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Original Research Article

Software assisted chemical sensor for arsenic detection and removal from sludge

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Abstract

With increasing industrialization, treatment of waste water became a serious concern. Heavy metal contamination is very common in industrial wastes and in sludge. Heavy metals are highly toxic and are quite stubborn to be removed by normal strategies adopted for removal. Arsenic is one very common and highly toxic to be taken into consideration. Even the treated sludge is found to have considerable amount of arsenic in it. The present paper describes the use of a developed chemical sensor (reagent impregnated TLC strips) for detection and nearly 94% removal of arsenic from alum treated sludge samples. The developed sensor is either dipped in sludge sample for detection or samples are filtered through it for filtration. The developed spot as a result of Complexation of arsenic with chemicals on sensor is scanned and effective intensities are calculated using MATLAB Software to know the amount present and filtered.
The sensor is found highly selective, efficient, portable, robust and have least interferences.
Key Word: Arsenic, Chemical Sensor, Complexation, MATLAB Software

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INTRODUCTION

The toxic chemicals are discharged by industries into air, water and soil. They get into human food chain from the environment. Once they enter our biological system they disturb the biochemical process, leading in some cases to fatal results. Heavy metals are most hazardous of the variety of toxic substances. The determination of heavy metals is a challenging subject for entire analytical chemists' fraternity. Similar chemistry of these heavy metals makes it bit difficult in regard of selectivity of the determination method. A large number of methods fulfilling these demands are available[1]. Heavy metals show a large tendency to form complexes, especially with nitrogen; sulphur and oxygen containing ligands of biological matter thus are too hazardous[2] and need to be sensed and removed from samples. Heavy metals (as soluble ions) are common contaminants of industrial wastewaters. Because of their toxicity they are typically removed prior to wastewater discharge. The most common heavy metal contaminants are: Arsenic, Mercury, Barium, Nickel, Cadmium, Selenium, Chromium, Silver, Copper, Zinc and Lead For removal of heavy metals from sludge, methods like ion exchange, adsorption, coagulation, precipitation, electro winning, reverse osmosis, electrocoagulation and cementation are commonly performed[3]. None of the above methods remove the arsenic effectively from the treated sludge water and thus some other effective method is required which could detect even below TLV and can remove effectively. Amlathe and Gupta have developed test paper on TLC strip and and indicator tubes for detection of hydrazine[4]. Further Abbaspour *et al* introduced paptode for determination of iron and hydrazine using the same principle and already developed reagent systems[5]. Authors have prepared paptode with new reagent system determination and for removal of arsenic, zinc, lead, selenium, copper, mercury and cadmium that could trace even below TLV and remove effectively up to 98%[6,12]. Arsenic (As) is a naturally occurring element in the earth's crust, natural groundwater, and even the human body. Arsenic is typically found as an oxy-anion in the environment, commonly in the oxidation states +3 and +5, out of which +3 is more stable and hence more hazardous[13]. It causes skin damage, circulatory problems, and type of cancer[14,17.] The presence of arsenic in the environment may cause a serious problem to all the living organism and aquatic environment. Arsenic is a highly toxic heavy metal present in sludge waste water. For removing this toxic metal various methods are to be employed. The waste water is treated with different substances such as coagulating material (i.e.alum) is added for separating heavy metal or particles from the water. But these methods are not sufficiently suitable for complete removal of arsenic. Looking to the effectiveness of the developed sensors here we present an application of chemical sensor [6] for arsenic for removal of arsenic (III) from treated sludge water. The main objective of the work is to remove the arsenic in waste water and sludge water by an already developed chemical sensor

MATERIAL AND METHODOLOGY

Reagent required

- Sulphanillic acid -1.5% (w/v) solution was prepared in boiled water
- NaOH- (pH 8-11)- 1%
- Alum
- NEDA (N-(1-naphthyl) ethylene diaminedihydrochloride)- 1%(w/v) solution was prepared in distilled water
- Sludge water and different water sample

Preparation of Reagent

- Sulfanillic acid – 750 mg sulfanillic acid dissolved in 50 ml of boiled water
- NaOH – 1gm powdered sodium hydroxide dissolved in 100 ml distilled water
- NEDA – N-1-naphthyl-ethylenediamine dihydrochloride (NEDA): 1% NEDA solution was prepared by dissolving 0.02mg of NEDA in 50 mL of distilled water.

