STUDY OF A NEW COORDINATION COMPOUNDS BASED ON Cr(III) AND SUCCINIMIDE IN AQUEOUS SOLUTION

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Abstract: *In this paper, the study of obtaining new coordination compounds of Cr (III) using as ligand, succinimide and the stability constants, were presented. Conductometric, pH-metric and spectrophotometric studies of Cr(III)-succinimide system were carried out in aqueous medium. The "molar ratio" method was used to study the complex formation in solution and for determine the stability constants was used Harvey-Manning method.From experimental data resulted that the combination ratio of the ligand succinimide with central metallic atoms was: 1:1, 2:1 and respectively 3:1.*

Keywords: *pH-metry, stability constants, combination ratio*

1. Introduction

Coordination compounds play an important role in the chemical industry and in life itself; find application in qualitative as well as quantitative estimation of metal ions [1-5]. The complex ions and coordination compounds formation is influenced by many physical and chemical factors. These include environmental factors such as temperature and pressure and more important factors like the nature of the metal ion and the nature of the ligand [6]. Succinimides represents an important class of organic compounds due their different applications in numerous fields, as: medicine – are used in the treatment of schizophrenia, epilepsy and depression, chemistry - they can be used as inhibitors or as intermediates and reagents for the synthesis of natural and unnatural compounds [7, 8].

The transition metal ion presented in this paper, Cr (III), have the potential to form different compounds, exhibiting a wide range of colors, structures, and chemical properties.

A wide range of chromim compounds based on the Cr(III) ion and different ligands such as peptides, urea, sulfates, proteins, ammonia, and organic acids, anions, acids, nucleic acids, and other macromolecules are described in the literature [9]. In aqueous medium, most chromium (III) compounds are found as coordination complexes.

The main aim of this study is to point out the formation of new compounds by the interaction of Succinimide ligand with chromium (III) ion in aqueous solution.

2. Experimental

All chemicals were obtained from commercial supplier and used without further purification. Succinimide (99%)

and $CrCl_3 \cdot 6H_2O$ (99%) were purchased from Sigma Aldrich in high purity.
A 10^{-2} M solution of Succinimide (noted L) and respectively of chromium chloride was prepared by dissolving the accurate weight in bidistilated water.
The coordination compounds composition was determined following the Harvey—Manning and respectively "molar ratio" methods.
In order to determine the combination ratio of Cr(III)-Succinimide it was prepared a set of 14 samples of the initial solutions, with the same concentration (10^{-2} M), of $CrCl_3$ and respectively of ligand (L) by mixing according to "molar ratio" method [10]. For each sample were measured the values of conductivity, pH and absorbance, respectively.
A Radelkis –Budapest OK 109 conductometer was used for the solutions specific electric conductibility determination. The pH measurements were carried out using a pH-meter type HACH ONE.
Perkin-Elmer Spectrum 100 spectrophotometer was used to record the spectra of chromium (III) solution, ligand solution and respectively of chromium (III)-Succinimide complex.
Chromium (III) coordination compounds were obtained according to the following equations:

$C_4H_5NO_2 + CrCl_3 + 4H_2O \rightarrow$
$[Cr(C_4H_4NO_2)(H_2O)_4]^{2+} + 2Cl^- + HCl$
$2C_4H_5NO_2 + CrCl_3 + 2H_2O \rightarrow$
$[Cr(C_4H_4NO_2)_2(H_2O)_2]^{+} + Cl^- + 2HCl$
$3C_4H_5NO_2 + CrCl_3 \rightarrow [Cr(C_4H_4NO_2)_3] + 3HCl$

All the experiments were performed at room temperature.

3. Results and discussions

The absorption spectrum of chromium (III)-succinimide shows the maximum absorbance at 570 nm. In all instances, measurements were made at 570 nm against reagent blank.
In Figure 1 the absorbance values as a function the molar ratio L/Cr^{3+} was presented.

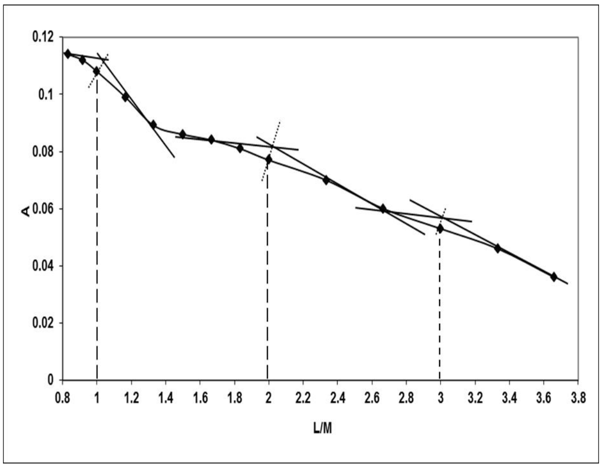

Figure 1. The curve representing absorbance values of the solutions L^- – Cr^{3+}, versus the molar ratio L^-/Cr^{3+}

It can be observed that the complexes formation occur in three stages demonstrated by the presence of three nodal points.

