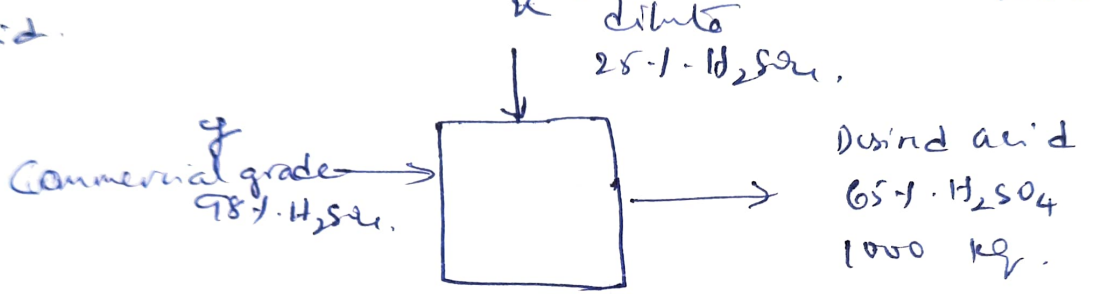
(2) The dilute acid containing 25-1. H_2SO_4 is concentrated by commercial grade sulphuric acid containing 98-1. H_2SO_4 to obtain desired acid containing 65-1. H_2SO_4. Find the quantities of the acids required to make 1000 kg of desired acid.



Basis: 1000 kg desired acid.

x and y be the quantities of dilute and commercial grade sulphuric acid respectively

Overall balance

$x + y = 1000$ ——— (1)

H_2SO_4 balance

$0.98x + 0.25y = 1000 \times 0.65$

$0.98x + 0.25y = 650$ ——— (2)

Solving (1) and (2)

$0.98(1000 - y) + 0.25y = 650$

$980 - 0.98y + 0.25y = 650$

$330 = 0.73y$

$y = \frac{330}{0.73} = 452.05$ kg

$x + y = 1000$

$x = 1000 - 452.05$

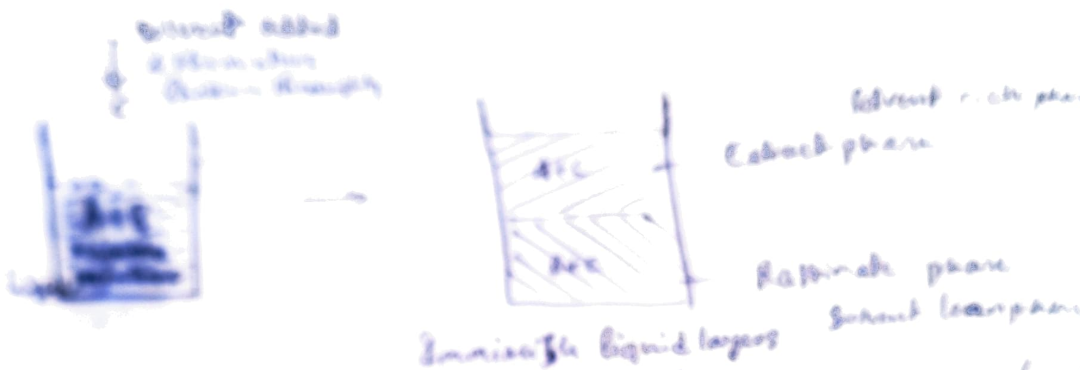
$x = 547.94$ kg

0.98
0.25
0.73

980
650
330

Extraction

When a mixture of liquids is not easily separable by distillation, extraction is employed. Normally the term extraction is used for liquid liquid separation. In this operation a "solvent" is added to the liquid liquid mixture. As a result two immiscible layers are formed both of which contain varying amounts of all the components. These isolated layers are removed as extract phase and raffinate phase using density difference.



Generally distillation has to follow extraction for the recovery of the solvent for re use.

