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Removal of Heavy Metals in Wastewater using Walnut Shells as Adsorbent

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Abstract
Heavy metals are harmful and contaminated water pollutant. These are not only affects the human beings but also affect the vegetation and animals, due their flexibility in aqueous ecosystem, non-biodegradability and toxicity. Heavy metal removal form the sewage is the most important study carried out in the field of environment. On the other hand different methods such as precipitation, membrane filtration , adsorption and ion exchange are used for heavy metals removals, adsorption procedure has fascinated towards many researchers because low cost, design efficiency and flexibility. Heavy metal (lead and cadmium) removal present review focused on the performance of natural adsorbent as walnut shell. The objective of study for the efficiency of walnut shell as adsorbent for heavy metals (lead and cadmium) elimination from the wastewater for batch adsorption study. The analysis was approved to identify the effect of contact time. pH and dosage for the same sieve size of the walnut shell at standard temperature condition. Results showed by the maximum removal efficiency of lead and cadmium are 75.61% and 54.1% respectively in the best condition .

Keywords: Adsorption, heavy metals, walnut shell

Introduction

Contamination of heavy metals exists in aqueous waste river from several industries such as metal plating, mining, tanneries, paints, car radiator manufacturing, as well as agricultural sources where fungicidal spray and fertilizers are regorously used. The presence of heavy metal ions from the conversion series, viz, Cu, Fe, Ni, Pb, Cd, etc. in the environment is of major apprehension due to their toxicity to numerous life forms. contrasting organic pollutants, the greater part of which are liable to biological dreadful conditions, metal ions do not humiliate into nontoxic end products.

Even though heavy metal elimination from aqueous solutions container is achieved by conservative methods, together with chemical precipitation, oxidation/reduction, electrochemical treatment, evaporative recovery, filtration, ion exchange and membrane technologies, they might be unproductive or cost-expensive.

Now a day's adsorption has became one of the alternate method, particularly for the prevalent manufacturing use. Activated carbon is one of the most used adsorbent. In spite of its production utility, carbon ruins luxurious substances because superior the value of activated carbon, the superior its price. Activated carbon as well requires good nature to get better elimination for inorganic matters.

So this circumstance makes it no longer good looking to be extensively used in small scale industries because of cost inadequacy. Recently, adsorbents which are biological are used efficiently and effectively. It is noticed that suitable modification of the raw biosorbents by crown esters and sulphur bearing groups like sulphides, thiols, dithiocarbamates and dithiophosphates be able to get rid of the drawbacks and get better performances considerably. Biosorption is one of the technique it uses low-cost biosorbent to appropriate noxious heavy metals. It has some merits over the conservative technique such as: reusability of substances, operating cost will be low, selection of exact metal, requires less operation time and no use chemical sludge.

This occupation includes the operation of walnut shell is one of the low cost biosorbent for the elimination of heavy metals from aqueous solutions. By varying parameters such as pH, dosage, concentration the kinetic studies and Equilibrium studies are conducted3.2. Title and author details

Materials and Methods

Materials

- ✓ Walnut Shell (collected from Argo based industry)
- ✓ Chemicals required
- ✓ Flame atomic absorption spectrometer (carried out in Multiplex biotech PVT.LTD)

Biosorbent Preparation

From local market walnut shells are collected were shells are comprehensively washed in tap water of about 1-2 h to

Walnut shells collected from local market were extensively washed in running tap water for 1–2 h to eliminate dirt and color, and then it is washed with distilled water for several times. The washed walnut shell was transferred to an oven maintained for 24 h at 150 °C to decrease the humid condition. Then it was grinded using kitchen grinder. Then the micronized powder was sieved by sieve shaker, then size is in the range of 600 µm was used for all experiments. The dried sorbent was stored in air tight container to protect it from humid condition.

Elemental analysis of Walnut shell										
Elem	C	H	N	O	Ca	Fe	Mg	Mn	Na	K
% age	45.5	6.7	0.9	33.9	0.28	0.001	0.009	0.002	0.024	0.019

Table 3.1: Elemental analysis of Walnut shell

Stock Solution Preparation

Lead and cadmium ions of solutions were were prepared by dissolving 91.8g and 45.8 g of lead acetate and cadmium chloride, correspondingly, in distilled water, therefore to attain the concentrations of 1000mg/L in the each flask. Metals ions of different initial concentration were prepared by diluting the stock solution. The solution of pH was adjusted using 0.1N hydrochloric acid and 0.1N sodium hydroxide solutions to attain the desired values.

