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RESEARCH ARTICLE

A SOLUTE ASSOCIATE OR DISSOCIATES IN *MISCIBLE* SOLVENTS.

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ABSTRACT

When a solute associate or dissociate inan immiscible solvents wetypically prefer Modified Nernst's developed distribution equation. It may be valid for a solute associate or dissociate in miscible solvents if the distribution ratio exists precisely for miscible solvents. This paper willingly gives a modified distribution equation when a solute associate or dissociate in either both the suitable miscible solvents or any one of the miscible solvent.

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INTRODUCTION

It is well known that the Nernst's distribution law is true only when aforcibly dissolved solute typically has the same molecular form that is the same molecular weight in a non-miscible solvents. The fundamental law can be properly stated as 'a dissolved solute, irrespective of its considerable amount, equitably distributes itself between two non-miscible solvents in contact with each other in such a way that at dynamic equilibrium, the observed ratio of the determined concentration of the solutes in the two distinct layers is constant, at any given temperature.' If the solute undergoes association or dissociation in one or both the immiscible solvents the distribution law is not valid and the concentration ratio is not constant then we prefer modified Nernst's distribution equation. Here the Nernst distribution law may bevalid for a system in which the distribution ratio exists for miscible solvents (R. Sanjeev *et. al*).

RESULTS AND DISCUSSION

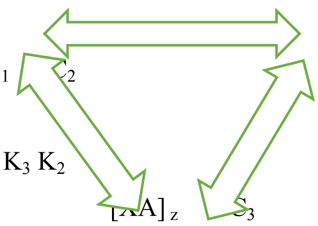
Considering a solute XA is distributing itself in x (non-polar), y (polar) and z (non-polar) solvents. C_1, C_2& C_3 is precisely the absolute concentration of a solute in the x, y and z solvents respectively. Properly obtaining the Distribution constant equation for miscible solvents.

1. *Solute exists as normal state in solvent x, y and z.*

K_1

$[XA]_x[XA]_y$

C_1 C_2



K_3 K_2

$[XA]_z$ C_3

Applying law of mass action to the dynamic equilibrium that exists as,

$K_{eq} = \frac{[XA]y}{[XA]\,x}$, $K_1 = \frac{C2}{C1}$ --(1)

$K_{eq} = \frac{[XA]z}{[XA]y}$, $K_2 = \frac{C3}{C2}$ --(2)

Here, the solute present in same molecular state and thedynamic equilibrium constant and distribution ratio are same for this system.

From used equation (1) and (2), we get,

$K_3 = K_1 \text{ x } K_2 = = \frac{C2}{C1} \text{x} \frac{C3}{C2}$

$K_3 = \frac{C3}{C1}$

K_3 is the distribution ratio for miscible solvents.

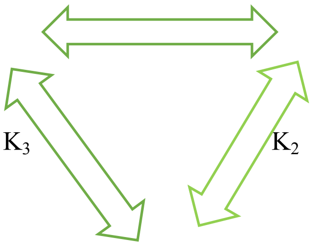
2. *Solute exists as normal state in solvent x & y but associated form as XA_n in solvent z.*

The following general expression occurs as,

K_1

n $[XA]_x$ n$[XA]_y$

C_1 C_2



K_3 K_2

Applying law of mass action to the dynamic equilibrium that exists as,

$K_{eq} = \frac{[XA]n}{[XA]n}$, $K_1 = \frac{C2}{C1}$ -- (1)

$K_{eq} = \frac{[XAn]}{[XA]n}$, $[XA]^n = \frac{[XAn]}{Keq}$, $[XA] = \sqrt[n]{\frac{[XAn]}{Keq}}$

$[XA] = \sqrt[n]{[XAn]}$ x Constant. ($[XAn] = C_3$), $K_2 = \frac{\sqrt[n]{C3}}{C2}$ -- (2)

From used equation (1) and (2), we get,

$K_3 = K_1 \text{ x } K_2 = = \frac{C2}{C1} \text{ x } \frac{\sqrt[n]{C3}}{C2}$

$K_3 = \frac{\sqrt[n]{C3}}{C1}$ -- (3)

This ismodified distribution equation (K_3), It is valid if a solute associate in miscible solvent z.

