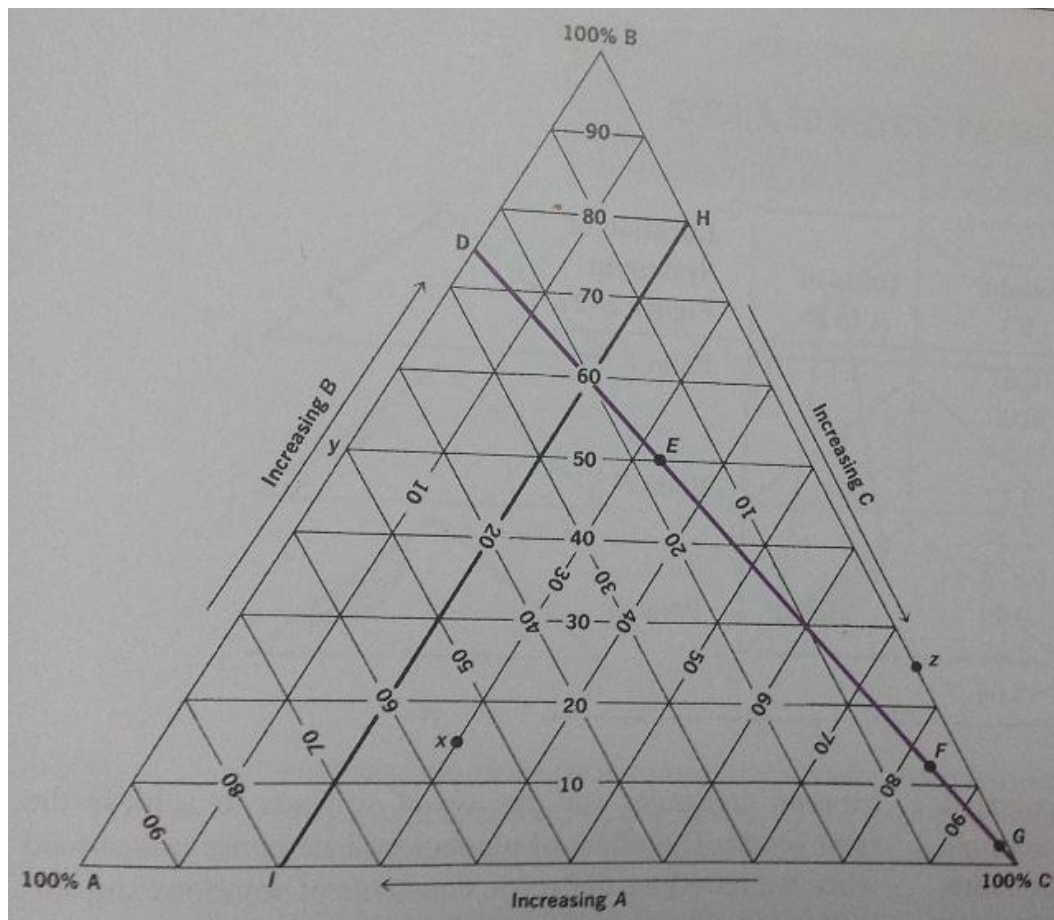


Three component systems

i. Introduction

It is essential that the reader becomes familiar with certain "rules" that relate to the use of triangular coordinates. It should have been apparent in discussing two-component systems that all concentrations were expressed on a weight-weight basis. This is because, although it is an easy and direct method of preparing dispersions, such an approach also allows the concentration to be expressed in terms of the mole fraction or the molality. The concentrations in ternary systems are accordingly expressed on a weight basis

ii. Rules relating to the triangular diagram



The triangular diagram for three-component systems

- 1) Each of the corners or apexes of triangle represent 100% by weight of one component (A, B & C) as a result, the same apex will represent 0% of the other two components.
- 2) The area within the triangle represents all possible combinations of A, B & C to give three component systems.
- 3) If a line is drawn through any apex to a point on the opposite side, then all systems are represented by points on such line have constant ratio of two components.
- 4) Any line drawn parallel to one side of the triangle represents ternary systems in which the proportion (or % by weight) of one component is constant.