Flame Atomic Absorption Spectrometer (AAS)

Fig 1: Flame atomic absorption spectrometer

Principle:

Atomic adsorption spectrometer quantitatively calculates the amount of concentration of elements present in a liquid sample. It utilizes the rule the elements in the gas phase absorb light at extremely exact wavelengths which gives the method outstanding specificity and finding the limits. The sample may be organic solution and aqueous solution; certainly it may still be solid provided it can be dissolved effectively. The liquid is drained in to a flame wherever it is ionized in the gas phase. Light of a specific wavelength appropriate to the element being analyzed is shown during the flame, the absorption is relative to the elements concentration. Quantification is attained by preparing different standards of the element.

2.2.2 Working:

Atomic adsorption spectrometer units have about four basic parts: a flame or furnace apparatus for volatilizing the sample or hydride generation apparatus and a photon detector, a sample aspirator, interchangeable lamps that emit light at element- specific wavelengths. In sequence to analyze for any given element, a wavelength of light is produced by lamp then it is absorbed by the chosen element. To facilitate, solution of sample containing element is longing in to the flame. If flame contains the ions of element, then they will absorb the lamp that produces the light before it reaches the detector. The sum of light produced by the lamp absorbed depends on the quantity of the element presents in the sample. Unknown samples absorbance values are compared to calibration curves organized by successively known standard concentrations. Atomic adsorption spectrometer is a microprocessor forbidden double beam spectrometer prepared with a graphite furnace attachment which is employed for flameless analysis. Nitrous oxide fuel and acetylene mixtures can be used for the analysis of a broad choice of elements.

Typical Applications of AAS

- Quantitative metal concentrations in solutions
- Industrial effluent streams containing trace metals are monitored.
- Raw materials along with ICP-MS/ trace elements in manufactured goods
- Study of additives and spotlessness in steels and added metal alloys
- Study the low level contaminants.

Methodology

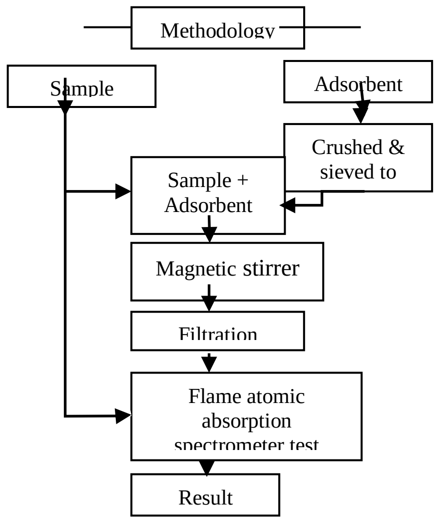

Fig 2: Flow chart

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Analysis

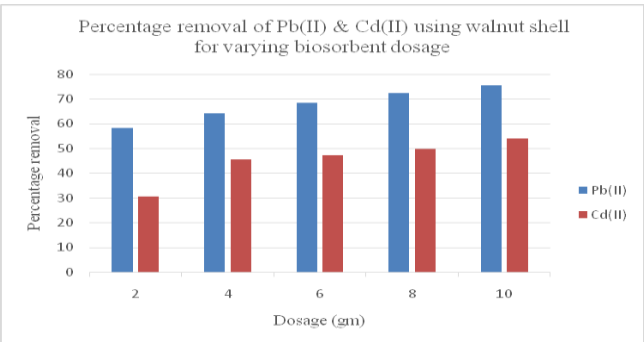
For the solution of Single Metal System, stock solution of a fixed volume with different concentration in a conical flask were mixed vigorously with different concentration of biosorbent dose at 200 revolutions per minute (rpm) for 30min and room temperature. For sorption experiment a contact period of another 150min is given to ensure the equilibrium. By using 0.1 M HCl and 0.1 M HNO_3 the pH will be varied. The solutions will be separated from the biomass by filtration at the end of the experiment by using wattmanfilter paper. By using Flame Atomic Adsorption Spectrometer(AAS) the filtrates of SMS will be diluted to 10 to 20 mg/L with demonized water and analyzed for metal concentration

Results

Percentage removal of Cd (II) and Pb (II) using walnut shell for varying biosorbent dosage

From graph 1, it was observed that for a contact period of 150min, the removal efficiency and specific uptake of Cd (II) depends on type and quality of the biosorbent. The percentage removal of Cd (II) using walnut shell powder as a biosorbent of varied amount from 2 to 10 g/100mL was 30.4% to 54.1% as represented in graph 1. This shows that with the increase in concentration of biosorbent, the removal efficiency also increased. Further increase in the amount of biosorbent dosage beyond 10 g/100mL, there was a negligible increase in percentage removal.

