Leaching-02

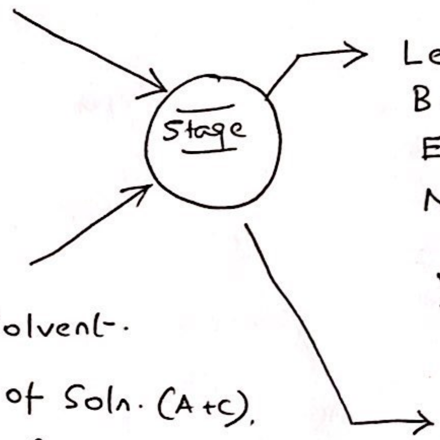
RM/01

Single Stage Leaching Unit

For Leaching

$A \rightarrow$ Solvent.
$B \rightarrow$ Insoluble.
$C \rightarrow$ Solute

Solid to be Leached.
$B \rightarrow$ Mass of Insolubles.
$N_F = \frac{B}{A+C}$
$y_F = \frac{C}{A+C}$



Leached Solid.
$B \rightarrow$ Mass of Insoluble.
$E_1 \rightarrow$ mass of $(A+C)$ in Solid Stream.
$N_1 \rightarrow$ Fraction of B on a B Free Basis.
$y_1 \rightarrow$ mass fraction of C on a B Free Basis

Leaching Solvent.
$R_0 =$ mass of Soln. $(A+C)$.
$x_0 =$ Mass fraction of C on B free Basis.

Leach Solution
$R_1 \rightarrow$ mass of Solution $(A+C)$.
$x_1 \rightarrow$ mass of C / mass of $(A+C)$

For Pure Solvent, $x_0 = 0$, and $y_F = 1$.
$N_0 = 0$.

Each stage represents the entire operation, including mixing of Solids, with Leaching solvent, ~~and~~ upto mechanical sepn. of resulting insoluble phases.

For all practical purpose, B is insoluble in Solvent and a clear Liquid Leach Solution is obtained.

$$B = N_F \cdot F = E_1 N_1 \qquad -(1)$$

Also, a solute balance gives. [C balance]

$$F \cdot y_F + R_0 x_0 = E_1 y_1 + R_1 x_1$$

So, the Solvent (A) is as follows:-

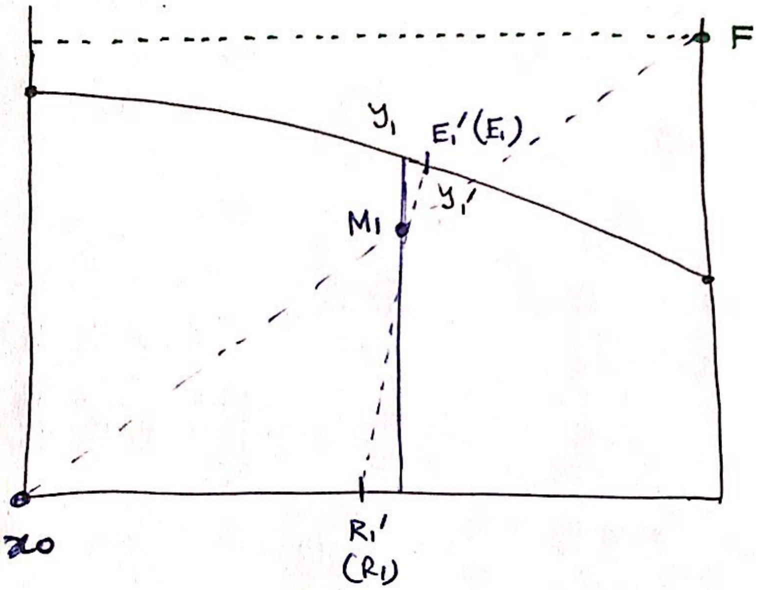
$$F(1-y_F) + R_0(1-x_0) = E_1(1-y_1) + R_1(1-x_1)$$

