HETEROGENEOUS EQUILIBRIA
(DETERMINATION OF PARTITION COEFFICIENT OF ACETIC ACID BETWEEN n-BUTANOL AND WATER)

THEORY:

A solute distributes itself in two immiscible solvents in such a way that the ratio of the concentration of the solute in the two solvents is a constant at a constant temperature, provided the solute dissolves in both the solvents in the same form and no chemical reaction takes place and there is neither association nor dissociation of the solute in the solvent.

This is mathematically expressed as $C_1/C_2 = K_d$; where $C_1$ is the concentration of the solute in one solvent and $C_2$ is that in another. $K_d$ is called the distribution or partition co-efficient.

An example of this type is the distribution of acetic acid between n-butanol and water.

PROCEDURE:

Preparation of solutions and experimentation:

Take two bottles I and II which contains –

Bottle I: 40ml n-Butanol and 60ml water and 1 to 2 ml acetic acid

Bottle II: 30ml n-Butanol and 70 ml water and 1 to 2 ml acetic acid

Shake the bottles vigorously after every 3 to 4 minutes for 20 minutes durations. And after each time of shaking, open the lid of the 2 bottles to relies the pressure. Then wait for 5 min. and pour the entire solution into a separating funnel. Allow the mixture to separate two clear layers where the upper layer is the organic layer and the lower layer is aqueous layer.

Step I

The aqueous layer was collected in a clean and dry 100 ml beaker. 5ml of the solution was pipette out in to conical flask. About 10 ml of distilled water was added and the resulting solution was titrated with supplied ~0.2 (N) NaOH using phenolphthalein indicator. At end point color of the solution is light pink.

Step II

The organic layer was collected into a clean and dry 100ml beaker. 5ml of the organic layer was pipette out into a conical flask. About 10 ml of distilled water was added and the resulting solution was titrated with supplied ~ 0.2 (N) NaOH using phenolphthalein indicators. During titration the solution was shaken vigorously. At the end point color of the solution is light pink.
The process of Step-1 & Step-2 is done for the 2 bottles. And at least two readings are taken for each titration.

**RESULT:**

**Recording of temperature:**

<table>
<thead>
<tr>
<th>Initial temperature(°C)</th>
<th>Final temperature(°C)</th>
<th>Mean temperature(°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Titration data for acetic acid in aqueous and organic layer:**

<table>
<thead>
<tr>
<th>Bottle No:</th>
<th>Volume of solution taken (ml)</th>
<th>Titration of Aqueous Phase (ml)</th>
<th>Titration of Organic Phase (ml)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Initial burette reading (ml)</td>
<td>Final burette reading (ml)</td>
<td>Initial burette reading (ml)</td>
</tr>
<tr>
<td></td>
<td>Volume reading (ml)</td>
<td>Mean volume (ml)</td>
<td>Final burette reading (ml)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Volume reading (ml)</td>
<td>Volume reading (ml)</td>
</tr>
<tr>
<td></td>
<td>Mean Volume (ml)</td>
<td></td>
<td>Mean Volume (ml)</td>
</tr>
<tr>
<td>I. (4:6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II. (3:7)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CALCULATION:

1 c.c 1(N) NaOH solution = 0.06gm CH₃COOH
v c.c. s(N) NaOH solution = 0.06 X v X s gm CH₃COOH
Hence distribution co-efficient (K_d) = 0.06 X u X s /0.06 X v X s
=u/v
=volume of NaOH solution for organic layer/ volume of NaOH solution for aqueous layer

Set 1: (K_{d1}) = org./aq =…. …/.…………=………………

Set 2: (K_{d2}) = org/aq =………/.…………=………………

:. The average distribution coefficient (K_d) = (K_{d1}+K_{d2})/2 =……………….. at …….0°C.

DISCUSSION:

The distribution coefficient or partition coefficient of a solute between two immiscible solvents depends on the nature of the solvent, concentration of the solute as well as on the temperature. So prior to the experiment all the apparatus should be well cleaned with distilled water so that no impurities be present. If impurities be present it might make complex with the solute of higher concentration of solute be used it may associated or dissociated. These altogether might make the result erratic. The experiments were performed at a fixed temperature. The solutions were shaken properly to make a good distribution of solute between the two phases. If the solutions are not shaken properly, a particular solvent might contain higher amount of solute compared to other and proper distribution or partition coefficient cannot be found out. Higher amount of indicator should not be used; otherwise estimation of concentration of solute in the two phases will be erratic.

CONCLUSION:

The average distribution coefficient (K_d) of acetic acid in n-butanol and water is
…………………………………………..at ………………0°C.