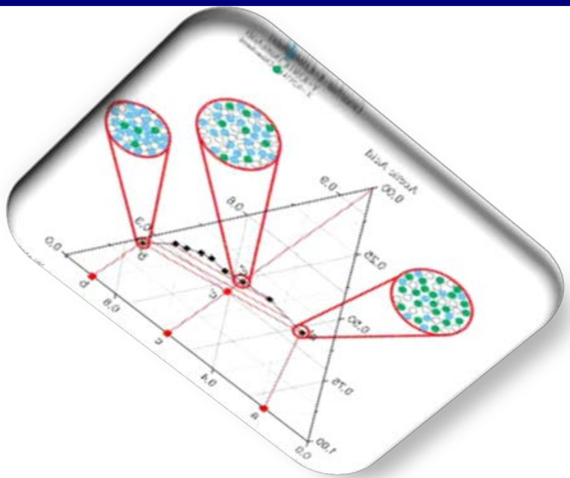
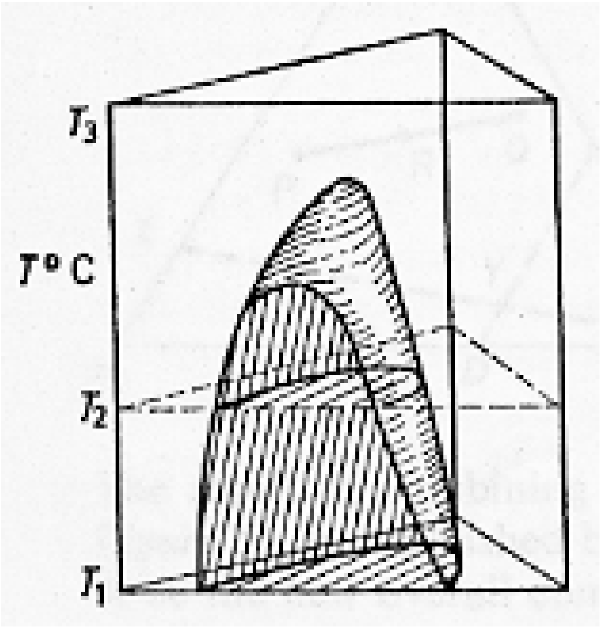
Chapter 4: Three Component System



- In three – component systems, the Phase Rule states that ***P + F = 5***
- The maximum number of degrees of freedom is four, namely, the temperature, the pressure and the concentrations of two of the components.
- The concentration of the third is fixed since, if two are ***A%*** and ***B %***, the third must be ***(100 – A – B)* %.**
- four variables cannot be represented graphically, pressure is considered fixed at 1 atm.
- The rest of the variables (**concentration variables**) plotted on a three-dimensional graph having an equilateral triangle.



Two sections of the three-dimensional equilibrium curve at temperatures T_1 and T_2

Explanation of the Equilateral Triangle

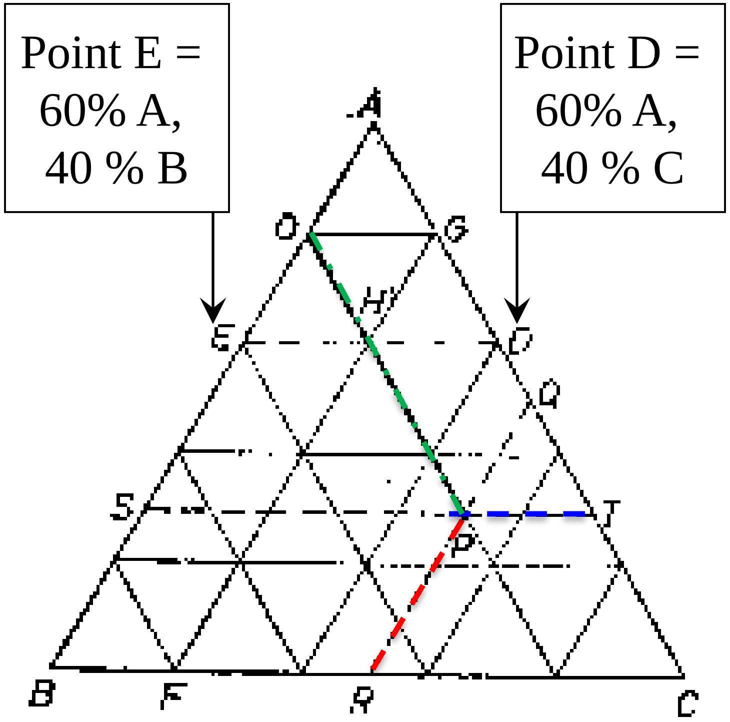
1) Each corner of the triangle will represent a pure component, that is, ***100% A***, ***100% B***, ***100% C***.

2) Each side will represent a binary mixture

3) The interior of the triangle represents all ternary compositions. *i.e.* fraction or % of ***A*** will be given by *PR*, of ***B*** by *PT*, and of ***C*** by *PO*.

4) Point *D* represents a mixture of *A* and *C*

$$\frac{\text{Amount of A}}{\text{Amount of C}} = \frac{DC}{DA}$$



Concentration plotting

5) A line parallel to one side of the triangle represents a constant percentage of one component. Thus all points on DE are for mixtures containing 60% A with varying amounts of B and C.

