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REVIEW ARTICLE

THERMODYNAMICS PROOF FOR THE DISTRIBUTION RATIO EXISTS FOR *MISCIBLE* SOLVENTS

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ABSTRACT

It is well-known that the Nernst's distribution law applicable for a solute distributes between two immiscible solvents. Thermodynamics proof for a solute distributes itself between two miscible solvents, until to get equilibria, the ratio of activity of a solute in two miscible solvents remains constant, but it's possible only when the distribution ratio exists for miscible solvents.

INTRODUCTION

The distribution of a solute between to miscible solvents in contact with each other is governed the Nernst distribution law. Considering a system, XA and x, z miscible solvents. When a solution of XA in x and z, it is observed that the XA distributes itself between x and z layers in such a way that at dynamic equilibrium, the ratio of the concentrations of XA, in two layers is constant, at any given temperature. If a_1 represent an activity of XA in x layer and a_2 represent its activity in z layer, then,

$$D = \frac{a1}{a3} \qquad (1)$$

The constant D is known as the distribution or partition coefficient of the system and the equation (1) is known as Nernst Distribution law, it can be stated as 'a dissolved solute, irrespective of its amount, distributes itself between two miscible solvents in contact with each other until to attain equilibrium, the ratio of the activity of the solute in two miscible solvents remain constant, at any given temperature.

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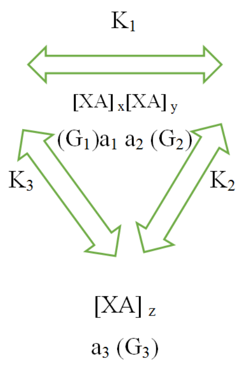
Theoretical Method: A solute XA is distributing itself in x (non-polar), y (polar) and z (non-polar) solvents. a_1, a_2& a_3 is precisely the absolute activity of a solute in the x, y and z solvents respectively.

Properly obtaining the Distribution constant equation for miscible solvents. The partial Gibbs free energy of a solute in solvents x, y, and z is G_1, G_2 and G_3 respectively. A solute exists as a normal state in solvent x, y and z.

The following general expression as,



Partial Gibbs free energy equation for this system as,

$G_1 = G_1^0 + RT \ln a_1$, $G_2 = G_2^0 + RT \ln a_2$, $G_3 = G_3^0 + RT \ln a_3$,
The equilibria is maintained between the system, the change in Gibbs free energy for this system is zero,

$\Delta G = 0$, $G_2 – G_1=0$, $G2 = G_1$,
$G_2^0 + RT \ln a_2 = G_1^0 + RT \ln a_1$,
$G_2^0 - G_1^0 = RT \ln a_1 - RT \ln a_2$
$G_2^0 - G_1^0 = RT (\ln a_1- \ln a_2)$
$\Delta G^0= RT \ln \frac{a1}{a2}$
$\frac{\Delta G0}{RT}= \ln \frac{a1}{a2}$

Constant $(K_1) = \ln \frac{a1}{a2}$ (2)

$\Delta G^1 = 0$, $G_3 – G_2=0$, $G_3 = G_2$,
$G_3^0 + RT \ln a_3 = G_2^0 + RT \ln a_2$,
$G_3^0– G_2^0 = RT \ln a_2 - RT \ln a_3$
$G_3^0– G_2^0 = RT (\ln a_2 - \ln a_3)$
$\Delta G_1^0= RT \ln \frac{a2}{a3}$
$\frac{\Delta G10}{RT}= \ln \frac{a2}{a3}$

Constant $(K_2) = \ln \frac{a2}{a3}$ (3)

The another constant for miscible system from equation (2) and (3), we get

$K_3 = K_1 \times K_2$
$K_3 = \ln \frac{a1}{a2} \times \ln \frac{a2}{a3}$
$K_3 = \ln (\frac{a1}{a2} \times \frac{a2}{a3})$
$K_3 = \ln (\frac{a1}{a3})$
$K_3 = \ln (\frac{a1}{a3})$
$e^{K3}= \frac{a1}{a3}$ (constant[1] (D) = e^{K3})

$D = \frac{a1}{a3}$ (4)

RESULTS

Equation (4), this is the exact expression of distribution law. If the solutions are dilute, the activities are equal to concentration, so that the above expression is modified as, $D = \frac{C1}{C3}$(C_1, and C_3 are concentration of miscible solvent xand z respectively)

Conclusion

It is concluded that as shown in the above result the thermodynamics proof indicates that the distribution ratio exists for miscible solvents.

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