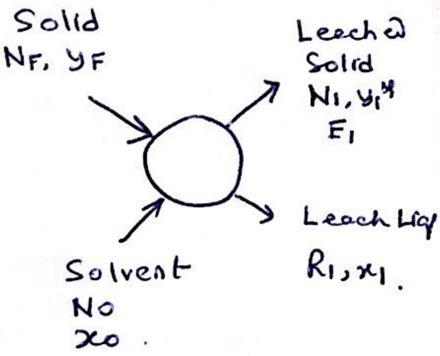
Overall Balance (B Free Basis)

$$F + R_o = E_1 + R_1 + M . \quad — (2)$$

The mixture point on B free Basis is given by

$$N_{M_1} = \frac{B}{F + R_o} = \frac{B}{M_1} \quad \text{and} \quad y_{M_1} = \frac{y_F F + R_o x_o}{F + R_o}.$$





Once the Co-ordinates of the Point. E_1 and R_1 are found out, then. Equation (1) and (2) to find out E_1 and R_1.

Stage Efficiency can be Calculated

as $$\eta = \frac{y_F - y_1'}{y_F - y_1^*}$$ < Arguably due to short Contact time >.

Multi Stage Cross Current Leaching →.

In this approach the leached Solids of the First stage is contacted with the fresh Solvent.

This process is ideally suited in Systems where there is tendency of the solute to remain stuck ~~in the~~ within the porous, insolubles.

Example: 13.2, Worked out, page 749

Caustic Soda is made by treatment of $Ca(OH)_2$ with solution of Sodium Carbonate. The resultant slurry contains particles of Calcium Carbonate ($CaCO_3$) suspended in 10% solution of NaOH, 0.125 kg. Suspended solid / kg solution.. This is settled and the clear sodium hydroxide solution withdrawn and replaced by equal weight of water, and the mixture thoroughly agitated. After repetition of this procedure (a total of two fresh water washes), what fraction of the original NaOH in the slurry remains unrecovered and therefore lost in the sludge? The settling characteristics show adsorbtion of the solute on the solid.

The Equilibrium data is given as.

x = Wt fraction of NaOH in clear soln.	N = kg $CaCO_3$/kg soln. in settled sludge.	y^* = Wt. fraction NaOH in soln. of settled sludge.
0.0900	0.495	0.0917.
0.0700	0.525	0.0762.
0.0473	0.568.	0.0608.
0.0330	0.600	0.0452.
0.0208	0.620	0.0295.
0.01187	0.650	0.0204.
0.00710	0.659	0.01435
0.00450	0.666	0.01015

The equilibrium data and tie line are plotted.

Here B is $CaCO_3$.

A + C = NaOH and Water. 10% NaOH in Water.

C = NaOH (Solute)

A = Water.

If we take basis as 1 kg ~~feed~~ of Solution

Then C = 0.1 kg B = 0.125 kg.