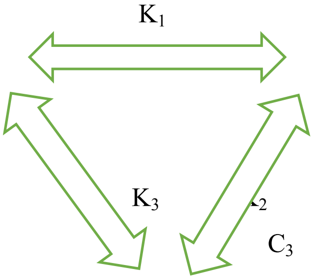
3. *It exists as normal state in solvent y & z but associated form as XA_n in solvent x.*

The following general expression occurs as,

K_1

$[XA_n]_x$ n$[XA]_y$

C_1 C_2



K_3 K_2

n $[XA]_z$ C_3

Applying law of mass action to the dynamic equilibrium that exists as, $K_{eq}=\frac{[XA]n}{[XAn]}$, K_{eq} x $[XA_n]$ = $[XA]^n$, $[XA] = \sqrt[n]{[XAn]}$ x Constant, $C_1 = [XA_n]$

$$K_1 = \frac{C2}{\sqrt[n]{C1}} \qquad \text{--} (1)$$

$$K_{eq} = \frac{[XA]n}{[XA]n}, \qquad K_2 = \frac{C3}{C2} \qquad \text{--} (2)$$

From used equation (1) and (2), we get,

$$K_3 = K_1 \text{ x } K_2 = \frac{C2}{\sqrt[n]{C1}} \text{ x} \frac{C3}{C2}$$

$$K_3 = = \frac{C3}{\sqrt[n]{C1}} \qquad \text{--} (3)$$

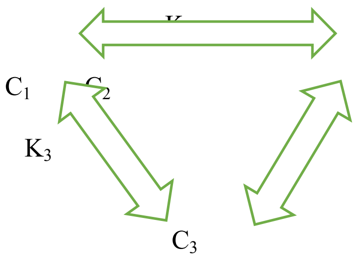
This is the modified Nernst's distribution equation, it is valid if a solute associate in miscible solvent x.

4. *It exists as normal state in solvent x & z but associated form as XA_n in solvent y.*

The following general expression occurs as,

$n[XA]_x[XA_n]_y$

$n[XA]_z$



Applying law of mass action to the dynamic equilibrium that exists as,

$K_{eq}=\frac{[XAn]}{[XA]n}$, $[XA]^n = \frac{[XAn]}{Keq}$, $[XA] = \sqrt[n]{[XAn]}$ x Constant. ($[XA_n] = C_2$).

$$K_1 = \frac{\sqrt[n]{C2}}{C1} \qquad \text{--}(1)$$

$K_{eq} =\frac{[XA]n}{[XAn]}$, $[XA] = \sqrt[n]{[XAn]}$ x Constant. ($[XA_n] = C_2$)

$$K_2 = \frac{C3}{\sqrt[n]{C2}} \qquad \text{--}(2)$$

From used equation (1) and (2), we get,

$$K_3 = K_1 \text{ x } K_2 = \frac{\sqrt[n]{C2}}{C1} \text{ x } \frac{C3}{\sqrt[n]{C2}}$$

$$K_3 = \frac{C3}{C1} \qquad \text{--}(3)$$

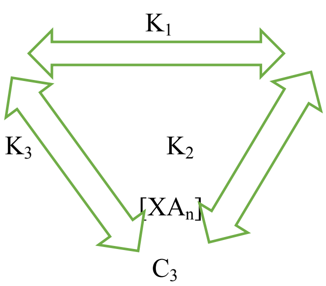
This is the distribution equation (K_3), it is valid if a solute associate in solvent y.

5. *It exists as normal state in solvent y but associated form as XA_n in solvent x and z.*

The following general expression occurs as,

$[XA_n]_x n[XA]_y$

C_1 C_2



Applying law of mass action to the dynamic equilibrium that exists as,

$K_{eq} = \frac{[XA]n}{[XAn]}$, K_{eq} x $[XA_n] = [XA]^n$, $[XA] = \sqrt[n]{[XAn]}$ x Constant, $C_1 = [XA_n]$

$K_1 = \frac{C2}{\sqrt[n]{C1}}$ --(1)

$K_{eq} = \frac{[XAn]}{[XA]n}$, $[XA]^n = \frac{[XAn]}{Keq}$, $[XA] = \sqrt[n]{\frac{[XAn]}{Keq}}$, $[XA] = \sqrt[n]{[XAn]}$ x Constant. ($[XAn] = C_3$),

$K_2 = \frac{\sqrt[n]{C3}}{C2}$ -- (2)

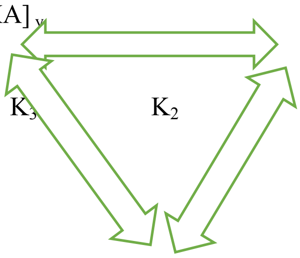
From used equation (1) and (2), we get,

$K_3 = K_1 \text{ x } K_2 = = \frac{C2}{\sqrt[n]{C1}} \text{x} \frac{\sqrt[n]{C3}}{C2}$, $K_3 = \frac{\sqrt[n]{C3}}{\sqrt[n]{C1}}$ -- (3)

This is the modified distribution equation, it is valid if solute associate in both miscible solvents.

6. *Solute exists normal state in y and z but dissociate in x.* The following general equation as,

K_1
$\{[X + Y]_x \leftarrow\!\!-\!\!-\!\!-\!\!\rightarrow [XA]_x\}$ $[XA]_y$
C_1 C_2



$[XA]_z$
C_3

The dynamic equilibrium between un-dissociated and dissociated molecules in solvent x is represented as,

X + A[XA]

C_1 α C_1 α C_1 (1- α) α is the degree of dissociation of the solute in solvent x, then the total concentration of un-dissociated molecules will be C_1 (1- α).

