

Chemical Speciation of Antimony(III and V) in Water by Adsorptive Cathodic Stripping Voltammetry Using the 4-(2-Thiazolylazo) – Resorcinol

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Abstract

A simple adsorptive cathodic stripping voltammetry method has been developed for antimony (III and V) speciation using 4-(2-thiazolylazo) – resorcinol (TAR). The methodology involves controlled preconcentration at pH 5, during which antimony(III) – TAR complex is adsorbed onto a hanging mercury drop electrode followed by measuring the cathodic peak current ($I_{p,c}$) at -0.39 V versus Ag/AgCl electrode. The plot of $I_{p,c}$ versus antimony(III) concentration was linear in the range 1.35×10^{-9} – 9.53×10^{-8} mol L⁻¹. The LOD and LOQ for Sb(III) were found 4.06×10^{-10} and 1.35×10^{-9} mol L⁻¹, respectively. Antimony(V) species after reduction to antimony(III) with Na₂SO₃ were also determined. Analysis of antimony in environment water samples was applied satisfactorily.

Keywords: Antimony(III, V), 4-(2-Thiazolylazo)-resorcinol, Cathodic stripping voltammetry, Speciation, Certified reference material (IAEA Soil-7), Red sea water, Wastewater

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1 Introduction

Antimony and its compounds have many industrial uses e.g. manufacture of glass pottery and ceramics as well as in fire retardants and semiconductors [1]. Ultratrace level concentrations of antimony are commonly found in aquatic environment because of various human activities [2,3]. Antimony tends to accumulate in bottom sediments then releases into animal and vegetable tissues [4], thereby reaching humans and causing chronic diseases [5–8]. Antimony and its compounds are listed as priority pollutants by different international or government organizations [9]. Elemental antimony is more toxic than its salts and trivalent antimony compounds are generally more toxic than pentavalence form [10–12].

Numerous analytical techniques have been reported to measure antimony in environmental samples such as microwave induced plasma-atomic emission spectrometry (MIP-AES) [13,14], laser induced fluorescence [15,16], high performance liquid chromatography (HPLC) [17] and electroanalytical techniques [18–22]. Voltammetric methods are among the electrochemical techniques described for the analysis of antimony. These are relatively widespread and, due to their accuracy and sensitivity, have contributed greatly to its determination at trace level [22–24]. Adsorptive stripping voltammetry has also been used for antimony determination using complexing agent such as Alizarin Red S [25].

The reagent 4-(2-thiazolylazo)-resorcinol, abbreviate as TAR (Figure 1) is the one of the popular chelating reagents. It forms either neutral or ionic stable chelates with high molar absorptivity with many metal ions according to the solution pH [26–28]. Recent literature survey has revealed no study of the reagent TAR for determination and/or chemical speciation of antimony. Thus, the present article reports a simple, accurate, convenient and low cost DP CSV procedures using the title reagent (TAR) for trace and ultra trace determination of antimony(III) and antimony(V) in water at a hanging mercury drop electrode. Mercury film and HMDE are the only electrode types sensitive enough for metal speciation measurements and in-situ metal measurements including antimony [29] and other metal ions [30,31] in natural waters. This electrode is safe as long as storage and disposal of Hg is undertaken in a safe manner. HMDE is widely used for ultra-trace metal speciation in natural waters.

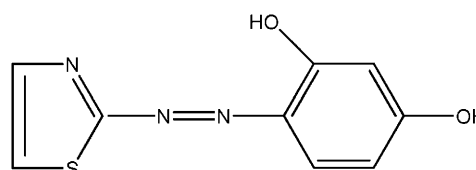


Fig. 1. Chemical structure of the reagent (4-(2-thiazolylazo)-resorcinol).