Instrumentand software

- Incubator
- MATLAB software
- Scanning machine

Preparation of chemical Sensor

To construct the sensor strips for arsenic, strips of TLC was dipped in known concentration of sulfanillic acid and dried then dipped in known concentration of NEDA for few second and again dried. The sludge water sample containing arsenic was injected on prepared chemical sensor. A magenta colour of varying intensity depending upon the concentration of arsenic in sample is formed, the sensors were scanned and images were transferred and analysed by software system for finding their R, G, B, value. Any colour can be analysed to obtain its corresponding R, G and B value and then effective intensities can be known. Effective intensity for any colour values of colour spot was calculated as follows:

$$A_m = - Log\ RsGsBs/R_bG_bB_b$$

A_m is an effective intensity for magenta colour. Rs, Gs, Bs and Rb, Gb and Bb refer to R, G and B values of sample and blank respectively. To obtain calibration curves, effective intensities of R, G and B values were plotted with respect to analyte concentrations.

Stability of Paptode: The prepared sensor can be used at its best for 15 days and on a stretch for 25 days. The sensors were stored in dark and in an air tight container to avoid environmental oxidation.

OBSERVATION AND RESULTS

Table 1:

S. No.	Name of the sample	Arsenic present in original sample	Arsenic added	Arsenic found before treatment	Arsenic found after coagulation treatment (ppm)		% of coagulated sample
					NaOH	Alum	
1	Sludge Water	Nil	100	41	19	27	46
2	Lake Water	Nil	100	28	9	22	32
3	Tap Water	Nil	100	19	-	18	94

Table 2: Removal through Chemical Sensor from NaOH treated Sample

Sr. No	Name of sample	Arsenic amount in treated sample before removal	Amount of arsenic after removal	Adsorbed amount of arsenic	% removal of arsenic
1	Sludge Water	16	2	14	88
2	Lake Water	10	1	9	90
3	Tap Water	-	-	-	-

Table 3: Removal through Chemical Sensor from alum treated sample

S. No.	Name of sample	Arsenic amount in treated sample before removal	Amount of arsenic after removal	Adsorbed amount of arsenic	Arsenic Removal %
1	Sludge Water	16	1	15	94
2	Lake Water	16	2	14	88
3	Tap Water	12	1	11	92

CONCLUSION

The proposed spot analysis is superior to all of them in terms of being quantitative and highly sensitive. The method is simple, rapid and easily employable. The method is effectively applicable for removal of arsenic.

RESULT AND DISCUSSION

According to the 2011 Census of India Bhil or Bheel is the most popular tribe with a total population of 46118058, constituting 37.7 % of the total ST population. These tribal's are mainly in habitat western parts of India i.e. in the states of Madhya Pradesh, Gujarat, Rajasthan and Maharashtra. In Madhya Pradesh these tribals are spread over in four districts, viz. Jhabua, Dhar, Khargone and Ratlam. Bhilala, Bhil, Pataya extravagance varies aliments with plant based remedies on the foundation of their rich information about the plant species found in forest. Basically this community is forest dweller and well acquainted with medical properties of plants of their surroundings. Major part of the district is covered by dense forest area in which various tribes, like Bheel, Bhilala and Pataya are in Majority. Out of these tribes Bheel and Bhilala stand high in strength scattered in most of the villages of the district. Bheel are the one of the oldest tribal community not only of India but of the world. Among Tribal villages more common trees are Borassus *flabellifer* (Linn.), Mimusops *hexandra* (Roxb.), Syzygium *cumini* (Linn.), Ficus *bengalensis* (Linn.), Cassia *tora*, (Linn.), Khair Acaceia *catech* Khajur (phonex *silivestris*),Khejra (prospis *spicigera*),Mahua (Bassia *catifolia*),Pipal (Ficus *religosa*),Haldu (Adina *cordifolia*),Anwala (cassia *quriculata*),Thor Euphorbia *neffifolia*),Cassia *tora*[37]. The plants which are commonly used by the tribal people of Jhabua Community for preparation of Medicines Frequently grow.

CONCLUSION

This Study deal determination use this plant and this Traditional, Oldest, ancestral acquaintance, innate knowledge, Aboriginal knowledge, Traditional, Ancestral, invaluable knowledge, about uses and preparations of this plant. This study is a little Effort of documentation of the Traditional Therapeutic Ethno botanical plant Manilkara *hexandra* (Roxb.) Used by Autochthon of Jhabua district as a Natural Rarity.

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