# Gas Absorption with Plate Absorbers

*One man's magic is another man's engineering.*

Lazarus Long

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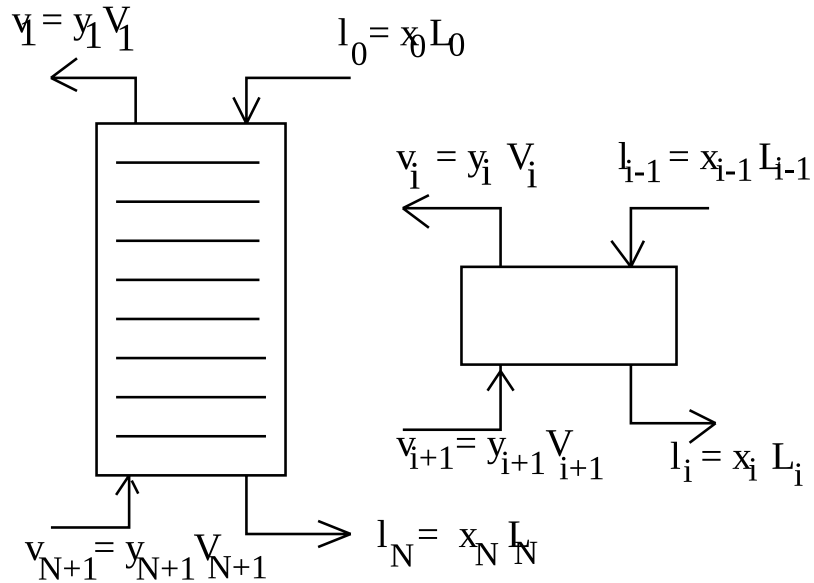
- This unit operation is modeled as a cascade of equilibrium stages
- The assumption of equilibrium is weak and is corrected by the use of tray efficiencies

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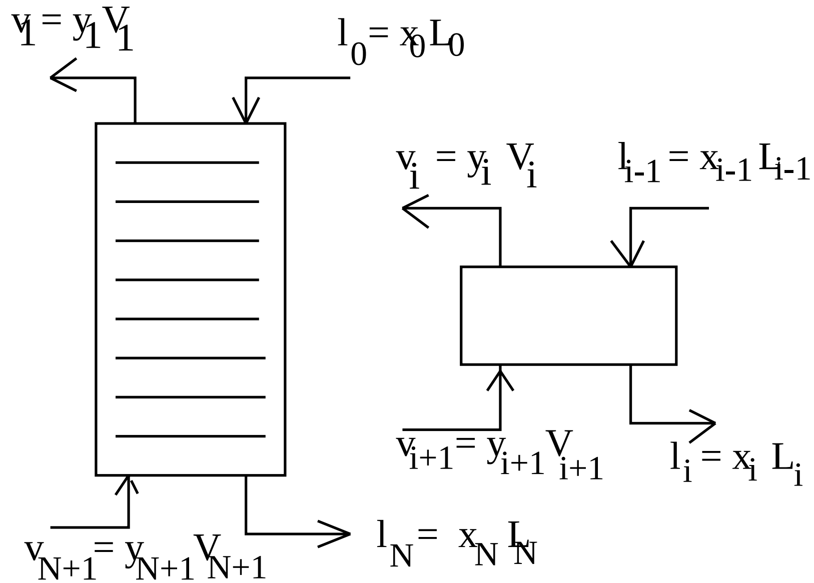


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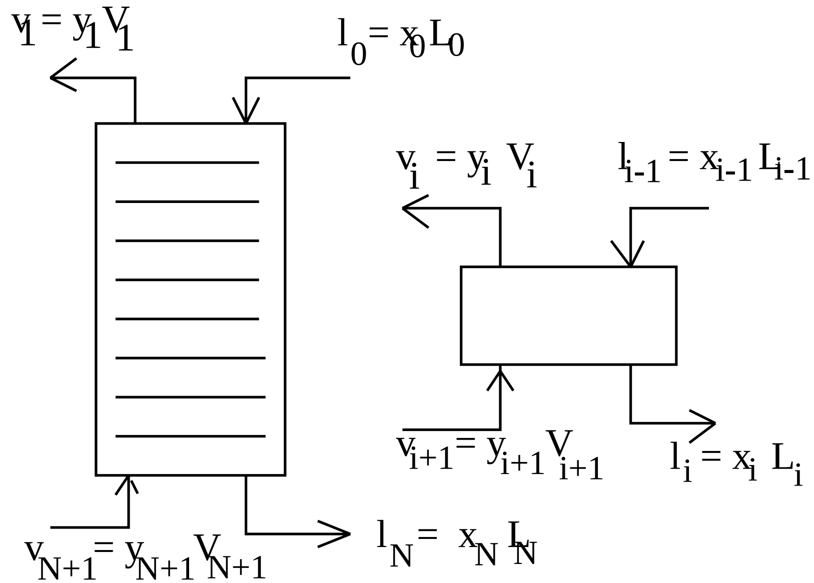