A = 0.9 kg

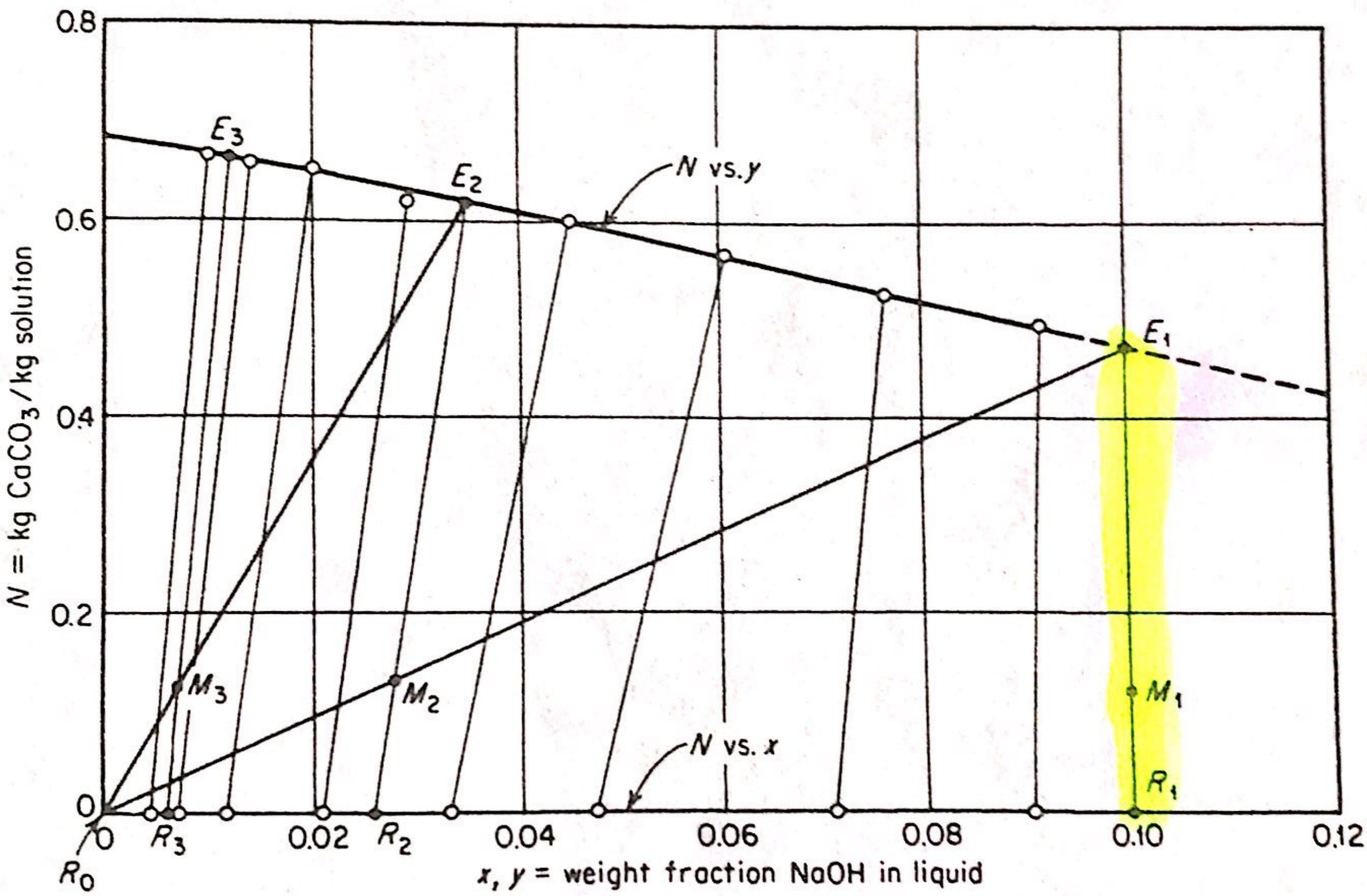


Figure 13.27 Solution to Illustration 13.2.

Basis : 1 kg ~~of~~ Solution in the original mixture.
Which Contains 0.1 kg NaOH (C) and 0.9 kg H_2O (A).

$B = 0.125$ kg $CaCO_3$.

Mixture Composition. $N_{M_1} = 0.125$
$y_{M_1} = 0.10$

So First we locate point M_1 and then draw the tie line through it. So we get the Composition of E_1 and R_1.

From graph. $N_1 = 0.47$
$y_1 = 0.10$

$\therefore E_1 = \dfrac{B}{N_1} = \dfrac{0.125}{0.47} = 0.266$ kg Solution in the Sludge.

$\therefore$ Clear Soln $= 1 - 0.266 = 0.734$ kg Clear solu. withdrawn after the first stage.

<u>Stage 2:</u> $R_o = 0.734$ kg. water (Solvent) added.
$x_o = 0$.

$\therefore M_2 = E_1 + R_o = (0.266 + 0.734)$ kg $= 1.0$ kg.

$N_{M_2} = \dfrac{B}{E_1 + R_o} = 0.125$.

