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EFFECT OF 1,10 PHANANTHROLINE IN FE(II) SALT TITRATION

Dr. B. Padma,[1] Dr. J Nelson Samuel Jebastin,[2] Abdulrazak Shekhasaheb Bagawan,[3] Prof Dr Jayesh Gujarathi,[4] Dr Yogesh Jorapur[5]

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ABSTRACT:

The goal of this study is to foster a straightforward, naturally harmless substitute logical strategy for concurrent assessment of iron oxidation states. This proposed technique for iron speciation is in view of 1,10-phenanthroline (phen) altered redox capability of progress metal particles. In a pre-step overabundance cerium (IV) oxidizes iron (II) in example to iron (III). Introductory back titration of un-responded cerium (IV) with cobalt (II) in presence of phen gives measure of iron (II) in example, decrease of iron (III) with cobalt (II) is then used to appraise complete iron as iron (III). The potentiometric titration strategy has been effectively tried for conclusions of iron (II) and complete iron in engineered and regular examples and addresses an unmistakably green option in contrast to other detailed conventions of iron speciation examination.

Keywords: ligand effect on redox potential, 1,10-phenanthroline, iron speciation, green analytical chemistry, potentiometric titration

[1]Assistant Professor, University Post Graduate College, Secunderabad Osmania University
[2]Assistant Professor in Bioinformatics, Department of Zoology, Annamalai University, Annamalainagar, Chidambaram, Cuddalore Dt., Tamilnadu, India. 608 002
[3]Associate Professor, Department of Chemistry, M G V C Arts Commerce and Science College, Muddebihal Dt: Vijayapura, Affiliated to Rani Channamma University, Belagavi
[4]Professor and HoD, Dept of Chemistry, Pratap College Amalner Autonomous, Maharashtra, India
[5]Assistant Professor, Department of Chemistry, Pratibha College of Commerce and Computer Studies, Chinchwad, Pune 411019

INTRODUCTION

In some cases, the stability constants of metal-ligand complexes and the stability constants of the corresponding proton-ligand complex can be linearly related. This means that even minor structural changes in the ligand will have a linear effect on the stability constants of the two complexes. For the analytical chemist, the existence of such linear relationships is of the utmost importance because it enables him to approximate the stability constant values of a particular metal and a ligand when the constants of this metal have been measured for other ligands that are comparable to it. Relationships or empirical trends

in the variation in stability between a group of metals and a particular ligand are equally significant. The Irving-Williams Series (1), for instance, asserts that the stability of metal complexes will typically correspond to the metal's second ionization potential for the majority of ligands. For ions of equal charge, the order of stability of a ligand with the following metals is consistent with this generalization: Zn: Cu, Ni, Co, Fe, Mn In addition, it has been demonstrated in a few instances (alkali metals, alkaline earths, and rare earths) that the charge squared divided by the metal ionic radius, or er, determines the stability of the complex with a particular ligand. There are theoretical justifications for expecting complex stability to be inversely proportional to ionization and electrostatic potentials, but these are only rough estimates due to the many other factors that must necessarily have a significant impact on a complex's overall stability. In order to feel justified in applying the theoretical generalizations to all complex compounds, it is only necessary to recognize, interpret, and, if at all possible, separate these additional effects. With the Irving-Williams Series, this is the case. Although there are notable exceptions that demonstrate the rule, the sequence appears to hold for an excessive number of diverse ligands to reject the correlation. One such exception is the 1,10-phenanthroline complexes, with the most obvious deviation being that the stability of the tris(1,10-phenanthroline) nickel(II) complex and the tris(l,10-phenanthroline) iron(II) complex is greater than that of the copper(II) complex, whereas this would be the case for most ligands. Although the 1,10-phenanthroline complexes themselves possess numerous additional properties that are of interest, this exceptional behavior on its own would be sufficient to warrant a serious investigation into its explanation. The intense color formation of the 1,10-phenanthroline iron(II) and copper(I) complexes has made them a common analytical tool. The fact that a number of metals react kinetically slowly with 1,10-phenanthrolines (3) has facilitated novel analytical separations and raises intriguing questions regarding the interpretation of chelate reaction mechanisms. Although 1,10-phenanthroline complexes have received a lot of attention in the literature (4), it has only recently been attempted to systematically measure the stabilities of transition metal complexes with 1,10-phenanthroline, with the exception of iron complexes (5)>. Even less research has been done with complexes of substituted 1,10-phenanthrolines. It is hoped that the current work will at least contribute to this end. The far off object as a top priority, notwithstanding, is to endeavor to lay out the linearity, and the constants for the direct condition relating the security of the metal edifices to the soundness of the proton buildings, for a progression of subbed 1,10-phenanthrolines. The substituent effect of a given metal in relation to an arbitrary standard cation, the proton, is then represented by this equation. Various transition metals have the ability to be measured for the substituent effect. The subsequent inquiry is: Is there a connection between the effects of substituents as the metal changes? From a theoretical perspective, what is this relation likely to be? Indeed, answering these primary questions would be beneficial.

