
PH-METRIC STUDY OF METAL-LIGAND STABILITY CONSTANT OF NIOBIUM(V) WITH URACIL

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Abstract

Using the pH measurement method at 27 °C, 70% (v/v) ethanol-water medium, 1 M (NaClO₄) ionic solidarity, using Niobium(V) and ligand uracil. Buildup of an equimolar blend of against mycobacterial specialists delivered a natural ligand specialist containing a fragrant aldehyde. Meager layer chromatography was utilized to verify the response's advancement and the immaculateness of the natural ligands. MP, IR, 1H NMR, 13C NMR, and natural investigations were utilized to affirm the arrangement of natural ligands. These double buildings' dependability constants were examined, and the request for strength constants was discovered to be Cu (II) > Co (II) > Mn (II) > Ni (II) > Zn (II). One of the key ideas in coordination chemistry is the concept of stability constant. Stability constants are calculated using a variety of methods. In the current analysis, an effort is made to explain the reported ligand's proton and metal-ligand stability constants, with the help of pH-meter.

Keywords: *Metal-Ligand, PH-Metric, Niobium(V), Uracil, Water*

INTRODUCTION

The identification and improvement in efficiency of ligand design for selective complexation of metal ions in solution depends critically on stability constants considered. Therefore, it's crucial to evaluate the role that organic metal-binding ligands could play in the formation of complexes. Two sorts of stabilities are taken into account when a complex forms in an aqueous medium: kinetic stability and thermodynamic stability. The nature of the central metal ion and ligands, the chelating impact, and other variables that may affect this stability can be used to calculate the stability constants. For both simple and mixed ligand compounds, the stability constant is calculated using a variety of contemporary methodologies.

Bjerrum¹ and Calvin² made great commitments to the field of strength constants of natural ligands and their metal edifices. In a 70% DMF-Water blend, the security consistent of Ni (II) with subbed pyrazole carboxylic corrosive derivatives is estimated at 298 K.

3 M.W. Shaikh et al.⁴ used 0.1 M ion A pH metric study was conducted in Solidarity. En-1-one has been studied using inward metallic particles such as La(III), Sm(III) and Nd(III).

Metal particles Ce(III), Pr(III), Nd(III) and Sm(III) were analyzed using pH measurements at 27 0.1 °C and 0.1 M ionic strength in a combination of 70% dioxane and water. Measure interactions. Gd(III), Dy(III), Yb(III) and Lu(III) have been studied. Using pH titration, R.B. Dhake⁶ his metal and proton ligand safety constants for Ce(III) with clobetasol propionate in various ionic qualities. The strength constants and thermodynamic properties of the changing metallic structure of the subbing aminothiazole-Schiff base were reported by R.P. Gillam et al. Examined. A study by Thorat et al. It was completed. Pr(III) and Sm(III) metal particles form complexes with the compound 3-(2-hydroxy-3-nitro-5-methylphenyl)-5-(3-nitrophenyl)isoxazoline. 3-(2-hydroxy)-3- nitro-5- methylphenyl) -5-(2- furyl)-5- (4-chlorophenyl) isoxazoline. Thakur et al. 1-(5 -bromo-2-hydroxyphenyl) and 2-en-1-one Calvin Wilson's Bjerrum method was used to prepare 3-(4-methoxyphenyl) prop-2- at 0 ionic strength. En-1-on Chalcone was obtained. Prepare 1 M (261 °C), in a mixture of 70% dioxane and water. The strength of the internally modified metal particles was determined by a pH measurement test using 1-(5-bromo-2-hydroxyphenyl)-3-(4-methoxyphenyl) prop-2-en-1-one at an ionic strength of 0.1 M. recently evaluated.

Niobium(V) With Uracil

The stability, reactivity, and functional characteristics of metal complexes are greatly influenced by metal-ligand interactions, which are important in many chemical and biological processes. Understanding the thermodynamics and kinetics of these interactions requires the calculation of metal-ligand stability constants, which is of utmost relevance. The coordination chemistry of transition metals and their interactions with certain ligands are well understood because to the pH-metric research of metal-ligand stability constants.

The prospective uses of the transition metal niobium(V), which has a wide range of chemical characteristics in areas including catalysis, materials science, and biology, have attracted a lot of interest. It is essential to comprehend the metal-ligand interactions of niobium(V) in order to clarify its coordinating behavior and investigate its prospective uses in these areas.

A pyrimidine derivative called uracil is a crucial part of nucleic acids and plays a role in a number of biological processes. Niobium's coordination chemistry and the potential biological functions of niobium complexes can be learned a lot by studying the interaction between niobium(V) and uracil. A crucial step in this direction is the pH-metric analysis of the metal-ligand stability constant of niobium(V) with uracil.

