

Removal of Copper (II) using Paper Optode

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Abstract

Optodes based on digital colorimetric (RGB) analysis for copper (II) determination and removal has been developed on a paper substrate. MATLAB image processing tool has been utilized to transform the color information into digital RGB values that can be treated as analytical information. The Paper optode has been prepared by immobilizing resorcinol and oxalic acid 1% of 1:1 solution on chromatographic (TLC) strip and heating for 15min at 70-80°C. The obtained color pattern was analyzed using image processing tool of MATLAB software to determine copper (II). The paptode is used as a filter to remove copper. The removal for different concentration of copper has been studied. The maximum 90% removal using the paptode was observed and thus the developed paptodes are found as a potential tool for the purpose.

Keywords: Paptodes | Removal | MATLAB | TLC | Image processing,

Introduction

Copper is an essential metal for plants, microorganisms, animals and human beings to perform specific biological functions. Copper is often added to fertilizers to serve as a supplement to plants. Its deficiency leads to a variety of biochemical and physiological disorders in plants. As a toxicant at elevated levels of biologically available form, it produces a physiological response. However, excess copper because of its potential incorporation in component organisms of food webs is of concern.

A variety of methods for removal of copper are available. But they have their own limitations.

Sensors, due to their simplicity and selectivity, prove very promising for environmental pollution monitoring especially for heavy metals than analytical testing. Paper optodes that is optical chemo sensor offer clear and distinct advantages over standard analytical methods for direct monitoring of environmental pollutants in the field since the system is simple, rapid and selective.

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Amlathe and co-workers have developed paptodes for senso-removal of various metal ions using RGB analysis. Paptodes for determination of Cu (II) has also been developed.

Heavy metal ions are highly toxic for animals and human beings. Presence of such toxic heavy metal in drinking water system is a potential health hazard. Heavy metal ions pose a serious risk to the environment and endanger public health and the environment. Therefore, they should be removed from water and wastewaters before discharge. The developed paptodes were successfully applied for removal of Cu (II).

Experimental

Apparatus and software: JEOL JSM -6390 SEM, The scanner (HP-SCANJET G2410), the MATLAB software, MICROLITE micro pipette were used.

Chemicals and Reagents: All reagents used were analytical grade chemicals. Double distilled water is used throughout the experiment. A stock of 5000 $\mu\text{g mL}^{-1}$ and 1% solution of oxalic acid and resorcinol (1:1 by weight) were used.

Procedure: In presence of copper a deep magenta red colored spot is produced on the paptode. Effective intensity for any color values of color spots was calculated by following formulae:

Effective Intensity = $-\text{Log} (\text{RGB value of Sample}/\text{RGB value of Blank})$



Photograph of Development of color on strip after injection of copper

Result

Application for Removal: To apply these paptode for removal of copper different concentration are allowed to be filtered through it and the paptodes were scanned before and after adsorption to know the change in RGB values. It is observed that adsorption increases with decrease in concentration of analyte from 5000-1000 $\mu\text{g mL}^{-1}$. The highest possible removal through the developed paptode was calculated 90.0% (figure 1). The disposable filter is allowed to remain in contact of 1000 $\mu\text{g mL}^{-1}$ copper solution for an hour and change in value is observed at every 5 minute.

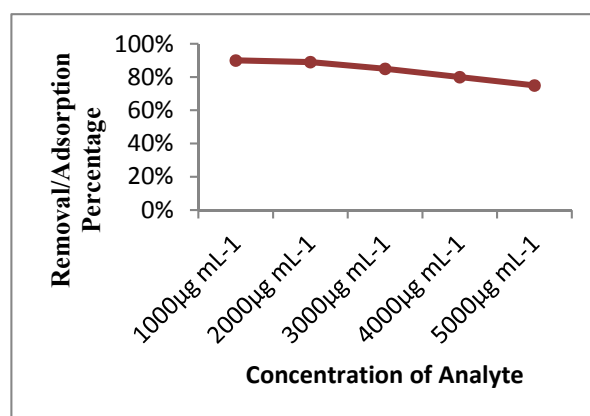


Figure 1: Variation of adsorption with respect to changing concentration

It is found that best adsorption took place within 20 minute (figure 2).

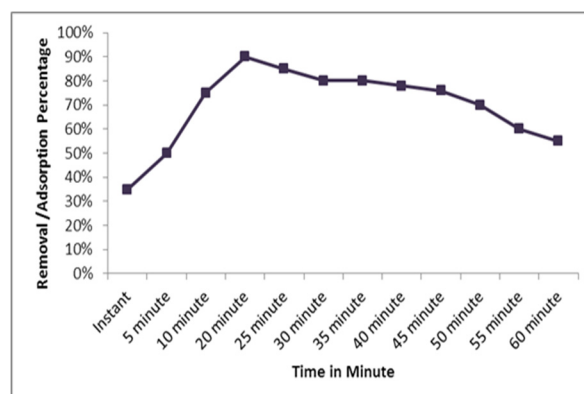


Figure 2: Effect of contact time on adsorption

Conclusion

The developed paptode is a potential tool to monitor excess Cu (II) ions in water. The paptodes are cheap, simple, user friendly and environmental friendly tool and thus advantageous over other methods of removal.

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