A Review on Spectrophotometric Determination of Heavy Metals with emphasis on Cadmium and Nickel Determination by U.V. Spectrophotometry

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Abstract*—The presence of heavy metals in the wastewater is harmful for human being. The waste water containing metal ions can contaminate soil and water resources. These metals enter human bodies through food and water. In order to understand the heavy metal concentration from wastewater, it is desired to have effective, accurate but simpler and low cost method for heavy metals. Various methods such as atomic absorption spectroscopy, X ray diffraction, chromatography and other advanced analysis techniques are available for this purpose. These methods and equipments are costly. U.V. spectrophotometer promises cost effective solution to the analysis of heavy metals. Cadmium and nickel are two key heavy metal pollutants. The current review summarizes selective research on spectrophotometric determination of heavy metals, especially cadmium and nickel.*

Keywords— wastewater, analysis, organic matter, heavy metals, sensitivity, accuracy.

I. INTRODUCTION

Pure and safe drinking water is very essential for healthy life. Various pollutants can enter the human bodies through food and beverages. The presence of organic pollutants can deplete oxygen content of water[1,2,3]. The presence of heavy metals and organic matter can cause various short term and long term diseases[4,5,6]. The removal of these pollutants can be carried out by various physical, chemical and biological and advanced methods[7,8,9,10]. In order to apply effective treatment method, it is very important to accurately determine concentration of these metals. Cadmium and nickel are two such heavy metals. These metals enter the water bodies through the effluent of battery, ore, electroplating, galvanizing, chemical, petroleum, paint and many other industries. The analysis of these metals can be carried out by spectrophotometric methods. U.V. spectrophotometric method is cheaper and simpler alternative for determination of these metals. Current review aims at summarizing various investigations to analyze water for nickel and cadmium. The review covers selective research papers on spectroscopic analysis, especially U.V. spectroscopic analysis.

II. A REVIEW ON SPECTROPHOTOMETRIC DETERMINATION OF HEAVY METALS WITH EMPHASIS ON CADMIUM AND NICKEL

Sarker and Ullaha carried out investigation on determination of trace Amount of Cu (II) using UV-Vis.spectrophotometric method[11]. They compared the results of U.V. spectrophotometer with atomic absorption spectrophotometer. They used 1-(2-pyridylazo)-2-naphthal (PAN) as spectrophotometric reagent for their analysis. They prepared standard solutions by using AR crystallize copper sulfate. EDTA, potassium permanganate and tartarate solutions were prepared by adding appropriate amounts of reagents. The results obtained were in excellent agreement with results of atomic absorption spectroscopy.Parveen and Rohan carried out studies on a sensitive and simple spectrophotometric method for determination environmental parameters in samples[12]. Their studies were mainly focused on lead removal. They used dithizone as a chromogenic reagent.They were able to detect the concentration of the pollutant in simple and rapid manner.

Heghedűş-Mîndru et.al. attempted the determination of micro-elements like lead (Pb), nickel (Ni), iron (Fe), copper(Cu), chromium (Cr), and cadmium (Cd) from the mineral waters from romania[13]. They collected water samples from three different regions in Romania. Krishna et.al. carried out investigation on a rapid, simple, sensitive and selective spectrophotometric method for determination of cadmium in the wastewater[14]. They

used synthesized reagent cinnamaldehyde-4-hydroxybenzoylhydrazone (CMHBH) in neutral surfactant of TritonX-100-5%. Cadmium formed yellow dye with this reagent in the pH range 8 to 9. Maximum wavelength was found to be 383 nm. Phosphate buffer solution was used for pH adjustment. They observed that a 10-fold molar excess of CMHBH was necessary for complex and constant colour development. The colour remained for more than 12 hours. Studies on selective determination of nickel from water was carried out by Muthuselvi[15]. She prepared nickel sample solution from $Ni(NO_3)_2.6H_2O$. It was standardized by dimethyl glyoxime. She reported isonicotinohydroxamic acid(INHA) as analytical reagent. She prepared buffer solution by mixing 1 M hydrochloric acid-1 M sodium acetate (pH 1.0–3.0), 0.2 M acetic acid-0.2 M sodium acetate (pH 3.5-7.0). Also ammonium buffer was prepared from ammonium chloride solution. It was observed that maximum colour was obtained in the pH range of 8.0-9.0. Optimum wavelength was 610 nm.The reaction was instantaneous and colour was retained for 48 hours. The relative standard deviation was 1.1 %.Shanthalakshmi and Belagali carried out studies on determination of copper, zinc, cadmium, cobalt and nickel[16].They used UV double-beam spectrophotometer. According to these studies determination of zinc, cadmium, cobalt and nickel can be done above pH 4−5.

