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Evaluation of Stability of Fe (III) Complexes

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Abstract: *A novel technique calledIonophoretic technique has been used for the study of stability of binarycomplex of Fe(III)-Maleic acid and ternary complexes of Fe(III)-Maleic acid –EDTA. A graph of Absorbance difference against pH is plotted for binary complex and Absorbance difference against –log [EDTA] is used to obtained information on the formation of mixed ligand complexes and to calculate the stability constant. The stability constant of Fe(III)-Maleic acid and Fe(III)-Maleic acid –EDTA complexes have been found to be 4.53 and 4.13 respectively at 25 0 C.*

Keywords: *Ionophoretic technique, Ionophoretic tube , binary complex, ternary complex*

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I. Introduction

The technique of electrophoresis was first introduced by A. Tiselius (1).His main field of interest was the chemistry of serum proteins. Electrophoresis involve the separation of charged molecular species on the basis of their movement under the influence of an applied electric field where positively charged ions moves towards cathode and negatively charged ions moves towards anode. In 1907 Field and Teageu (2) studied the electro migration of diphtheria toxin with antitoxin in agar jelly. The present work is based on the above idea and a novel technique has been evolved which can be termed as “solution electrophoresis or Ionophoresis”.Ionophoretic technique has been made for the study of Fe(III), Zn(II) - glutaratebinary complexes (3) and binary and ternary complexes of Cu(II) ,Co(II) (4,5). The stabilities of different types of species in complexationequilibria depends upon the materials used, pH metric studies, UV-Visible studies (6). Transition metal complexes of Mn(II)/Mn(III), Cu(II) and Fe(III) have notably shown important antioxidant properties(7).
An attempt has been made to investigate the complexation of metal ion Cu(II) with maleic acid as primary ligand and EDTA as secondary ligand .It was found that one EDTA molecule coordinate with one metal ion giving a stable complex which is formed in the low PH value and remain stable in the higher pH value.

II. Experimental

Procedure for the study of binary complex:

The mixture containing 1X10 -2 M ligand solution ,1X10 -2 M Maleic acid,0.1 M perchloric acid solution and 1X10 -4 M Fe(III) solution was prepared and the PH of the solution is adjusted (by adding NaOH solution) . Then 10ml of this mixture is taken in the electrophoretic tube. The position of the tube is so adjusted that the level of the mixturein one end arm reaches a circular mark on it. This adjustment fixed the volume on either side of the middle stopper. The arms of the tube are then marked as cathodic and anodic compartments. Two 0.5 X 0.5 cm -2 platinum electrodes were then connected to electrophoretic power supply; cathode electrode is negative and anode electrode is positive supply. A potential difference of 50 volts was applied between electrodes and middle stopper was allowed for 45 minutes. After 45 minutes the middle stopper was closed, power supply turned off and electrodes withdrawn. There after the electrolyzed solution of anodic compartment was collected in a 15 ml measuring flask. The volume was raised up to the mark with NH 4 SCN and then absorbance of Fe(III)thiocyanate complex was measured at 480 nm against a reagent blank.

Procedure for the study of ternary complex:

An appropriate reaction mixture containing metal ion and primary ligand and 0.1 M acid was adjusted for pH8.0 and the secondary ligand (EDTA) was added .progressively and the ionophoreticmobility was recorded. The mobility was plotted against – log [EDTA].

III. Result And Discussion

The Absorbance difference (y-axis) is plotted against pH (x-axis)
Figure 1

12345678910111213141516171819202122232425
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Mobility curve of Fe(III) - Maleic

Acid

The Absorbance difference (y-axis) is plotted against –log[EDTA] (x-axis)

Figure 2

12345678910111213141516171819
-0.04
-0.02
0
0.02
0.04
0.06
0.08
0.1
0.12
Mobility curve of Fe (III) - Maleic Acid - EDTA

The stability constant has been determined with the above described method. For the study of binary complexation a fixed concentration of primary ligand. For the study of binary complexation a fixed concentration of primary ligand is taken and absorbance is recorded at different pH values. For the study of ternary complexation secondary ligand , EDTA concentration is increased at pH 8 and difference in absorbance was checked.

Fe(III) – Maleic Acid complex species at the absorbance difference are different from the absorbance differences of the ternary complex .Since the absorbance difference is more negative than the mobility of pure metal –EDTA complex ,it is inferred that EDTA is coordinated with metal –ligand complex. The interaction of secondary ligand EDTA is represented as

$ML + L_1 \leftrightarrow^{k1} MLL_1$

Where M is Fe (III)

L is Maleic Acid
L_1 is EDTA

Under these conditions over all moiblities can be given by the following expression.

$U = U_0 + U_1 K_1 [L] / 1 + K_1 [L]$

Where U_0 and U_1 are mobilities of M-Ligand and complexes respectively. Using again the principle of average point, K_1 can be determine to be equal to $1/L_1$ .However the formation of ML_1 that is Metal –EDTA Metal –Maleic acid complex the equilibrium $M + L_1 \leftrightarrow ML_1$ holds good where K_1 is the stability constant of Metal- EDTA-Maleic acid complex.
From these two chemical equilibrium

$[MLL_1] = k_1 [ML] [L_1] = kk_1 [M] [L] [L_1]$

This is how the stability constant of metal ligand complexes can be assessed.

Stability constants (log K) of Metal - Maleic Acid binary complexes at temperature 25 ^{0} C

TABLE- 1

Metal ion	Calculated value	Literature value
Fe (III)	4.53	-

Stability constants (log K) of Metal - Maleic Acid - EDTA ternary complexes at temperature 25 ^{0} C

TABLE -2

Metal ion	Calculated value	Literature value
Fe(III)	4.13	-

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