Q. An aqueous solution of pyridine containing 27% (by wt) pyridine and 73% by wt water is to be extracted with chlorobenzene. The feed and solvent are mixed well in batch extractor and the mixture is then allowed to stand for phase separation. The extract phase contains 11% pyridine, 88% chlorobenzene and 0.9% water by weight. The raffinate phase contains 5% pyridine and 95% water by wt. Calculate (a) the quantities of the two phases (b) the weight of solvent ... to feed based on 100 kg of feed

Basis : 100 kg of the feed to extractor

Let x, y and z be the quantities of extract phase, raffinate phase and solvent required respectively.

Overall material balance :

Feed + Solvent = Extract + Raffinate

$100 + z = x + y$ ——— (1)

Material balance of Pyridine

$100 \times 0.27 + z(0) = 0.11x + 0.05y$

$27 = 0.11x + 0.05y$ ——— (2)

Material balance of water

$100 \times 0.73 + z(0) = 0.009x + 0.95y$ ———

$73 = 0.009x + 0.95y$ ——— (3)

Solving equations (2) and (3)

$x = 211.4$ kg and $y = 74.84$ kg

Substitute the values of x and y in Eqn 1)

$100 + z = 211.4 + 74.84$

$z = 211.4 + 74.84 - 100$

$z = 186.24$ kg

Weight ratio of solvent to feed $= \frac{186.24}{100.00}$

$= 1.8624$

~~Prob~~

(5) A 100 kg mixture of 27.8 wt.% of acetone (A) and 72.2 wt.% of chloroform (B) by weight is to be batch-extracted with a mixed solvent at 25°C. The mixed solvent of an unknown composition is known to contain water (S_1) and acetic acid (S_2). The mixture of the original mixture and the mixed solvent is shaken well, allowed to attain Equilibrium, and separated into two layers. The compositions of the two layers are given below

layers	composition, wt.%			
	A	B	S_1	S_2
Upper layer	7.5	3.5	57.4	31.6
Lower layer	20.3	67.3	2.8	9.6

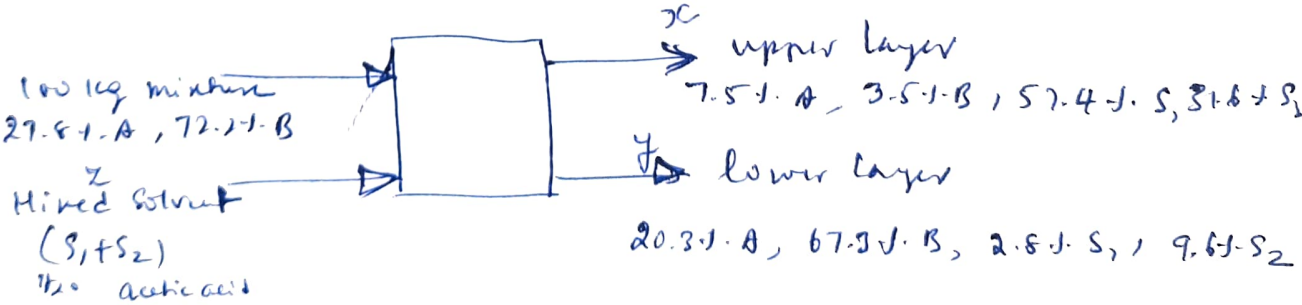
Find (a) the quantities of the two layers

(b) the weight-ratio of the mixed solvent to the original mixture

(c) the composition of the mixed solvent (wt. basis)

Basis: 100 kg original mixture.

The problem is of type (iii) because here the system contains more than one component and the balance of each of the component will yield the complete material balance.



Let x, y, and X be the quantities of upper layer, lower layer and mixed solvent respectively.