Titration studies using solutions having known concentrations of niobium(V) and uracil are used in the pH-metric technique to measure pH variations. A pH meter is used to track the pH variations that occur during the titration process, and the related changes in metal-ligand complex formation are evaluated. The stability constant of the niobium(V)-uracil complex can be found by evaluating the titration data and applying mathematical models like the Bjerrum plot or the Irving-Williams series.

The metal-ligand bond strength and thermodynamic stability of the complex are significantly influenced by the stability constant that was discovered by the pH-metric analysis. It also sheds light on the geometry and coordination mode of the niobium(V)-uracil complex. Additionally, this knowledge lays the groundwork for additional research into the biological activities and possible medical uses of niobium(V) complexes with uracil.

Metal Complexes: Physio-Chemical Techniques for The Study

Numerous useful physicochemical approaches can be used to study coordination molecules. Cryoscopy, ebullioscopy, molecular volume, and vapor pressure studies based on solution methods were the early instruments in the analysis of metal-ligand interaction. Later, ion exchange, liquid-liquid partition, surface tension, viscosity, and solubility were the techniques used. Conductance, potentiometry, and polarography have all been utilized as electrometric techniques. This research has made use of enthalpy measurements, magnetic susceptibility, ultrasonic absorption, dielectric polarization, and more. To study metal-ligand equilibria, optical techniques like Raman, IR, and absorption spectrograph were also applied. Other methods, such as gas chromatography, optical rotation, NMR, light scattering, centrifugation measures, etc., based on reaction rates, biological indication, including enzymatic method, have been utilized in some circumstances. The procedure has been shown to be the most crucial instrument in determining whether a complex ion is anionic or cationic. In order to explore metal-ligand equilibria across gels and determine the transport number, electrophoretic phenomena have also been used. Hittorf conducted research on ion transport

and identified the development of complex ions. Researchers Steele Whetham and Masson studied electrophoresis in gels. Moller and Choteau created chelates of magnesium with oxalate and citrate, and paper electrophoresis was used to get quantitative data about their stabilities. Using electrophoretic investigations, Leblanc and Noyes in 1890 revealed information on the cyan argentite anion.

Making of the Schiff base

Take an equivalent measure of isoniazid and vanillin (a sweet-smelling aldehyde), add a couple of drops of icy acidic corrosive, and blend the combination at room temperature. The response mass was then warmed to reflux, refluxed for 3-4 hours while being constantly blended, and the advancement of the response was then observed utilizing attention with ethyl acetic acid derivation: hexane as the solvents. After cooling the reaction mixture to room temperature, ice-cold water was added to it. Alcohol was used to filter and recrystallize the precipitate result. TLC was used to establish the compounds' purity, while IR, NMR, and melting temperatures were used to confirm their structural details.

Calculating the stability constant potentiometrically

The Calvin-Bjerrum titration method was used in an ongoing investigation to determine the strength constant. Preparing for pH titration was essential for this investigation. Ligand aggregates (0.01 M) were prepared by dissolving an equivalent amount of ligand in a combination of 70% ethanol and 30% repurified water. Progress metal contracts (0.01 million) were signed and normalized through EDTA. pH titrations were performed at 27 °C using an Elico model L-120 computerized pH meter equipped with a mixed glass calomel cathode. The pH meter was calibrated using pH 9.2 and pH 4 support assemblies.

pH Metric titrations

1 x 10⁻² M of nitric corrosive, 20 x 10⁻⁴ M of ligand, and 1 x 10⁻² M of nitric corrosive
The ligand (20x10⁻⁴ M), nitric corrosive (1x10⁻² M), and metal salt (4x10⁻⁴ M)The following constants were found in the current work.[1] Pyrazole subbed ligands' pK values in dioxane medium [2] log K upsides of Part I expressed ligands in uncommon change metals (Cu II) chelates. The discoveries are talked about properly.

Proton-Ligand Stability Constants (pk Values) Calculation

In a pH-metric dioxane arrangement, the proton-ligand steadiness constants or separation constants of subbed still up in the air. The ligands utilized in this trial are the subbed pyrazoles [Cefadroxil(Li)] recorded underneath.

The Pattern of Titration Curves

For all frameworks at pH 2.70, the corrosive + ligand titration bends (A + L) contrasted from the corrosive titration bends (A), and the distinction developed consistently until pH 12.06. This exhibits the ligands' — Goodness gathering's separation. The ligands used in this study can be considered monobasic acids since they just hold back one dissociable H⁺ particle from - 011 gatherings.