$K_1 = \frac{C2}{C1\ (1-\alpha)}$ -- (1)

$K_{eq} = \frac{[XA]z}{[XA]y}$, $K_2 = \frac{C3}{C2}$ -- (2)

From used equation (1) and (2), we get,

$K_3 = K_1 \text{ x } K_2 = \frac{C2}{C1\ (1-\alpha)} \text{ x } \frac{C3}{C2}$

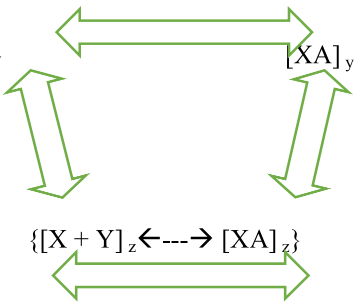
$K_3 = = \frac{C3}{C1\ (1-\alpha)}$ -- (3)

This is the modified Nernst's distribution equation, it is valid if a solute dissociate in miscible solvent x.

7. *Solute exists normal state in y and z but dissociate in x*. The following general equation as,

K_1
$\{[X + Y]_x \leftarrow\!\!-\!\!-\!\!-\!\!\rightarrow [XA]_x\}$ $[XA]_y$
C_1C_2

K_3 K_2



$\{[X + Y]_z \leftarrow\!\!-\!\!-\!\!-\!\!\rightarrow [XA]_z\}$
C_3

The dynamic equilibrium between un-dissociated and dissociated molecules in solvent x is represented as,

X + A[XA]
$C_1\alpha_1$ $C_1\alpha_1$ $C_1(1-\alpha_1)$

α_1 is the degree of dissociation of the solute in solvent x, then the total concentration of un-dissociated molecules will be C_1 (1- α_1).

$K_1 = \frac{C2}{C1\,(1-\alpha1)}$ -- (1)

The equilibrium between un-dissociated and dissociated molecules in solvent z is represented as,

X + A [XA]
$C_3\alpha_2$ $C_3\alpha_2$ $C_3(1-\alpha_2)$

α_2 is the degree of dissociation of the solute in solvent z, then the total concentration of un-dissociated molecules will be $C_3(1-\alpha_2)$.

$K_2 = \frac{C3\,(1-\alpha2)}{C2}$ ---(1)

From used equation (1) and (2), we get,

$K_3 = K_1 \text{ x } K_2 = \frac{C2}{C1\,(1-\alpha1)} \text{x} \frac{C3\,(1-\alpha2)}{C2}$

$K_3 = = \frac{C3\,(1-\alpha2)}{C1\,(1-\alpha1)}$ ---(3)

This is the modified Nernst's distribution equation, it is valid if a solute dissociate in miscible solvents.

8. *Solute exists normal state in y but dissociate in x and associate in z.* The following general equation as,

K_1
$\{[X+Y]_x \leftarrow\text{---}\rightarrow [XA]_x\}$ n $[XA]_y$
C_1 C_2

K_3 K_2

$[XA_n]_z$
C_3

The dynamic equilibrium between un-dissociated and dissociated molecules in solvent x is represented as,

X + A [XA]
$C_1\alpha$ $C_1\alpha$ $C_1(1-\alpha)$

α is the degree of dissociation of the solute in solvent x, then the total concentration of un-dissociated molecules will be C_1 (1- α).

$K_1 = \frac{C2}{C1\,(1-\alpha)}$ -- (1)

$K_{eq} = \frac{[XAn]}{[XA]n}$, $[XA]^n = \frac{[XAn]}{Keq}$, $[XA] = \sqrt[n]{\frac{[XAn]}{Keq}}$, $[XA] = \sqrt[n]{[XAn]}$ x Constant. ($[XA_n] = C_3$),

$K_2 = \frac{\sqrt[n]{C3}}{C2}$ --- (2)

From used equation (1) and (2), we get,

$K_3 = K_1 \text{ x } K_2 = \frac{C2}{C1\,(1-\alpha)} \text{ x } \frac{\sqrt[n]{C3}}{C2}$

$K_3 = = \frac{\sqrt[n]{C3}}{C1\,(1-\alpha)}$ -- (3)

This is the modified Nernst's distribution equation, it is valid if a solute dissociate in x and associate in z.

4. Conclusion

It is possible to find modified distribution constant for miscible solvents, whenever solute either an associate or dissociate in a miscible solvents. This technique is used for determination of a stability constant or an equilibriumconstant of complexes (Thermodynamic stability), solvent extraction method, and number of molecules associate or dissociate in solvents.

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