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Application of Nanomaterials for Wastewater Treatment

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ABSTRACT

Nanoparticles and nano composites have attracted researchers in recent years as they have shown feasible potential in water purification. Agricultural runoff, industrial wastewater, hydrothermal activities and many more activities are responsible for release of many pollutants such as heavy metals, dyes in the water bodies which causes severe diseases like muscle impair, kidney failure, cancer in skin, lungs and bladder. Nanocomposites are multi-phase solid materials made-up of two or more nano materials have shown effective characteristic in adsorption of heavy metals. In this paper preparation of Urea formaldahyde resin encapsulated with copper and reduction of arsenic through the resin in arsenic water have been discussed.

Keywords: *Nanomaterial, Wastewater, Heavy metal, Arsenic, Adsorption*

Introduction

Industrialisation, modern urbanization and deforestation are some major factors for global environmental degradation caused by pollution of air, water and soil [1] [2]. Untreated wastewater from paper, printing, textiles, pharmaceuticals, food processing etc. generates organic pollutants (dyes, phenols, pharmaceuticals and oil) inorganic materials (heavy metals and nutrients) [3], [4] [5]. These contaminants could be mutagenic and carcinogenic. All these contaminants compromise quality and quantity of water. Aquatic organism is affected by these contaminants and after that it enter into food chain and affect human-beings [6]

Thus, Environmental pollution is a global issue and it is badly affecting human development. Water which plays a vital role for the sustainable life on earth has been deteriorated by release of waste from agriculture, industries and municipal in water sources.

Untreated wastewater discharged water from Residential and Non-residential areas that are contaminated with organic pollutants (such as dyes, phenols, pesticides, and industrial waste), inorganic pollutants (such as sediments, salts, metals) and heavy metals.

Heavy metals cause serious problems to human health and the life of aquatic organisms. They can cause skin irritation, anaemia, liver damage, nervous and circulatory disorder, headache, impaired voluntary muscle function, kidney failure and many more. [7]

For living organisms a few metals are essential but exceeding this limit they are toxic.[8]. Water pollution by arsenic is a problem faced by many states of India Such as Bihar, West Bengal, UP and in many countries also such as Canada, USA, Hungary, Argentina, China and Bangladesh and other countries of South America and South Asia are also exposed to arsenic contamination in ground water and drinking water [8][9].

Arsenic is most dangerous among other heavy metals such as Lead, Cadmium, Mercury, Chromium, Zinc present in groundwater as it causes cancer in skin, lungs and bladder. According to WHO maximum permissible limit of As in drinking water is $10\mu g\ L^{-1}$ [10] and in Bihar the middle Gangetic plain in Bihar were reported of having Arsenic contamination exceeding $50\mu g\ L^{-1}$, much higher than the permissible limit. [11] [17-20].

Hydrothermal activities, industrial wastewater, special geological settings and mining are the major source of Arsenic discharge in water bodies. Several steps have been taken for the treatment of wastewater such as use of activated carbon, chemical oxidation, biological remediation, adsorption, electrochemical treatment, reverse osmosis, chemical precipitation, and coagulation extraction. But inadequate removal, high energy requirements, poor efficiency and costly disposal procedures are the disadvantages of these methods. Among them Adsorption is found most effective method in removal of Arsenic due to its ease of modification, low cost, high efficiency and biodegradability. Factors affecting adsorbent's efficiency are temperature, pH, stirring duration and initial concentration. [7] [12]

As exist as oxyanion arsenite, As (III) and arsenate As (V). As (III) is found 60 times more toxic than As (V) and it is primary carcinogenic [10].

Nanomaterial are used as sensor, adsorbents, catalyst [12], coatings and electronics, cosmetics, packing materials [13], MRI, biosensors, drug delivery for Cancer therapy [14] . Being extremely small NMs sustain in environment and human body for larger time and interact through different mechanisms causing harm to human and animals. The ultrafine small size tends them to aggregate into bulk material creating difficulty in separation and reuse. Thus, to persevere their property it must be distributed uniformly in matrices to prevent from aggregation [15].

Thus, copper oxide encapsulated Ureaformaldehyde is prepared by co-precipitation method is capable of removing As (III) from water. The method and result are discussed in the paper. The objectives of the present studies are (i) preparation of CuO encapsulated Ureaformaldehyde; (ii) investigation of its potential in As (III) removal. [16]

Material and Methods

CuO, Urea of Merck, formaldehyde of NICE, distilled water, NaOH, conc H_2SO_4 , watch glass are used for the synthesis. The Chemical Characterization have been done by XRD and UV visible spectrophotometer in wavelength of 200-300nm.