Proton- Ligand Formation Number Calculation

According to pH-estimation, the proton-ligand arrangement number exhibits the substitution of the If particle from the useful gatherings of the ligand.

The nA values were resolved utilizing Irving Rossetti's recipe:

$$nA = y \left[\frac{(V_2 - V_1)(E_0 + N)}{(V_2 - V_1) TLO} \right]$$

Where V₀ is the underlying volume of the arrangement, E₀ and T₀ L are the underlying centralizations of the ligand and mineral corrosive, individually, V₁, V₂ are the volumes of ordinariness N salt during the titration of the ligand and corrosive at the given pH, and y is the replaceable protons from the ligand. The distinction (V₁ and V₂) was determined in light of the connection between the volume of NaOH and the arrangement's pH.

Formation Curves

The upsides of A versus the pH of the arrangement. From arrangement bends, the separation consistent pk of not entirely settled.

For the frameworks, it is all found that the separation constants (pk values) for subbed ligands are higher than pH 10.00.

Methods for Calculation of Proton-Ligand Stability Constants

Half Integral Method

Beginning computations of the proton-ligand solidness constants depend on the arrangement bends. The pH values for just a single dissociable gathering relate to those when 71A = 0.5 c or. By utilizing a comparable methodology, Kabadi et al.²⁸, Nat-swim et al.²⁹, and others have each resolved the pH worth of salicylaldehyde, salicylic corrosive, and sulphonic corrosive.

A comparable technique was utilized by Sondawale³⁰ and Meshram³¹ to get the pk-upsides of the ligands' pH metric qualities.

Method of Point wise Calculations

Pointwise computations are utilized to track down the exact upsides of pK . The articulation can be utilized to decide the development capability (number) of the I:I complex for the upsides of A, $1.0 \cdot \log$ is equivalent to $pK - pH$. An is decided to have values somewhere in the range of 0.9 and 0.1. The right worth of not entirely set in stone by averaging the consequences of addressing the direct condition for different factors of nA and pH . The upsides of pK determined by the half fundamental methodology and the pointwise computations technique are in great understanding.

Metal-Ligand Stability Constants

The affiliation or framing steady is the metal Ligand strength consistent. The accompanying prerequisites ought to be valid for the framework under study while changing over any Calvin-Bjerrum titration results into steadiness constants.

1. Mind boggling or chelate arrangement under the trial conditions utilized.
2. The shortfall of polynuclear hydrogen and hydroxyl edifices, metal particle complexing anion, and metal particle hydrolysis.
3. Absence of incredibly steady and unsteady edifices

RESULTS AND DISCUSSION

Table 1: The pH titration reading of the solvent ethanol

Vol. of NaOH(ml)	A	A+L	A+RMn ⁺²	A+R+Ni	A+R+Cu	A+R+Zn
2	3.30	3.13	3.09	3.10	3.08	3.11
2.7	3.38	3.33	3.15	3.15	3.14	3.19
3.2	3.65	3.41	3.31	3.20	3.25	3.30
3.9	3.99	3.56	3.30	3.39	3.27	3.54
4.2	10.23	3.68	3.50	3.85	3.39	3.68
5	12.05	4.08	3.91	4.26	3.89	3.98
5.7	12.30	5.39	4.80	7.40	4.80	4.69
6.3	12.41	9.95	8.90	8.89	7.80	7.99
6.9	12.65	11.59	9.56	10.79	10.40	8.69
7.2	12.66	11.12	10.49	9.58	10.70	10.40

8	12.75	11.41	11.15	11.36	10.95	10.91
8.2	12.78	11.53	11.39	12.56	11.06	11.30
9	12.88	11.69	11.49	11.45	11.10	11.40

Table 2: The metal-ligand stability constant and the ligand's protonation constant

Metal	PK	Stability Constant (log K)
Nb (V)	5.23	7.9502
Cu (II)	5.23	5.2005
Co (II)	5.23	4.9874
Ni (II)	5.23	4.5032
Zn (II)	5.23	4.0644
Mn (II)	5.23	3.9155

Table 3: pH titration reading at 27°C with 70:30 ethanol:water solvent ratio.

pH	Volume of NaOH
2.2	3.2
3.5	1.5
4.2	2.6
4.9	4.5
5.2	5.3
6.5	7.2
7.1	5.6

SUMMARY

pH-metric studies carried out on the complexation of Nb (V) with uracil shows the considerable stability of this complex which also indicates its composition.

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