For example:

The area within the triangle represents all the possible combinations of A, B, and C to give three-component systems. The location of a particular three-component system within the triangle, for example, point x, can be undertaken as follows.

The line AC opposite apex B represents systems containing A and C. Component B is absent, that is, $B = 0$. The horizontal lines running across the triangle parallel to AC denote increasing percentages of B from $B = 0$ (on line AC) to $B = 100$ (at point B). The line parallel to AC that cuts point x is equivalent to 15%B; consequently, the system contains 15% of B and 85% of A and C together.

Applying similar arguments to the other two components in the system, we can say that along the line AB, $C = 0$. The point x lies on the line parallel to AB that is equivalent to 30% of C. It follows, therefore, that the concentration of A is $100 - (B + C) = 100 - (15 + 30) = 55\%$. This is readily confirmed by proceeding across the diagram from the line BC toward apex A; point x lies on the line equivalent to 55% of A.

Then find the percent of H, E, F, and G?

(Another example is used in the presentation)

iii. Experimental

Part I: prepare acetic acid (HAc), CHCl_3 and distilled water as well as conical flasks and burettes.

Part II:

1- Prepare 10 gm of the following combinations of HAc & CHCl_3 : 5%, 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90% w/w HAc: CHCl_3 in a small clean & dry flask which form one single phase

(S.G. for HAc = 1.009 and CHCl_3 = 1.3).

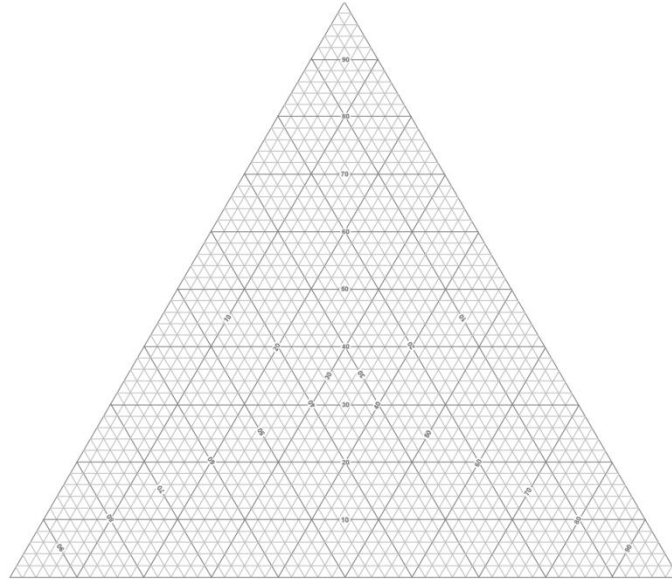
2- Add the water slowly to the prepared mixtures from a burette until a turbidity appears. Check the weight of water (which is equal to its volume).

3- Obtain a miscible curve by calculating the percent w/w of each component in the turbid mixture and plot this triangular diagram.

iv. Written laboratory report

Follow the general instructions for written laboratory reports.

Flask No.	Weight of each component (g)			Weight percentage of each component (%w/w)		
	HAc	CHCl_3	H_2O	HAc	CHCl_3	H_2O
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						



v. References

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Experiment 4

The Tie – Line for Three Component System

I. Introduction

Water & benzene are miscible only to a slight extent so a mixture of the two usually produces 2 phase system; the lower layer consists of water saturated with benzene while the lighter phase includes benzene saturated with water. On the other hand, alcohol is completely miscible with both benzene & water, therefore, that the addition of sufficient alcohol to water & benzene (2 phase) will produce single phase system in which all the three components are miscible.

It might be helpful to consider alcohol to act as a temperature in binary system of phenol & water. As the heat has been used to break the cohesive forces between molecules the miscibility will increase until one phase is formed, the addition of alcohol to benzene-water mixture achieves the same mission but by a different behaviour which is a solvent effect instead of temperature effect. Alcohol acts as an intermediate polar solvent that shifts the electric equilibrium of the dramatically opposed a highly polar water & non-polar benzene solution to provide solvation.