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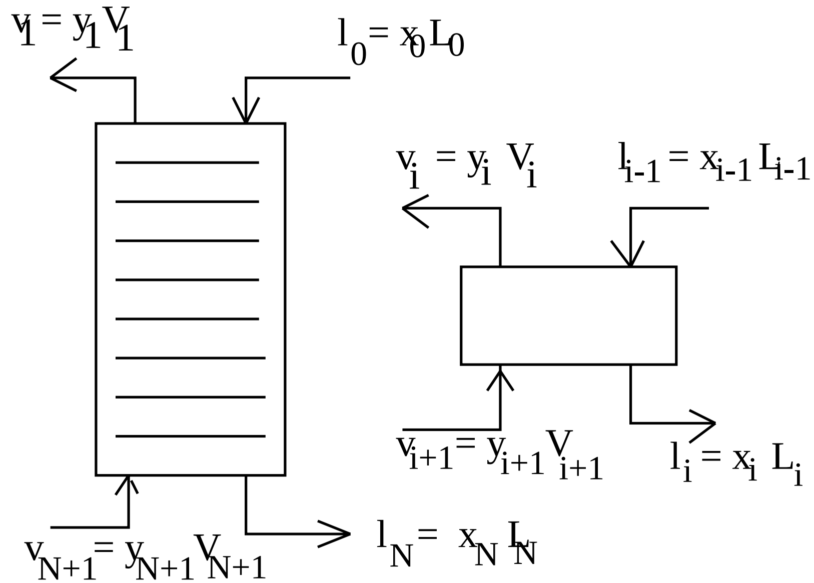


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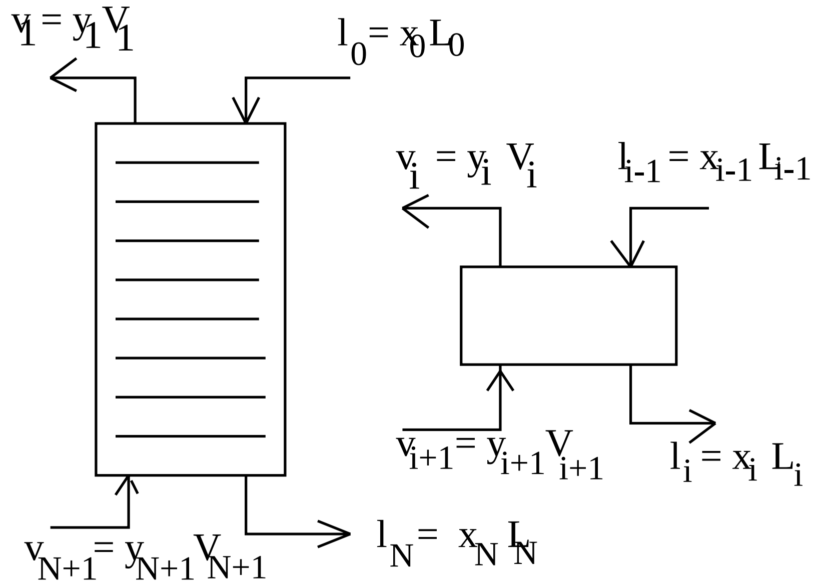


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  4. Flowrate ($L_0$) of the absorbing liquid stream

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For each stage, the absorption factor $A_i$ will be different. If we assume a constant absorption factor $A_E$ for all the stages, we get simplified mass balance equations.

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$$v_{N+1} = \sum_{i=0}^{N} (A_E)^i v_1 - \sum_{i=0}^{N-1} (A_E)^i l_0$$

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which simplifies the relationship for $v_{N+1}$ to:

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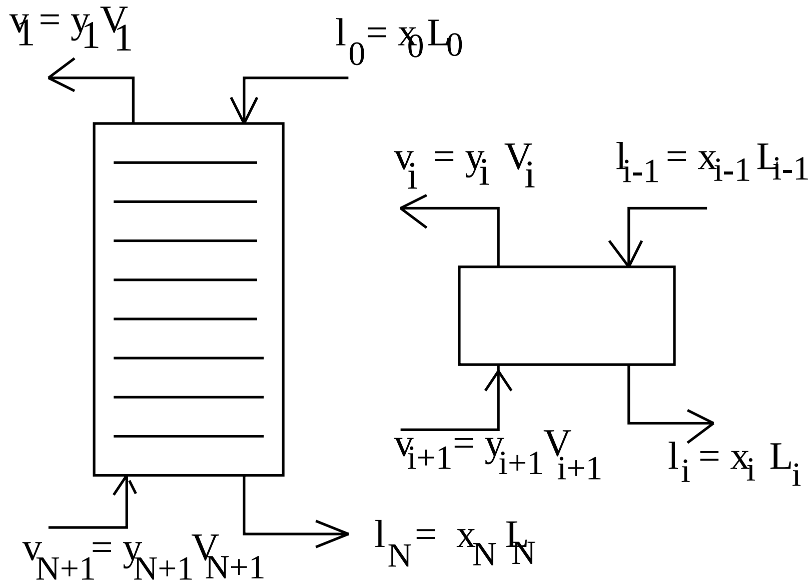


