LAB. 3

TIE LINE FOR THREE COMPONENT SYSTEMS

Introduction

Water and benzene are miscible only to a slight extent, and so a mixture of the two usually produces a two-phase system. On the other hand, alcohol is completely miscible with both benzene and water. It is to be expected, therefore, that the addition of sufficient alcohol to a two-phase system of benzene and water would produce a single liquid phase in which all three components are miscible.

In the diagram below, 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, 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. In fact, 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

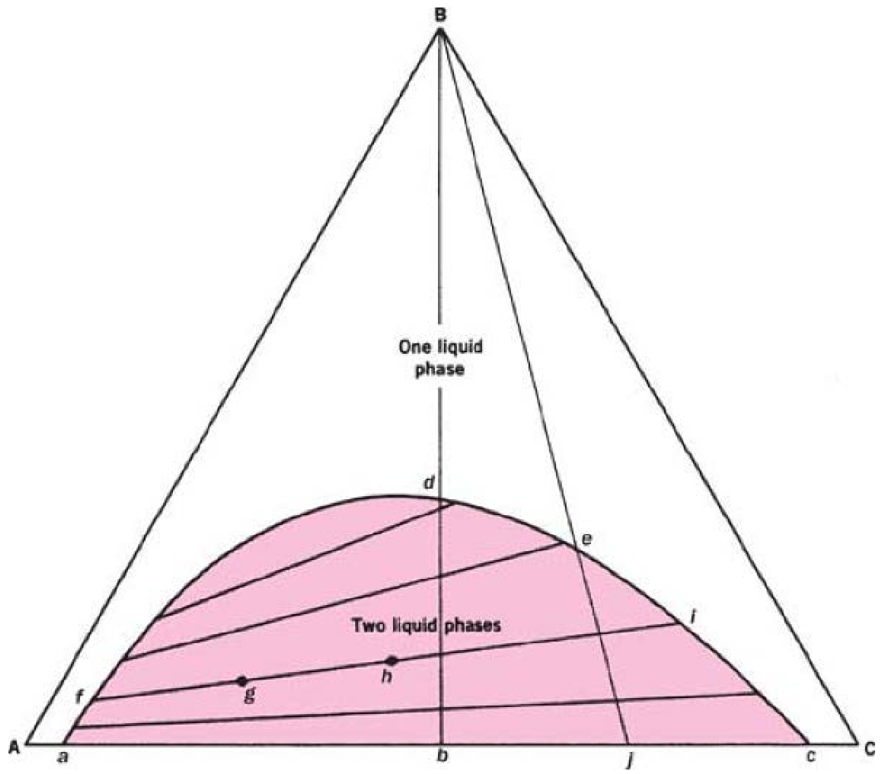


Fig 3-1: A system of three liquids, one pair of which is partially miscible.

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*.

Materials and equipment

1. Chloroforms, water, Acetic acid, 1N Sodium hydroxide solution, and phenolphthalein indicator.
2. Separatory funnel, conical flasks, burettes, and balance

Procedure

1. Prepare 50 g of a mixture having a composition that produce two phase system (4 g acetic acid + 16 g $CHCl_3$ + 30 g H_2O) in a separatory funnel.
2. Separate each layer in two conical flasks.
3. Titrate 10 g of each layer with 1 N sodium hydroxide solution using phenolphthalein as indicator until a pink color appear (end point).
4. Calculate the percent w/w of acetic acid in each layer and locate the values on the miscibility curve (drawn in lab. 2). The straight line joining these points is the tie line which should pass through compositions of the two phase system.

Calculations

No. of equivalents of acetic acid = No of equivalents of sodium hydroxide

$$\frac{w}{eq.wt} = C \times V$$

HAc NaOH

$$\frac{w}{60} = 1 \times 1$$

w = 0.06 g = chemical factor (the no. of grams of a substance which is equivalent to 1 ml of a standard solution.)
E.P 1 × 0.06 = g of HAc in 10 g of aqueous layer.
E.P 2 × 0.06 = g of HAc in 10 g of organic layer.
Change these values into percent.

For the upper layer (100 - % Hac) represents mostly water with little chloroform (aqueous layer).

For the lower layer (l00 - % Hac) represents mostly chloroform with little water (chloroform layer).