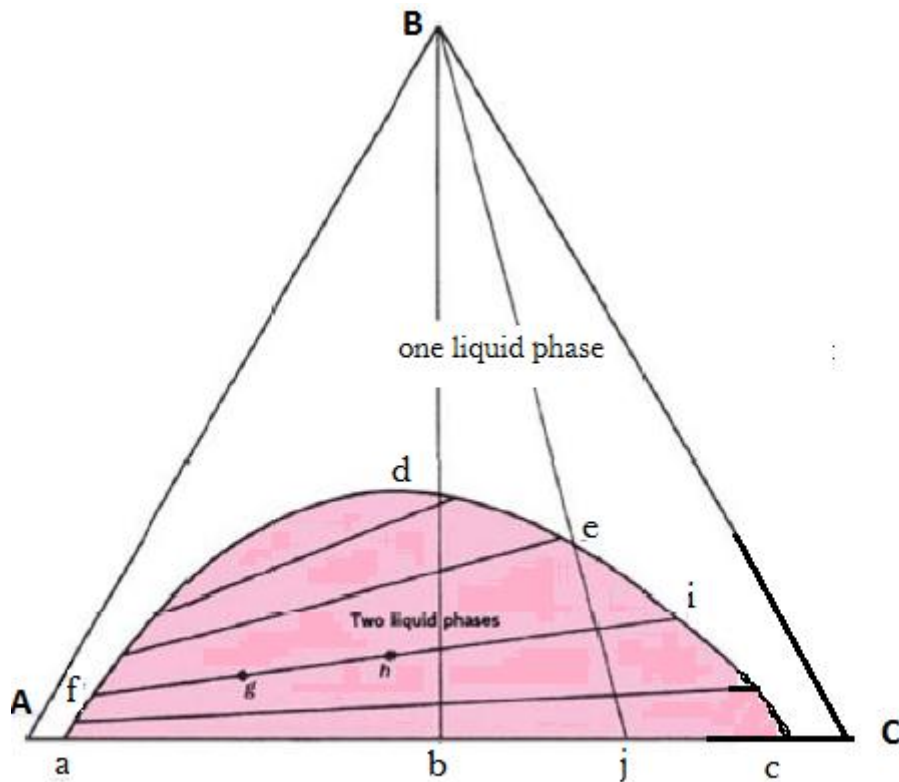
ii. Ternary systems with one pair of partially miscible liquid

suppose that A, B, and C represent water, alcohol, and benzene, respectively. The line AC therefore depicts binary mixtures of A and C, and the points a and c are the limits of solubility of C in A and of A in C, respectively.

The curve *afdeic*, frequently termed a *binodal curve* or *binodal*, marks the extent of the two-phase region. The remainder of the triangle contains one liquid phase.

The tie lines within the binodal are not necessarily parallel to one another or to the base line, AC, as was the case in the two-phase region of binary systems. The directions of the tie lines are related to the shape of the binodal, which in turn depends on the relative solubility of the third component (in this case, alcohol) in the other two components. Only when the added component acts equally on the other two components to bring them into solution will the binodal be perfectly symmetric and the tie lines run parallel to the baseline.

The properties of tie lines for binary systems still apply, and systems *g* and *h* prepared along the tie line *fi* are and both give rise to two conjugated phases having the compositions denoted by the points *f* and *i*.



A system of three liquids, one pair of which is partially miscible

Properties of the tie line of three component system:-

- 1- Any system that is prepared along the tie line will rise two phase having a constant composition.
- 2- The relative amount by weight of the two conjugate phases will depend on the position of the original system along the tie line.

iii. Experimental

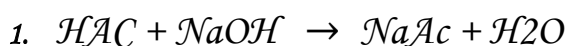
Part I: prepare H_2O , HAC , $CHCl_3$, $1N$ $NaOH$ solution and phenolphthalein as an indicator as well as burettes, separator funnel, conical flasks and a balance.

