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ORIGINAL PAPER

Spectrophotometric study of some Mn(II) ternary complexes and their analytical applications

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Abstract New ternary complexes of Mn(II) with py, bipy, and terpy as primary ligand (L_1) and 2′,4′,5′,7′-tetraiodofluorescein ($I_4FlCOOH$) as secondary ligand (L_2) were prepared. The stoichiometry for these complexes was found to be Mn(II):L_1:L_2 = 1:2:1, and the complex formula proposed is $[Mn(L_1)_2(I_4FlCOO)]^+$. The effect of substituent groups of L_2 and the nitrogen atoms of L_1 on complex formation with Mn(II) was studied. Moreover, the interference of some cations and anions in the determination of Mn(II) by this method was investigated and the interferences of Cu(II) and Fe(III) with Mn(II) in their corresponding alloys were considered. A simple, rapid, and sensitive spectrophotometric method for determination of Mn(II) in its salts and Mn in its alloys is suggested.

Keywords Mn(II) compounds · UV/Vis spectroscopy · Tetraiodo-fluorescein

Introduction

Manganese is the third most abundant transition metal, and is widely distributed in the earth's crust [1]. It is a biologically important element and is necessary for photosynthesis. Small amounts of $MnSO_4$ are often added to fertilizers because trace amounts of manganese are essential for plant and animal growth. In addition, Mn is an essential trace element in some enzymes such as arginase and phosphotransferases [2]. The oxidation state (+II) is very stable corresponding to loss of only the $4s^2$ electrons, and indicative of the stability of the half-filled *d* levels [1]. Thus Mn(II) is more stable than other divalent ions of transition elements and more difficult to oxidize than Cr(II) or Fe(II) [2].

Spectrophotometric methods are simple, rapid, and inexpensive; when combined with extraction, the selectivity and sensitivity of the determination are regularly improved. The classical spectrophotometric method for manganese determination is based on oxidation of Mn(II) to permanganate (MnO_4^-) followed by spectrophotometric measurement of MnO_4^- [3]. This method is not suitable for trace analysis, however, because of its fairly low sensitivity. Methods based on the formation of colored complexes of Mn(II) with chromogenic reagents, for example formaldoxime, provide higher sensitivity [4]. Much more sensitive methods are the so-called kinetic methods, based on the unique catalytic roles of Mn(II) on the redox reactions between various organic compounds and an oxidizing agent [5]. Spectrophotometric techniques were used to determine manganese in many materials, for example foodstuffs [6], natural [7] and river [8] water, cement [9], pharmacological preparations and vegetable fertilizers [10], medicinal plants [11], and coal fly ash and soil [12].

In recent work, some Mn(II) ternary complexes were characterized and determined spectrophotometrically. The complexes studied can be used to determine Mn(II) in its salts and Mn in its alloys.

Results and discussion

Complex formation

Pyridine (py) and related unsaturated heterocyclic amines such as 2,2′-bipyridine (bipy) and 2,2′:6′,2″-terpyridine

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