So we join $R_o E_1$, where it's value equals N_{M_2}, that's point M_2. Get the tie line from there. to get Point E_2

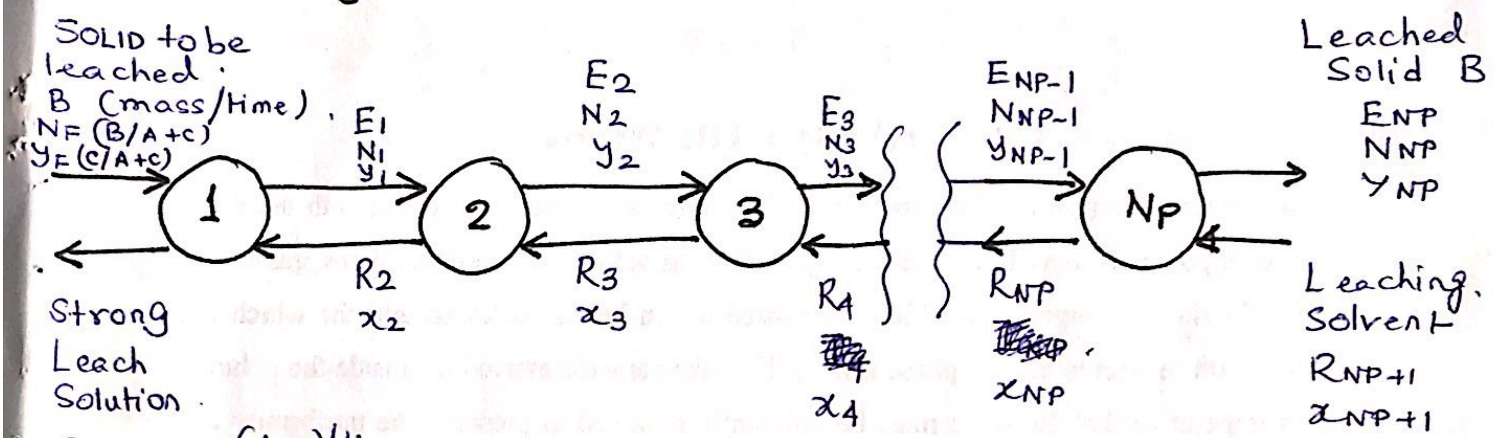
$N_2 = 0.62$, $y_2 = 0.035$

$E_2 = \dfrac{B}{N_2} = \dfrac{0.125}{0.62} = 0.202$ kg.

$\therefore$ Solution withdrawn is $1 - 0.202 = 0.788$ kg.

Similarly for stage ~~3~~ 3 find out E_3 and y_3.
Unrecovered NaOH is $(E_3 y_3)$

Multi Stage Counter Current Leaching.



R_1 mass $(A+C)$/time

x_1 mass C/mass $(A+C)$.

In the above flowsheet, it is assumed that solid B is insoluble and is not lost in the clear solution.

A <u>solvent</u> balance for the entire plant is

$$F + R_{NP+1} = R_1 + E_{NP} = M. \qquad (3)$$

$\Rightarrow \boxed{F - R_1 = E_{NP} - R_{NP+1} = M}$

and solution Balance is

$$F y_F + R_{NP+1} x_{NP+1} = R_1 x_1 + E_{NP} y_{NP} = M y_M.$$

M represents the hypothetical B free mixture obtained by mixing solids to be leached and the leeching solvent.

The co-ordinates of the point M are

$$N_M = \frac{B}{F + R_{NP+1}}$$

$$y_M = \frac{F y_F + R_{NP+1} x_{NP+1}}{F + R_{NP+1}}.$$

Similarly one can write. (based on a soln. balance)

