

Partition equilibrium of I₂ between two phases

Introduction

If a substance is soluble in two different liquids which are not miscible and the two solvents are in contact with each other, after reaching the thermodynamic equilibrium, the ratio of the thermodynamical activities of the substance in the two phases will be constant, thus the following equations will be valid:

$$\begin{aligned}\mu_{x,A} &= \mu_{x,B} \\ \mu_{x,A}^* + RT \ln a_{x,A} &= \mu_{x,B}^* + RT \ln a_{x,B}\end{aligned}$$

Where $\mu_{x,i}^*$ is the standard chemical potential of the given substance (x) in the i^{th} phase and $a_{x,i}$ is the thermodynamical activity of substance (x) in that i^{th} phase.

By rearranging the above equation:

$$\frac{\mu_{x,A}^* - \mu_{x,B}^*}{RT} = \ln \frac{a_{x,B}}{a_{x,A}} \quad (1)$$

It can be seen that on a given pressure and temperature the left side of the equation is constant and called as *partition-coefficient*. The $a_{x,B}/a_{x,A}$ ratio, because of the monotony of the logarithmic function, is also used, and named as *partition ratio*.

In that case when the substance is not dissociate and also not forming associates in neither of the solvents, the distribution is independent of the absolute concentration of the substance measurable in the contacting phases.

Description of the practice

Measure 0.1 g of I₂ on an analytical scale (notice its exact weight). Dissolve it in 20 cm³ toluene in an Erlenmeyer flask. Add 150 cm³ distilled water to it, close the flask, then put into a shaker device for 20 minutes. After the time of shaking has elapsed, transfer the content of the flask into a separatory funnel, and then separate the two phases. Take out 5 cm³ from the organic phase and 100 cm³ from the aqueous phase and titrate them with aqueous solution of 0.01 M Na₂S₂O₃. For the time of titration, transfer the remaining parts of the two phases back to the Erlenmeyer flask, replace the missing volumes of 5 cm³ and 100 cm³ with the neat solvents of toluene and water, respectively, and repeat the previous whole procedure from the beginning (*i.e.* from the shaking) three more times.

Preparation of the aqueous solution of 0.01 M Na₂S₂O₃:

Measure 0.2482 g of Na₂S₂O₃ · 5H₂O on an analytical scale, transfer into a volumetric flask of 100 cm³ and then fill the flask until sign with aqueous solution of 1v/v% of isobutanol. Determine the exact concentration of S₂O₃²⁻ by titrating 10 cm³ 0.0015 M KIO₃ solution (in which 0.3 g I₂ was dissolved and 1 cm³ of 20 w% HCl solution was added 2 minutes before the titration) with the prepared Na₂S₂O₃ solution. The end points of the titrations in aqueous phases are indicated by a small amount of starch (added just before the end point of the titrations).

Necessary equations:



Evaluation of results

Prepare the following table, where c_w is the determined concentration of I_2 in a aqueous phase, while c_o is the determined concentrations of I_2 in the organic phase, for each of the four measurements. K is the *partition ratio*. Calculate the average value of K and calculate also the standard deviation.

number of measurement	c_w mol dm ⁻³	c_o mol dm ⁻³	K
1.			
2.			
3.			
4.			