Types of Three Component System

- Systems of Three Liquids Exhibiting Partial Miscibility
- Ternary Eutectic Systems Including Compound Formation
- Aqueous Salt Solutions

TYPE I: SYSTEMS OF THREE LIQUIDS

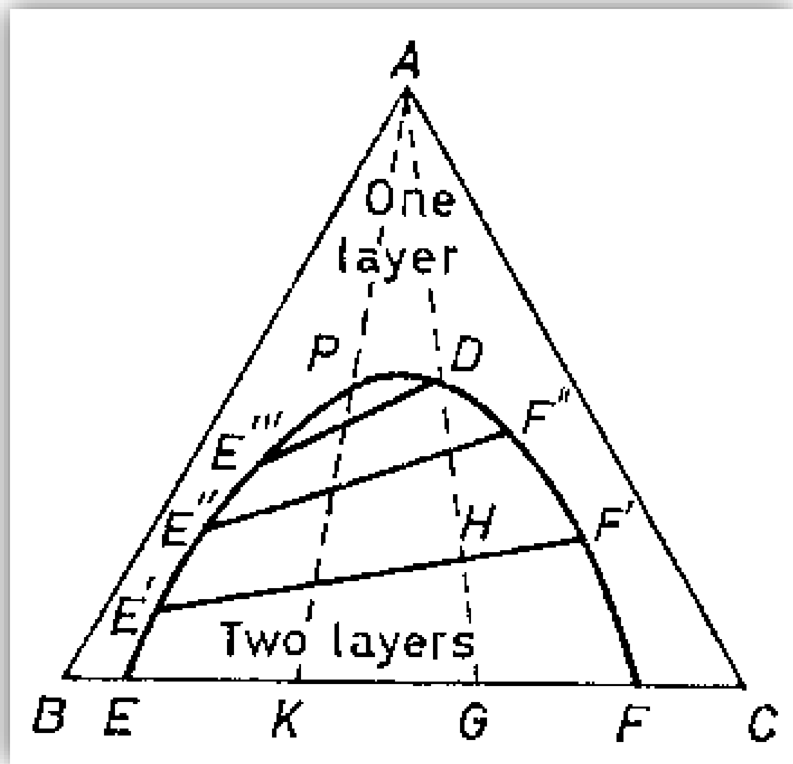
1) In acetic acid/chloroform/water system, the water and chloroform are only partially miscible.

2) In the concentration ranges BE and CF the mixtures of B and C form true solutions.

3) Between E and F the system will produce two liquid layers of varying amounts but of compositions E and F.

4) Point G represents two layers in the ratio:

$$\frac{\text{Weight of layer of composition E}}{\text{Weight of layer of composition F}} = \frac{GF}{GE}$$

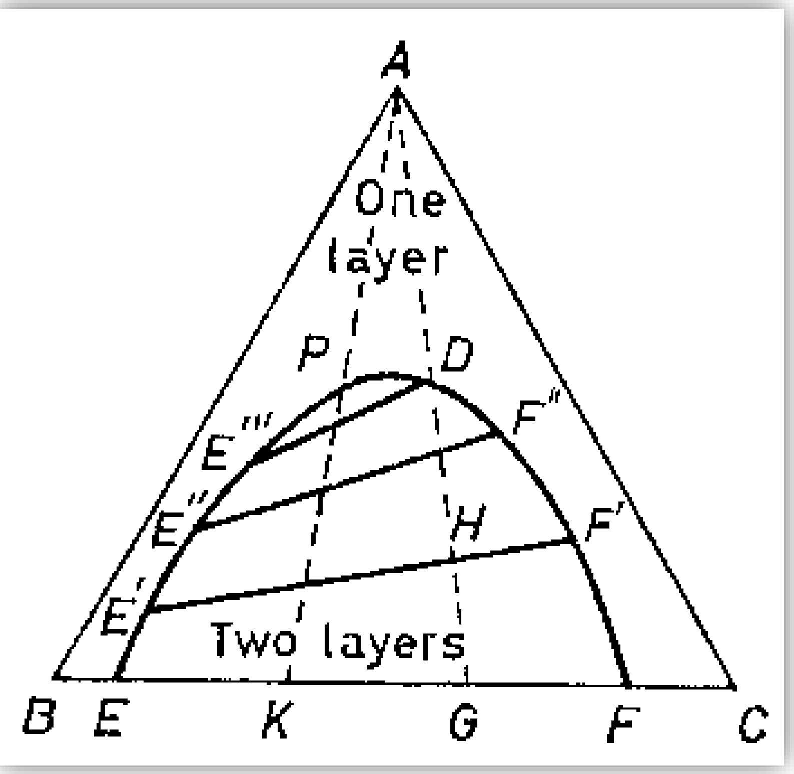


Ternary system, one pair partially miscible

5) line GA shows the effect of adding acetic acid to the original two – layer system G (i.e. addition of acetic acid to the mixture causes more water to dissolve in the chloroform layer and more chloroform in the water layer).

6) When the overall composition of the ternary system corresponds to point H, the two conjugate solutions present, have compositions E′ and F′ in the ratio:

$$\frac{\text{Weight of layer of composition E}'}{\text{Weight of layer of composition F}'} = \frac{HF'}{HE'}$$



7- The closed curve “binodal curve” is constructed from data in pairs.

8- The composition represented by any point inside the curve would yield a two – layer system

9- All mixture outside the curve would form single – phase solutions.

10- At point D on the boundary curve for the original mixture G, sufficient acetic acid has then been added to achieve complete miscibility.