Total balance

$$100 + X = x + y \quad \text{——— (1)}$$

Balance of A

$$27.8 + X(0) = 0.075x + 0.203y$$

$$27.8 = 0.075x + 0.203y \quad \text{——— (2)}$$

Balance of B

$$72.2 + X(0) = 0.035x + 0.673y$$

Solving ② and ③

$27.8 = 0.075x + 0.203y$

$72.2 = 0.085x + 0.673y$

$154.710 = 0.075x + 1.44210y$

$-126.910 = -0.075x - 0.203y$

$27.8 = 0.075x + 0.203y$

$126.91 = 1.2391y$

$y = \frac{126.91}{1.2391} = 102.42$ kg

$27.8 = 0.075x + 0.203y$

$27.8 = 0.075x + 0.203 \times 102.42$

$27.8 = 0.075x + 20.7912$

$0.075x = 27.8 - 20.7912$

$x = \frac{7.00874}{0.075}$

$x = 93.4498$ kg

we have $100 + z = x + y$

$100 + z = 93.4498 + 102.42$

$100 + z = 195.8698$

$z = 195.8698 - 100$

$z = 95.8698$ kg

Mixed solvent,

Weight ratio of mixed solvent to original mixture $= \frac{95.8698}{100}$

$= 0.9584.$

Balance of water (S_1):

Total S_1 in the system $= x(0.574) + y(0.028)$

$= 93.4498 \times 0.574 + 102.42 \times 0.028$

$= 53.64 + 2.867$

$= 56.507$ kg

Total S_2 in the system $= 93.4498 \times 0.316 + 102.42 \times 0.096$

$= 29.53 + 9.8323$

$= 39.36$

Quantity of the solvent $= 56.507 + 39.36$

$= 95.869$ kg

% S_1 in the mixed solvent $= \frac{56.507}{95.869} \times 100 = 58.94$

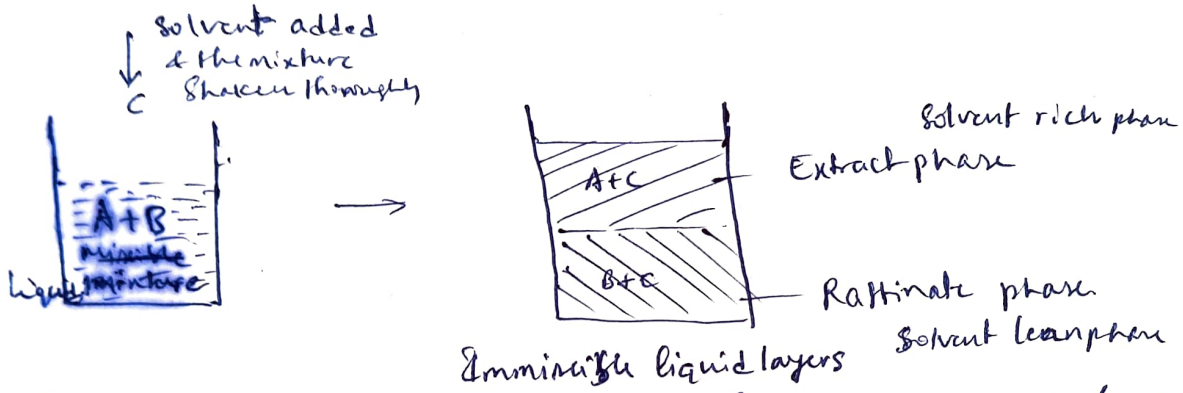
% S_2 in the mixed solvent $= \frac{39.36}{95.869} \times 100 = 41.05$

$0.085 \times x = 0.$

$x = 2.14$

Extraction.

When a mixture of liquids is not easily separable by distillation, extraction is employed. Normally the term extraction is used for liquid-liquid separation. In this operation a "solvent" is added to the liquid-liquid mixture. As a result two immiscible ~~phases~~ layers are formed, both of which contain varying amounts of different components. These isolated layers are removed as Extract phase and raffinate phase using density difference



Immiscible liquid layers

Invariably distillation has to follow extraction for the recovery of the solvent for re-use.

① An aqueous solution of pyridine containing 27 % (by wt) pyridine and 73 % (by wt) water is to be extracted with chlorobenzene. The feed and solvent are mixed well in batch extractor and the mixture is then allowed to stand for phase separation. The extract phase contains 11 % pyridine 88.1 % chlorobenzene and 0.9 % water by weight. The raffinate phase contains 5 % pyridine and 95 % water by wt Calculate (a) the quantities of the two phases (b) The weight ratio of solvent to feed based on 100 kg of feed