Part II:

1. In a separator funnel, prepare 50 gm of a mixture having a composition giving rise to a two phase system (e.g. 4gm HAC +16 gm $CHCl_3$ + 30gm H_2O).
2. Separate each layer in two conical flasks.
3. Titrate 10 gm of each layer with standard $1N$ $NaOH$ solution using phenolphthalein as indicator (the end point from colourless to pink).
4. Calculate the percent W/W of HAC in each layer and locate the values on the miscibility curve (drawn in lab 3). The straight line joining these points should pass through compositions of the two phase system.

iv. Data Analysis

Calculation:-



$$1 \text{ M.Wt. of } HAC = 1 \text{ M.Wt. of } NaOH$$

$$1 \text{ eq.wt of } HAC = 1 \text{ eq.wt of } NaOH$$

$$60 = 1000 \text{ ml } 1N \text{ } NaOH$$

$$60/1000 = 1 \text{ ml } 1N \text{ } NaOH$$

Each 1 ml of $1N$ $NaOH$ is equivalent to 0.06 gm, this is the chemical factor of that equation which is defined as the number of grams of substance that equivalent to 1 ml of standard solution.

E.P $1 \times 0.06 =$ gm HAC in 10 gm aqueous layer (upper layer).

E.P $2 \times 0.06 = \text{gm HAC in } 10 \text{ gm CHCl}_3 \text{ layer (lower layer)}$.

2. Change these values to percent.

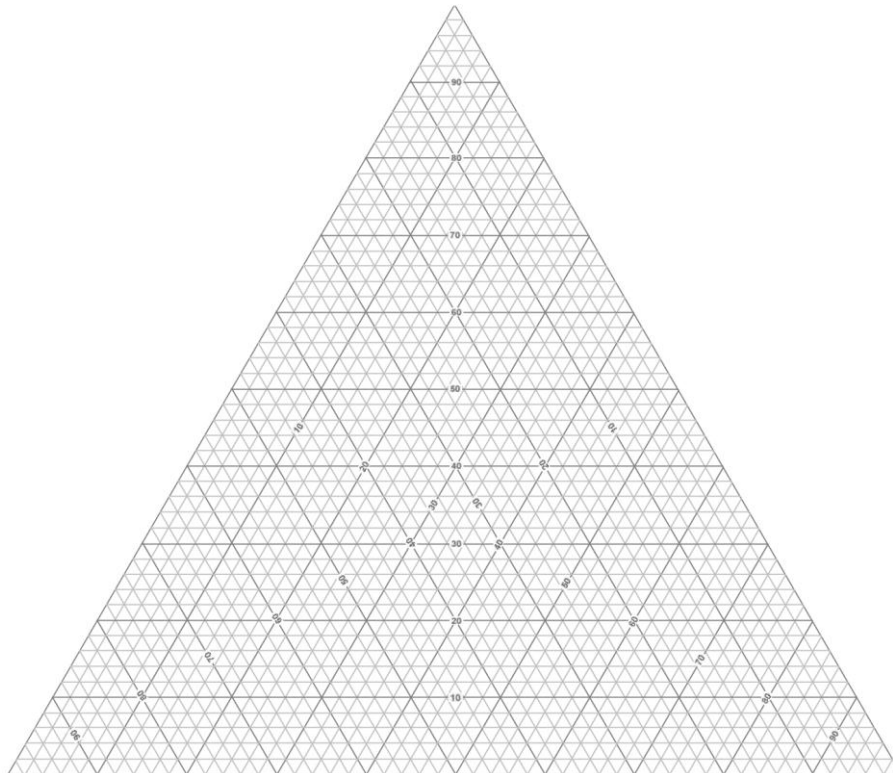
vi. Witten laboratory report

Follow the general instructions for written laboratory reports.

Results

Flask No.	End Point	Weight of HAC (g) in 10 g	% w/w of HAC	% w/w of H ₂ O	% w/w of CHCl ₃
Upper layer 1					
Lower layer 2					

Graph



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vii. References

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