MATERIAL BALANCE

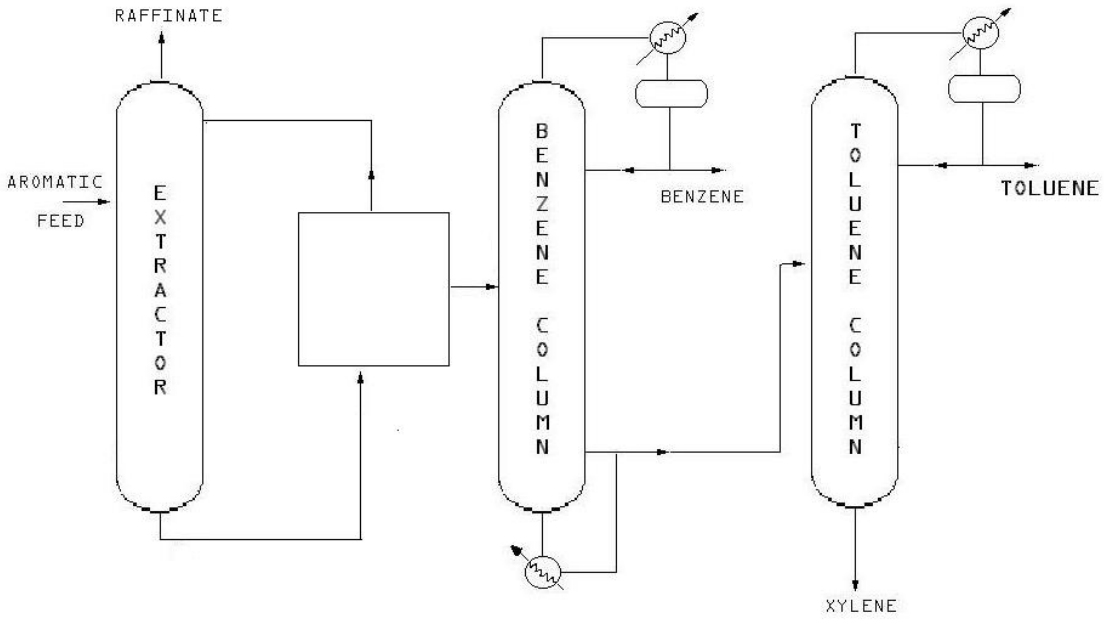
The material balance for this 'solvent extraction process' is done by referring the material balance table given in "Introduction to Petroleum Chemicals" by H. Steiner.

Diethylene glycol is used as a solvent.

Since the loss of Diethylene glycol is considered to be negligible, the total amount of solvent will remain constant through out the operation and do not require any make up volume as replenishment.

Therefore the composition of the pure aromatics(excluding solvent) will be same in solvent free basis at point 1 & 2 in the flow diagram where, point (1) refers the location where the extract is been send to the solvent stripper. And point (2) refers the feed to the first fractionator. Therefore the amount of solvent taken for this process is not considered in the material balance.

Therefore the flow diagram can be simplified to,



The material balance around the envelop I

It is assumed that fraction of C9 compounds which is very negligible in quantity, is mixed with Xylene compound.]

Then the feed composition becomes:

Compound	Vol. %	Wt %
Benzene	0.076	0.073
Toluene	0.215	0.2038
Xylene	0.229	0.217
Non aromatics	0.4616	0.5055

And the composition of the raffinate (R) is given as;

Compound	Vol%	Wt%
Benzene	0.001	0.00092
Toluene	o.009	0.00823
Xylene	0.025	0.0229
Non-aromatics	0.966	0.968

Now the basis is : 100 m^3

Overall material balance is;

$F = R + A$

The component balance is;

$F * x_F = E * z_E + R * y_R$

$\Rightarrow z_{E =(}F * x_F - R * y_R) / E$

Assuming the same temperature is been maintained in the extractor unit and the change in partial volume is negligible;

$R = 830 / 1650 \times 100 = 50.5\ m^3$

$\therefore E = 100 – 50.3$

$= 49.7\ m^3$

substituting these values in the above equations we get the composition of the Extract as

Compound	**Vol%**	**Wt%**
Benzene	15.19	15.68
Toluene	41.8	42.52
Xylene	40.21	41.56
Non-aromatics	0.2	0.0022(negligible)

Material balance around the Benzene column

From the table,

For the feed of 1659 bbl., there will be a aromatic extract of 820 bbl.

The volume% of benzene in extract = 15.19%

∴pure benzene present in the extract = 820 x 0.1519 = 124.558 bbl.

Where 99.5% of this is been recovered.(from the table)

∴pure benzene recovered = 124.558 x 0.995 = 123.93 bbl.

Assuming that the density of the top product from benzene recovery column tower has the same density as that of pure benzene.

∴ wt fraction of benzene/purity of benzene recovery column = 123.93/125 x 100

= 98%.

Now the density of feed = 870 kg/m3.

∴ Feed in Kgs = 870 x 49.3 = 42909.02 Kg.

∴ The distillate obtained from the Benzene column = 125/1650 x 100

= 7.57 m3.

= **6404.22 Kg.**

From the overall material balance,

W = F – D

⇒W = **36505 Kg**.

And from the composition balance

Xw = **0.02**.

Material balance around the Toluene column

The vol% of toluene present in the extract = 41.8%

∴ Pure toluene present in extract = 820 x 0.418 = 342.76 bbl.

∴ Pure toluene recovered = 342.76 x 0.98 = 355.9 bbl.

∴ Weight fraction of toluene = 335.90 / 348 x 100 = 96.52%

∴ xF = (42792 x 0.92 – 665 x 0.02)/36168

= **0.4932**

Distillate = (348 / 1650)x 100 =21.09 bbl,.

=21.08 x 866 = **18264.72 Kg**.

∴ W = F – D

= **17903.2**

∴ x_W = 0.0117

∴From the material balance,

for the product of 250 TPD of toluene the amount of feed required is,

= 250x1000 x 90.853 / 18264.72

= **1243.57 Kg/day.**

Amount of solvent required

And economically 8-15:1 weight ratio of solvent to feed is mostly attractive.

Select a solvent to feed ratio as 10: 1

∴ For a production of 250 TPD of toluene 2500 TPD of Diethyline glycol is added..