Preparation of Ureaformaldehyde resin

20 g formaldehyde and Urea are mixed in 2:1 molar ratio in a beaker and stirred magnetically, at 60ºC after 7 min 0.1 g of CuO and then 0.5 mL of H_2SO_4 was added. In the beaker bluish-white semi solid compound with black spot settled down. The compound was taken out and pressed in between two watch glass, a thin film of CuO embedded UF resin was prepared. Following the same process a similar compound without CuO was also prepared.

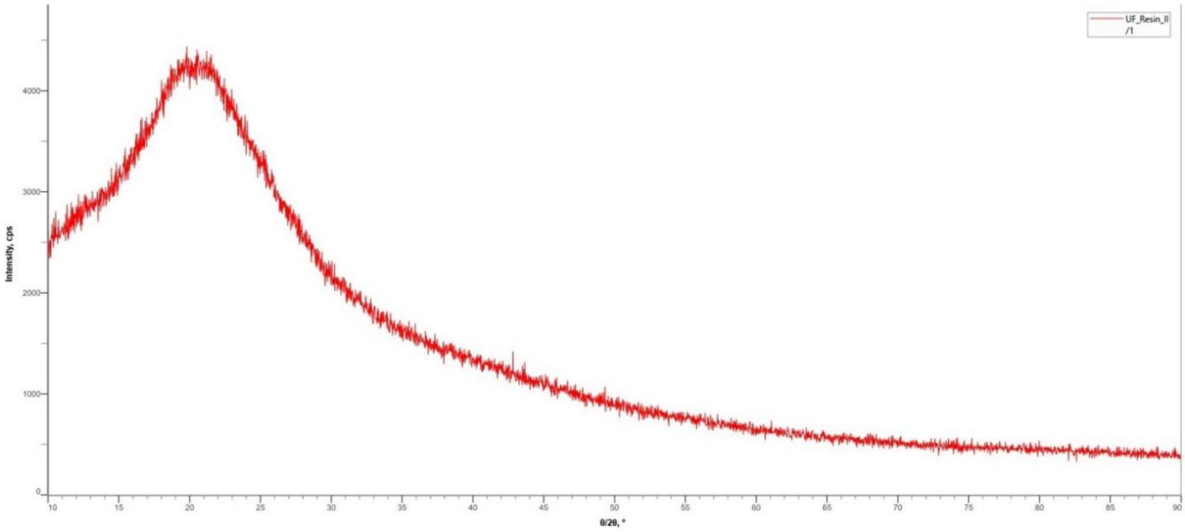

Fig.1-XRD diffraction pattern of CuO encapsulated Ureaformaldehyde

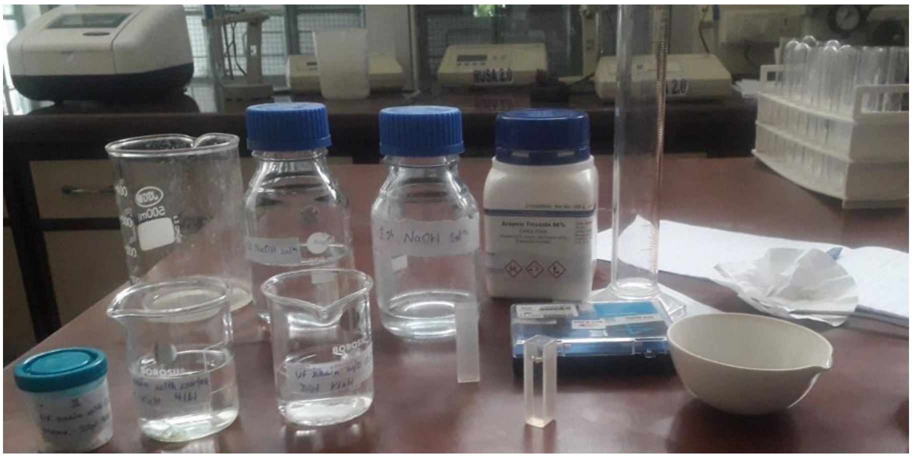

Fig.2 Apparatus used for UV Spectrophotometer

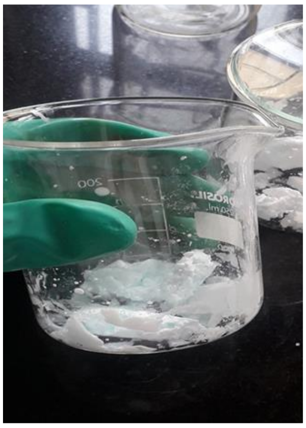

Fig.3(a) **Fig.3(b)**

Fig.3(a): UF resin before absorption, **3(b):** UF resin after absorption

Removal of As (III)

In 1% NaOH, saturated solution of Arsenic Trioxide was prepared and taken in two different beakers containing 100 mL each. In one beaker 1 g UF resin as sample and in other beaker 1 g CuO encapsulated UF resin was kept. 5mL of solution from both the beaker was taken at the interval of 0, 10, 20, 30 and 45 minutes and UV Visible Spectra were taken in wavelength range 200-300 nm through UV Spectrophotometer. From the absorbance at λ_{max} As (III) concentration were calculated. The CuO encapsulated UF resin show increase in As concentration where simple UF resin does not gave such result.

