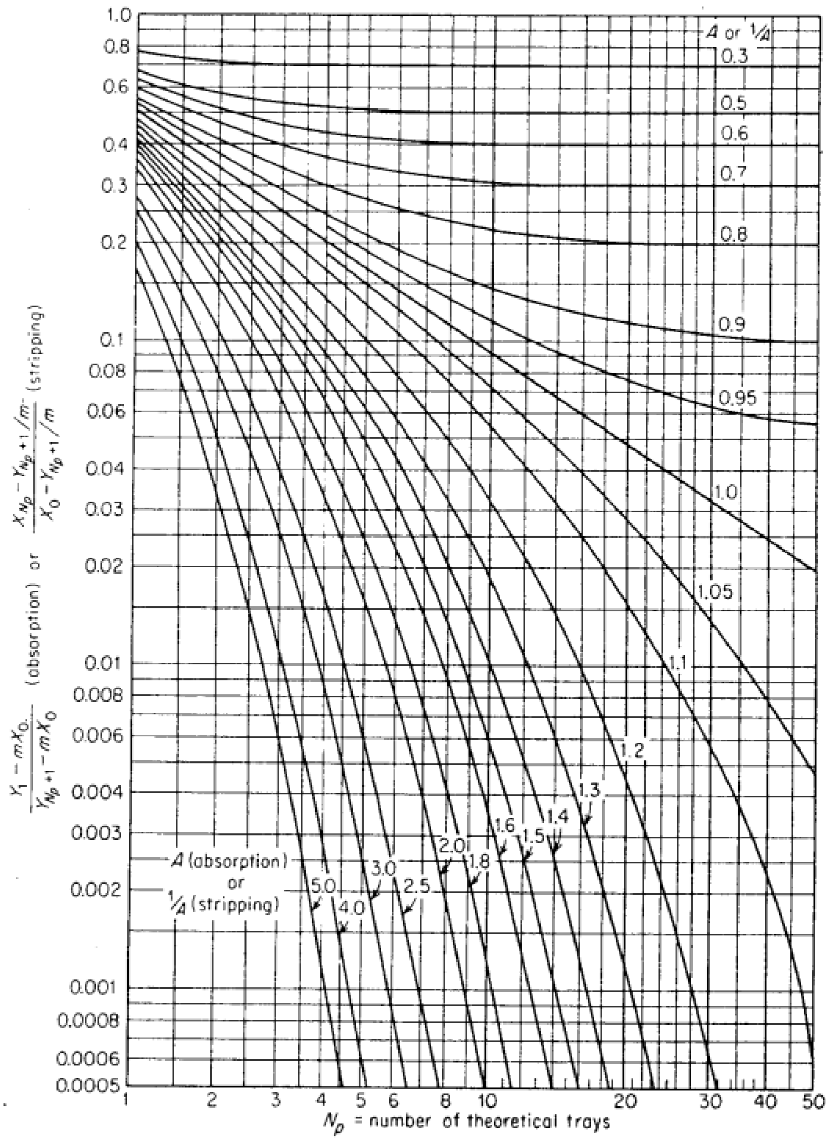

Figure 5.16 Number of theoretical stages for countercurrent cascades, with Henry's law equilibrium and constant absorption or stripping factors. [*After Hachmuth and Vance, Chem. Eng. Prog.*, **48**, *523, 570, 617 (1952).*]

Packed Towers:

The Kremser type equations for packed towers may be used:

$$y = m\,x$$

For absorbers:

$$N_{tOG} = \frac{ln\left[\frac{y_1 - mx_2}{y_2 - mx_2}\right]\left(1 - \frac{1}{A}\right) + A}{1 - \frac{1}{A}}$$

A =absorption factor = $\frac{L}{mG}$

For strippers:

$$N_{tOL} = \frac{ln\left[\frac{x_2 - y_1/m}{x_1 - y_1/m}\right]\,(1 - A) + A}{1 - \frac{1}{A}}$$

Relationship between N_{tOG} and N_p :

$$N_{tOG} = \frac{1}{1 - \frac{1}{A}}\ \ln A \quad N_p$$

A = 1.25 $N_{tOG} = 1.116\,N_p$

A = 2.0 $N_{tOG} = 1.386\,N_p$

For Strippers

$$N_{tOL} = \frac{\ln(S)}{1 - A}\ N_p$$