In water systems, iron is one of the most prevalent and significant bioactive trace metals. The degree to which iron is oxidized, hydrolyzed, and complexed with various inorganic and organic ligands in the water's environment determine its biogeochemistry in natural water. Iron(III) and iron(II) are the two oxidation states of dissolved iron, with iron(III) being the more thermodynamically stable form in oxygenated waters. However, there are a number of processes that reduce iron(III), resulting in measurable iron(II) concentrations in surface water. Even though good analytical methods of metal ion estimation like atomic absorption spectrometry (AAS), inductively coupled plasma atomic emission spectrometry (ICP-AES), and X ray fluorescent spectrometry (XRF) detect metal ions at mg L1 (ppm) and even lower concentrations, they cannot distinguish any difference in the metal oxidation states and are therefore inappropriate for the speciation of iron.4–7 This stimulates progress in developing analytical methods and instrumentation For the simultaneous determination of iron(II) and iron(III) in various samples, numerous alternative methods9–13 have been reported in the literature. However, strict procedures and sophisticated instrumentation that are out of reach for common labs are required for sampling, sample handling, pre-concentration, and/or separation of the speciated forms. As a result, eco-friendly analytical approaches with high selectivity, sensitivity, precision, and reproducibility are still desired. 14 We recently described potentiometric estimation of iron oxidation states through coordination inspired redox behavior of cobalt and iron species.18 This article describes green electrochemistry and extends the work to an environmentally friendly method for simultaneous speciation of iron(II) and iron(III). This is a continuation of our work on the complexation effect of redox potential15 and its utilization in novel analytical monitoring of transition metal ion mixtures. Under the redox potential modification with 1,10-phenanthroline ligand, the method is based on the redox reaction of cerium(IV) and iron(II) to produce iron(III), then back titration of cerium(IV) with

cobalt(II) for estimation of iron(II), and further titration of iron(III) with cobalt(II) to give total iron concentration. This potentiometric alternative for simultaneously estimating iron oxidation states is robust, less harmful, and atom-efficient in one step. Furthermore, solidification of reaction waste permits secure disposal, minimizing the risk of human exposure and water body damage. The results, which were in good agreement with those of a standard spectrophotometric method, were obtained for the determinations of iron(II) and total iron in laboratory-created (synthetic) and natural water samples (Dal Lake), standard iron ores, rock samples, and pharmaceutical samples. The 1,10-phenanthroline ligand modulated redox potential is used in this article to illustrate the concept of green electro analytical chemistry.

EXPERIMENTAL

Apparatus

Potentiometric titrations were performed manually using a commercially available platinum indicator and calomel reference electrode over a potentiometer (Systronics India Model 318) at T = 50 °C ± 2 °C. pH was measured using a Labindia pH analyzer (PHAN) fitted with Lp-01 pH electrode. A Siskin Julabo thermostat was used to maintain a constant temperature within ± 2 °C. The titration vessel consisted of a specially designed six necked vessel (one each for micro burette, platinum, calomel electrodes, temperature probe, inlet and outlet of nitrogen gas).

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