Ullah and Haque carried out studies on spectrophotometric determination of toxic elements from aqueous medium[17].They used 1, 2-dihydroxy anthraquinone-3-sulphonic acid, sodium salt as a reagent. Alizarin red S gives a deep greenish yellow chelate with cadmium which has an absorption maximum at 422 nm. They observed that the absorption spectra of the cadmium-alizarin Red S is a symmetric curve. The method was easy and cheaper than many other methods like pulse polarography, HPLC, AAS,ICP–AES, and ICP–MS. Melgarejo et.al. studied a derivative spectrophotometric method, based on the use of second-derivative absorption spectra for simultaneous determination of Nickel, Zinc and Copper[18]. In the second-derivative spectra each complex shows a separate spectra as in normal spectra these bands overlap. According to their investigation, the influence of foreign ions on the determinations was similar to that reported in the literature for normal spectrophotometry band. Nekouei And Nekouei studied determination of copper, nickel and cobalt in water and food samples[19]. They presented a solid phase extraction (SPE) procedure for the preconcentration of copper, nickel and cobalt. They filtered the water with membrane and oxidized the organic matter by using hydrogen peroxide. pH was adjusted to 9.5. They observed that this method was accurate and sensitive and can be used for analysis.Tehrani et.al. carried out investigation on derivative spectrophotometric method for simultaneous determination of Nickel(II) and Copper(II) using 6-(Anthracen-2-yl)-2,3-dihydro-1,2,4-triazine-3-thione[20].

Nosier carried out investigation on removal of Cadmium ions from industrial wastewater by cementation[21].They prepared the samples by using cadmium sulphate and used atomic absorption spectrophotometer for analysis.

Okereke investigated physico-chemical parameters of Ihuku river[22]. He used Versenate EDTA complexemetric titration for metal ion detection. A simple and rapid spectrophotometric method was developed for the determination of nickel by Polat et.al[23]. They prepared standard nickel solution by using $Ni(NO_3)_2.6H_2O$. Phosphoric acid, acetic acid and boric acid solutions were used for preparation of buffer solution.They obtained the maximum complex yield at pH 4.They obtained at a linear curve concentration in range of 0.24-2.11 µg/mL. The complex formed was stable upto 60^0C.

Mane et.al. investigated spectrophotometric determination of chromium and copper content[24].They analyzed water from Manjara dam. They observed seasonal changes in the concentrations. The determined chromium concentration from the water by s-Diphenyl Carbazide method and iron by Neocuproine method. Kumar et.al. studied spectrophotometric determination of nickel from wastewater[25]. They used 2hydroxy 2methoxy benzaldehyde thiosemicarbozone as spectrophotometric reagent.They observed that calibration graph was a straightline. They plotted absorption curves at 410 nm against reagent blank. They also recorded second order peaks. They concluded that derivative method was more sensitive than zero order method. Preconcentration technique was used for nickel removal by Rekha et.al.[26].They used 4-hydroxy benzaldehyde-4-bromophenyl hydrazone as a colour developing agent. The solution obeyed Beer's law in the concentration range of 0.01-0.1 µg/L. They applied this method successfully for the determination of Ni(II) in spiked, natural water and alloy samples.

Malik et.al. carried out investigation on spectrophotometric determination of cobalt, nickel, palladium, copper, ruthenium and molybdenum using sodium isoamylxanthate in presence of surfactants[27]. They concluded that sodium isoamylxanthate reacts with Co(II), Ni(II), Cu(II), Pd(II), Ru(III) and Mo(VI). This forms insoluble complexes with dissolve with surfactants. During Simultaneous determination of cobalt and nickel ,

they observed that the nickel complex was dissolved by ammonia while the cobalt complex remained unaffected. Gharde studied the removal of nickel by Tectona grandis bark substrate[28]. He used spectrophotometric method for nickel removal. Herve et.al. assessed the heavy metals concentrations in coastal sediments in north-western cities of Madagascar[29]. They used spectrophotometer atomic absorption flame (SAAF) for analysis. Dohare et.al. reviewed the analysis of groundwater quality[30]. They found that spectrophotometric methods are widely used for water analysis.

III. CONCLUSION

The analysis of heavy metals is important aspect of environmental monitoring. The trace amounts of nickel and cadmium can be determined by spectrophotometric methods. These metals can be made to react with the chemical agents to form coloured complex or intermediate. The absorbance of these coloured samples depends on the concentration of heavy metals. This can be analyzed spectrophotometrically by applying Beer's law. It can be concluded that the U.V. spectrophometric method is simpler, accurate and effective alternative for heavy metal(cadmium and nickel) determination in the wastewater.

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