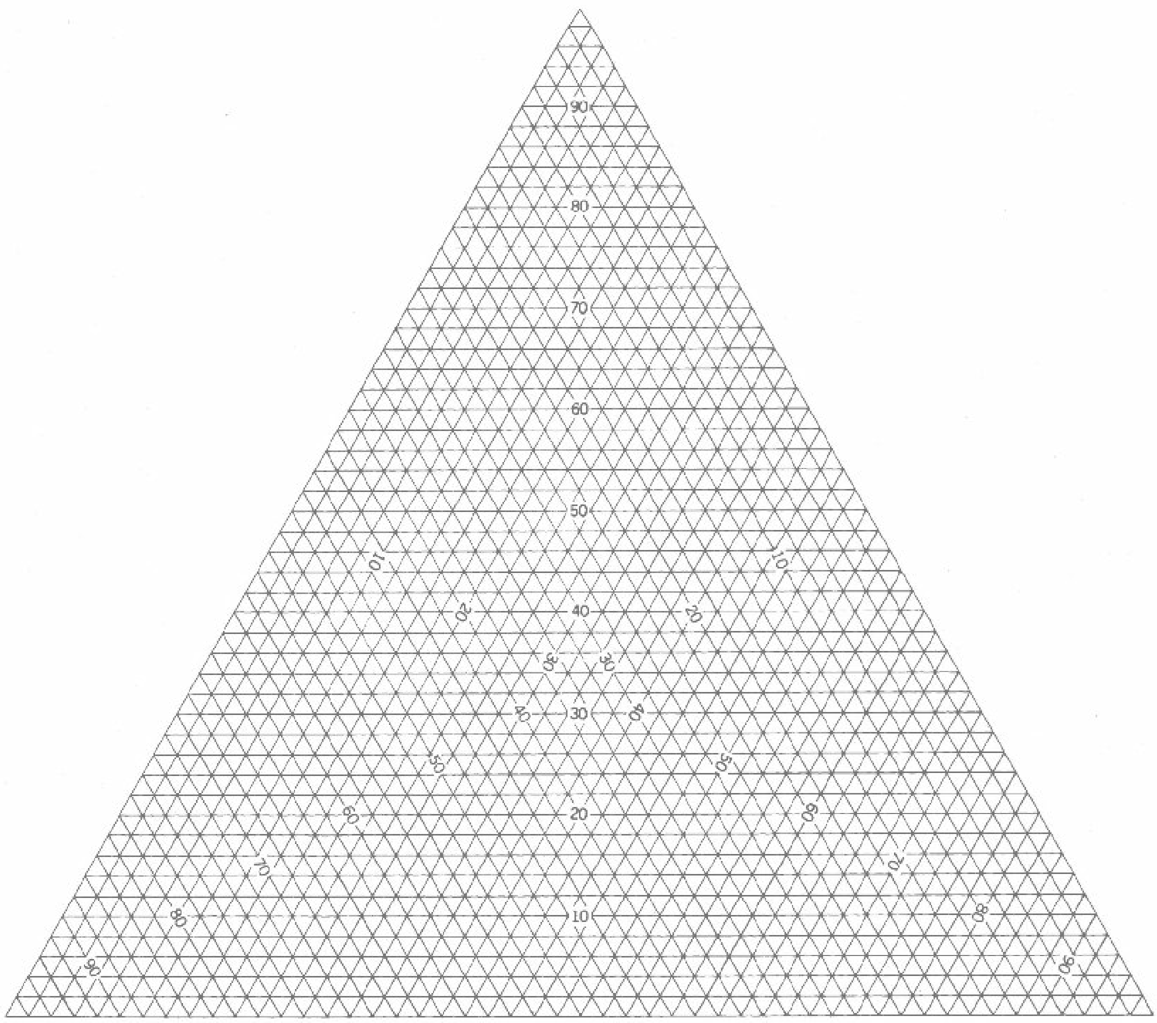
Group: Subgroup: Date: ***Lab instructor signature:***

Names:

Results

Flask No.	End Point	Weight of HAc (g) in 10 g	% w/w of HAc	% w/w of H_2O	% w/w of $CHCl_3$
Upper layer 1					
Lower layer 2					

Graph



Homework

1. What does the direction of the tie line mean in this case?