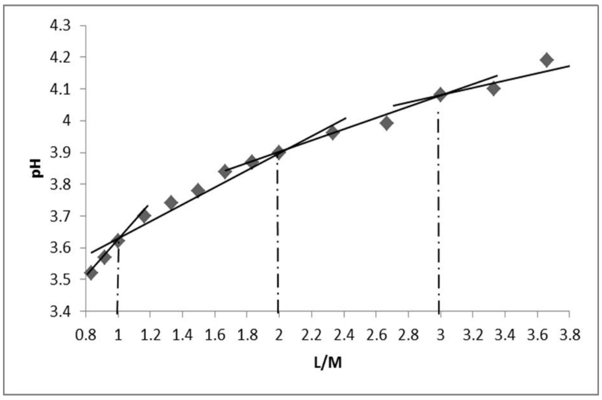

Figure 2. The pH dependence on the molar ratio L^-/Cr^{3+} for the solution of obtained complexes

From the "molar ratio" method experimental data in pH - metric variant it can be pointed out that are obtained curves with change of slope at the combination ratio (ligand: central atom) 1:1, 2:1 and 3:1

respectively. These facts demonstrate that the metal ion adds to one, two or three ions from the ligand, obtaining the corresponding complexes.

It was pointed out that the pHs range of 3.5−4.1 corresponds to the stability of all obtained complexes.

In Figure 3, it can be observed that the conductivity dependence on the molar ratio L^-/Cr^{3+} presents three straight line segments with three different slopes which corresponds to the combination ratio 1:1, 2:1 and 3:1 L^-/Cr^{3+} respectively.

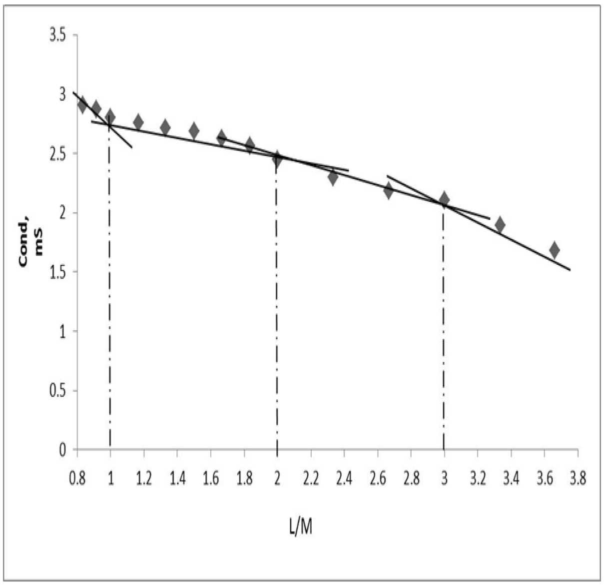

Figure 3. The conductivity variation as function of the molar ratio L^-/Cr^{3+} for the solution of obtained complexes

Conductivity-decrease or increase in the electrical conductance of the solution in which complex formation occurs may result due to disappearance or production of ions of comparatively higher mobility [11].

The decrease of solution conductivity values with L^-/Cr^{3+} molar ratio can be attributed to the decrease of charge of ionic species present in the solution.

The formation of the three complexes in aqueous medium was demonstrated by the three presented methods.

The effectiveness with which a metal ion is coordinated by a ligand, L, in aqueous solution may be assessed by determining the equilibrium constant described by, for example, an overall stability constant.

In order to determine the coordination compounds stability constants, in solution, it is necessary to know the reactants concentration at the equilibrium.

The stability of Cr(III) coordination compounds depends on the radius and charge of the Cr^{3+} ion and the stabilization due to the splitting of the d orbitals [12].

Based on the Harvey-Manning method [13] and taking in account the obtained data from molar ratio method, the stability constants were calculated.

Calculations were made with the use of the following equations:

$$K_d = \frac{C^n \alpha^{n+1} n^n}{1-\alpha} \quad (1)$$

$$\alpha = \frac{A_M - A_R}{A_M} \quad (2)$$

$$\beta = \frac{1}{K_d} \quad (3)$$

where:

K_d = instability constant (dissociation),
C = complex ion maximum concentration, at the combination ration L/M,
α = complex dissociation degree,
n = coordination number,
A_M = maximum absorbance at the ligand excess, from the graph constant portion which reproduce A = f (L/M),
A_R = stoichiometric ratio absorbance L/M,
B = stability constant.

Table 1. Stability constants of the studied coordination compounds

Coordination compound/molar ratio	Stability constant β (L/mol)
Succinimide - Cr^{3+} 1:1	$0.64\cdot10^{5}$
Succinimide - Cr^{3+} 2:1	$0.45\cdot10^{7}$
Succinimide - Cr^{3+} 3:1	$4.29\cdot10^{10}$

It can be observed that the higher the value of the stability constant, the more stable the coordination compound is.

4. Conclusions

In the present work, three new coordination compounds with succinimide ligand were obtained in aqueous solution. The pH-metry, conductivity and UV-Vis spectrometry methods relieved the formation of complexes in 1:1, 2:1 and respectively 3:1 molar ratio L/M.
The stability constants pointed out that the coordination compound in the molar ratio 3:1 L/M was the most stable.

5. References

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