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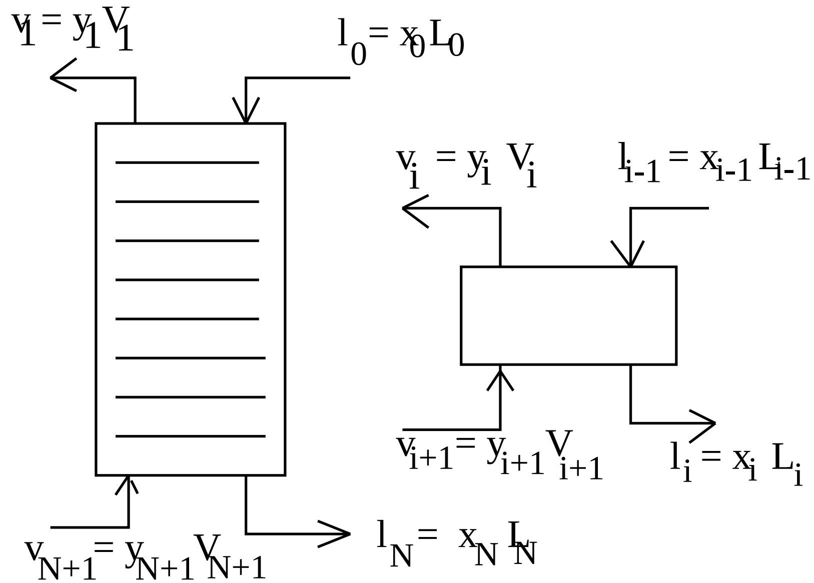


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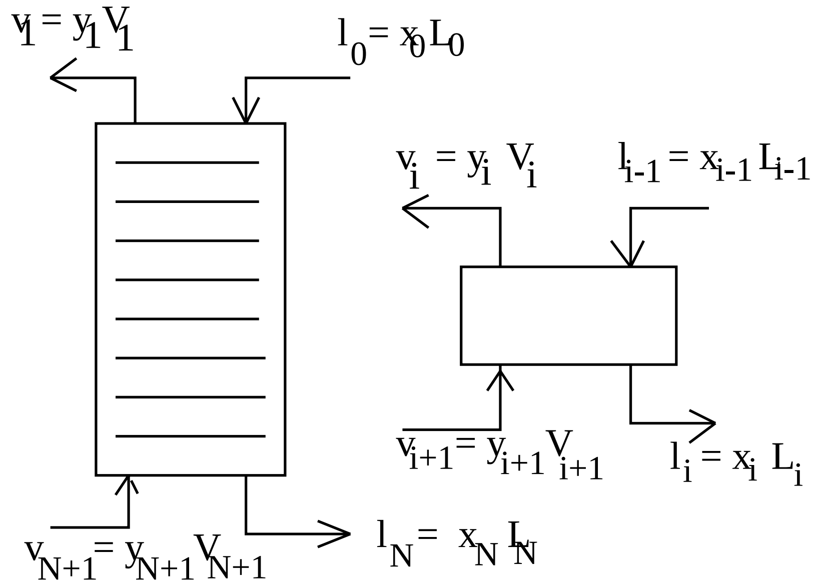
$$l_N = v_{N+1} + l_0 - v_1$$

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The above equations are valid for any component $k$ in the column.

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Substituting for $\beta_N$ in terms of $A_E$, and solving for $N$ results in the Kremser equation:

$$N = \frac{ln\left\{\dfrac{l_0^n + (r - A_E)v_{N+1}^n}{l_0^n - A_E(1-r)v_{N+1}^n}\right\}}{ln\left\{A_E\right\}}$$

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- Solvent temperature (assume isothermal operation)
- The absorption factor $A_E = 1.4$ (choose this as initial guess) which fixes the liquid flow rate

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- Calculate the number of stages from the Kremser equation

$$N = \frac{ln\left\{\dfrac{l_0^n + (r - A_E)v_{N+1}^n}{l_0^n - A_E(1-r)v_{N+1}^n}\right\}}{ln\left\{A_E\right\}}$$

- Calculate absorption factors for non-key components

$$A^k = \frac{L_0}{V_{N+1}} \frac{P}{P_k^0(T)} \quad k \neq n$$

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- Calculate aggregate terms ($\beta$ values) for non-key components

$$\beta_N^k = \frac{\left[1-(A^k)^{N+1}\right]}{1-A^k}$$

$$\beta_{N-1}^k = \frac{\left[1-(A^k)^{N}\right]}{1-A^k}$$

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  2. If too much solvent vaporizes in $v_1$, increase $P$ or decrease $T$.
  3. If too many undesirable components are absorbed, increase $T$, decrease $P$, or select a more suitable solvent for absorption.