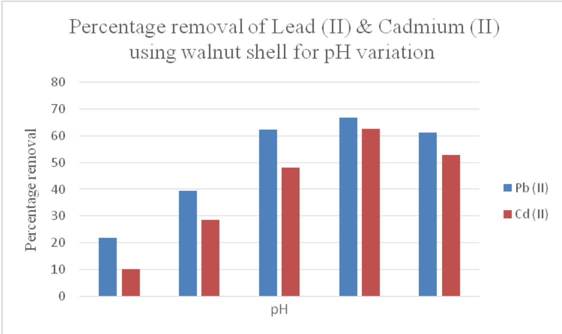
The number of sites available for biosorption depends upon the amount of the adsorbent. The effect of the biosorbent concentration on the removal efficiency of Pb (II) was observed from graph 1 and is presented ingraph 4.1.The metal ions uptake was found to increase linearly with the increasing concentration of the biosorbent for the biomass concentration of 2 g/100mL. Beyond this dosage, the increase in removal efficiency was lower. Increasing the biosorbent dosage caused a rise in the biomass surface area and in the number of potential binding sites



Graph 1: Percentage removal of Cd (II) and Pb (II) using walnut shell for varying biosorbent dosage

Percentage removal of Cd (II) and Pb (II) using walnut shell for pH variation

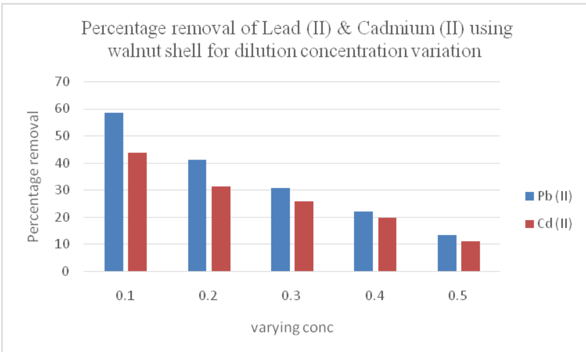
In heavy metal biosorption, pH is the most important parameter and speciation of metals in the solution is pH dependent. The pH of the solution was varied in the range of 1.0 to 6.3,by using 0.1N HCl and 0.1N NaOH as buffers as shown in graph 2 maximum removal of Cd(II) was achieved at pH 5±0.01,whereasPb(II) had an optimum pH of 5±0.02. At pH higher than 6.5 for both metals precipitation occurred, due to this reason biosorption was not studied beyond pH of 6.5.



Graph 2: Percentage removal of Cd (II) and Pb (II) using walnut shell for pH variation 6.2

Percentage removal of Cd (II) and Pb (II) using walnut shell for variation in dilution concentration of stock solution

It was observed that the percentage removal of Cd (II) and Pb (II) using walnut shell powder gradually decreased when the percentage dilution concentration of stock solution increased as shown in graph 3



Graph 3: Percentage removal of Cd (II) and Pb (II) using walnut shell for variation in dilution concentration of stock solution

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Conclusion

a) The removal efficiency for Cd (II) and Pb (II) using walnut shell powder as biosorbent are 54.1% and 75.6% respectively. The optimum dosage for maximum cadmium (II) and lead (II) are 2 g respectively.

b) By comparing the results obtained, for 150min contact time with walnut shell powder showed substantial increase in Cd (II) and Pb (II) removal.

c) The pH was found to be the most important factor affecting the biosorption potential. Results obtained showed that, maximum adsorption was achieved in acidic range.

d) According to cost analysis done, cost to treat one liter of wastewater containing heavy metals is estimated to be Rs. 1.3/-. Hence, the method is economical

e) Heavy metals removal using walnut shell is a low cost wastewater treatment and can be effectively used in small scale treatment plants.

f) Transportation and storage problems for biosorbent are negligible.

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