$$F - R_1 = E_1 - R_2 = E_2 - E_3 = \Delta R.$$

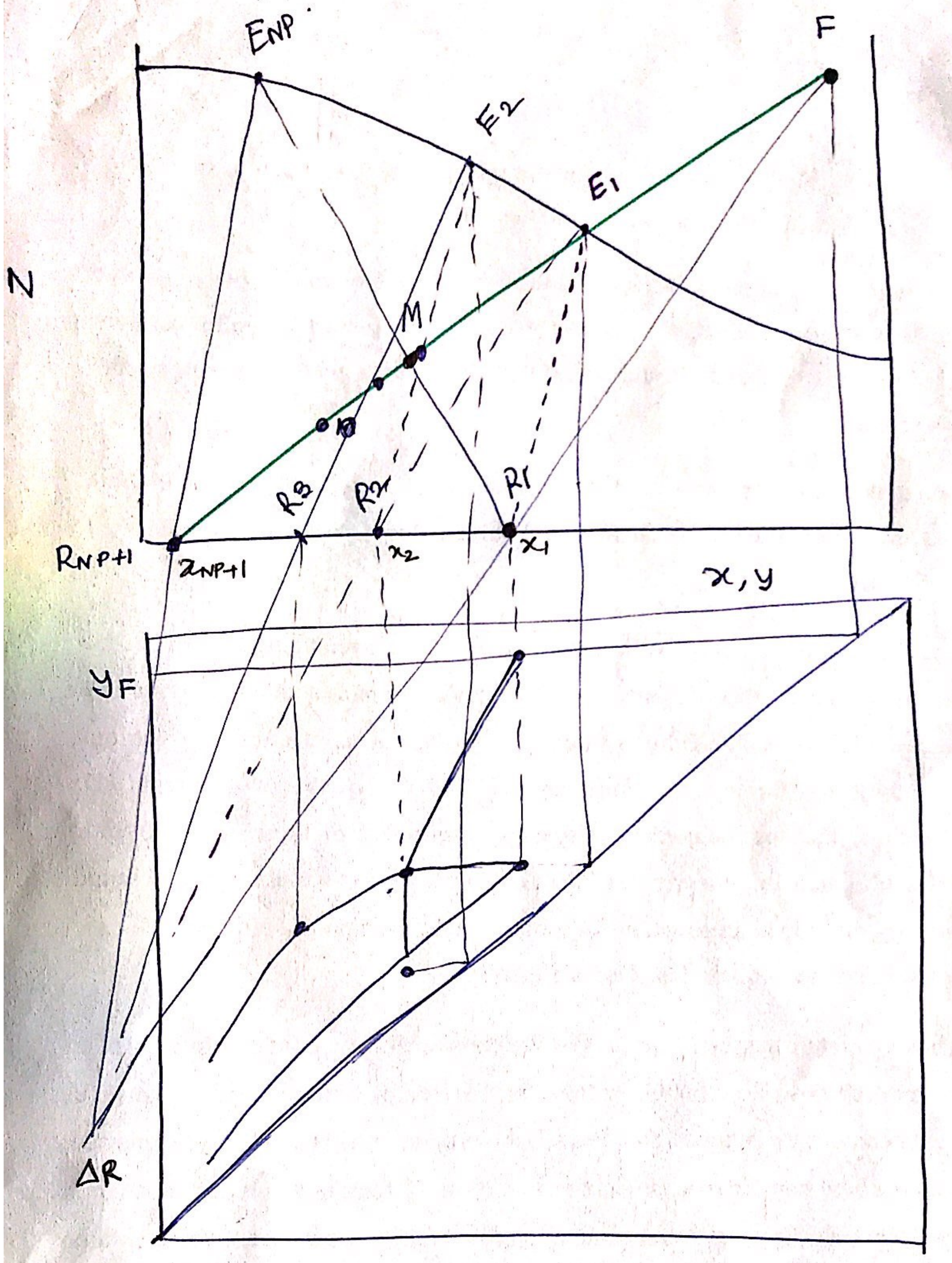
ΔR represents the constant difference ū flow $E - R$. (usually negative).

After locating ΔR., A line from E_1 to ΔR. provides R_2. and so forth.

The points E_{NP} and ~~R_{NP+1}~~ R_1 represents the effluent. from the cascade.

$$F - R_1 = E_{NP} - R_{NP+1} = \Delta R.$$

Similarly $F - R_1 = E_3 - R_4 = \Delta R.$



Locate F
Locate R_1

Locate E_{NP}
Locate R_{NP+1}

To do so we need
y_F, x_{R_1}
y_{NP}, $x_{R_{NP+1}}$
and corresponding N.

The points E_{NP} and R_1, represents the effluents from. the cascade, must lie on a line ~~Patti~~ passing. thru' M., and Further E_{NP} will be on the equilibrium. Curve

Eqn (3) Can be re-written as

$$F - R_1 = E_{NP} - R_{NP+1} = \Delta_R .$$

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