Result and Discussion

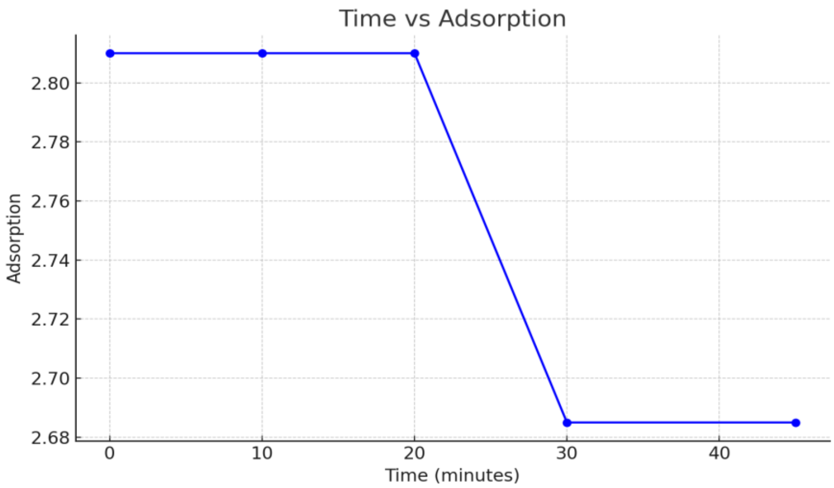

Fig.4. Effect of contact time on As adsorption by UF resin

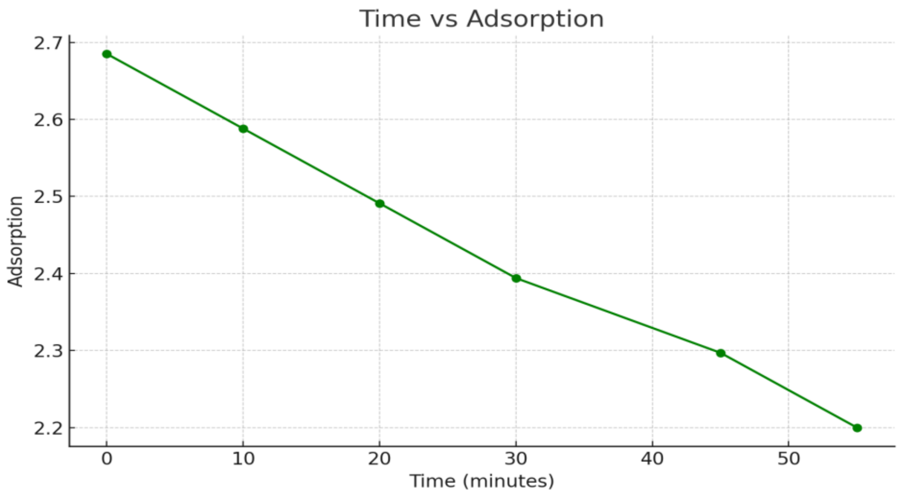

Fig.5. Effect of contact time on As adsorption by CuO embedded UF resin

Fig 1. shows the powder X-ray diffraction pattern of CuO encapsulated Ureaformaldehyde resin. Fig.3(a) is the freshly prepared UF Resin and Fig.3(b) is the UF Resin after the adsorption process is complete, the bluish colour of embedded CuO changed into greenish colour. Fig.4. represent the adsorption of Arsenic by UF resin at different time interval and Fig.5. represent the adsorption of Arsenic by CuO embedded UF resin at different time interval. The simple UF resin stops adsorption after a certain time, but the change in concentration at different time interval in Fig.5. shows that UF resin with CuO embedded in it is capable in adsorption of Arsenic, and it is higher than the simple resin without CuO.

Conclusion

Among different methods, adsorption is the most favoured because of having renewability, low cost, biodegradability and ease of modification. In the preparation of nanocomposites specific time, pH, stirring time and addition of acid at particular temperature is required therefore proper care must be taken during the synthesis. The CuO embedded UF resin is less time consuming and economic adsorbent for As (III) removal from solution.

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