REMOVAL OF HEAVY METAL IONS FROM WASTE WATER USING A GROUNDNUT SHELL AND TEA BAG AS A NATURAL ADSORBENT

BY

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ABSTRACT

Sample of waste collected at Kanwuri Area Sokoto, was analyzed using a groundnut shell and tea bag as natural adsorbent, by adopting the method of atomic absorption spectrophotometry. And this research showed that groundnut shell and tea bag can be effectively used as an excellent adsorbent for the removal of Cu, Zn, Pb, and Cr, from aqueous solution. This study also highlights the effect of different parameters such as, contact time, PH, adsorbent dose initial concentration of heavy metal ions. The concentration of heavy metal ions obtained from the analysis, were calculated to be 99.2%, 8.0%, 96.0%, 94.0%, and 92.0%, for Copper, Zinc, Nickel, Lead and Chromium, respectively.

CHAPTER ONE

1.0 INTRODUCTION

The awareness of increasing water pollution implies studies concerning water treatment, removal of heavy metal ion from industrial waste water are primary importance. The use of natural material for heavy metal ions becomes a concern in all countries. Natural materials that have potential to be used as low cost adsorbent as they represent unused resources are widely available (Dean et, al 1992).

The application of low cost natural adsorbent including carbonaceous material, agricultural product and waste by-product has been investigated in many previous studies which have been recognized as potential alternative to the conventional technologies such as precipitation, ion exchange, solvent extraction and liquid membrane for removal of heavy metals from industrial wastewater because these processes have technical and economical constraints (Nguyen et, al; 2001).

1.1 HEAVY METAL IONS

The term “heavy metal “ is collectively applied to a group of metal and metal like element with density greater that 5g/cm3 and atomic number above 20 like (Amal wt, al;2012). And also heavy metal refers to any metallic chemical element that has relatively high atomic weight and is toxic or poisonous at low concentration e.g

(Ni, Cu, Zn, Pb, Cr, Hg, Cd) etc. or a heavy metal is a chemical element within the upper range of atomic weight (Ward, 1995). Heavy metals ion have been excessively release into environment due to rapid industrialization and cause a major pollutant in the environment due to creatures and human being at high concentration (Beliles 2007). Copper (Cu) is highly toxic because it is non biodegradable and carcinogenic, the effect of Nicket (Ni) exposure very from skin irritation to damage of the lungs nervous system; and mucous membrane. While Zinc (Zn) exposure cause depression. Lethargy, neurological signs and increase thirst. Chromium (Cr) has been considered as one of the top 18^{th} toxic pollutant and because of its carcinogenic and tetratogenic characteristics on the public, it has become a serious health concern. (Khan, et, al; 2006). Nickel and chromium which are widely used as extremely toxic in relatively low dosages, the main pathway through which nickel and chromium enter bodies via waste from industrial process (Alluri, 2007).

Industrial waste water which organization from metal plating, mining activities, smelting, battery, manufacturing, pesticides, pigment, petroleum refining, paint manufacturing, printing and photographic industries etc. Heavy metals ion becomes one of the most serious environmental problems today. (Kadirvelu et al;2001)

The idea of using various agricultural products for the removal of heavy metal ions from the waste water has been investigated by several number authors (Henderson et, al; 1997). Henderson have investigated the efficiency of number of different organic waste as absorbent for heavy metals ions such absorbent including, coconut shell, rice husk, eggshell, banana peels, groundnut shell, peanut shell, saw dust, waste tea, eucalyptus tree back and leaves etc have been considered for the adsorbent on waste (Henderson et al;1997).

12. **WASTE WATER**

Waste water from chemical industries such as textile tanneries, Agrochemical ceramic and paint effluent is the attention of the environmental protection agencies all over the world (Chu, 2001). Waste water containing heavy metals are produced each year by textiles industries and other industrial process. These waste water is also carcinogenic, Geenotoxic, mutagenic in both plant and animal species (Alluri, 2007).

There are numerous method currently employed to remove and recover the metal ion from our environment and many physiochemical method have been proposed for their removal of metal ion from waste water (Akhatar, 2002).

1.3 GROUNDNUT SHELL

Groundnut shell is a carbonaceous fibrous solid waste which is used for so many application, and generally used for its fuel value, it also use for removal of heavy metal ions, such as chromium (iii), nickel (Ni), lead (Pb), Copper (Cu), and Zinc (Zn) etc. And also is a source from trustworthy which is one of the renewable agricultural waste products (Parker, 1980).

1.4 TEA BAG

Green tea is one of the most popular beverage in the world, and also the agricultural product that is very useful, which is above 3.5millions tones of a green tea was consumed annually in the world (Parasad et, al; 2008).

1.5 LITERATURE REVIEW

(Amarasinghe, et al; 2007) they use tea waste as low-cost adsorbent for the removal of Cu and Pb from waste water, the percentage removal of Cu is 87%, Pb is 90%.

(Cay et, al; 2004) were investigated the removal of Cu (ii) single (non-competitive and binary (competitive) in aqueous system, the removal of Cu (ii) 95% and Cd (ii) 75%.

(Malkoc et, al; 2005) were investigated for the removal of Nickel from Aqueous solution were by maximum removal of the NI is 95%.

(Henderson, et al; 1997) Have investigated the efficiency of number of different organic waste materials as adsorbent for heavy metal such as coconut shell, rice husk and peanut shell, these show that agricultural product are very adsorbent.

(MShavi et al; 2005) were studied the remova; of Cd, Pb, and Ni from industrial waste water using a tea waste, were by the removal of Cd 87% Pb 95% and Ni 75%.

1.6 AIM AND OBJECTIVES

The aim of this research is to determine how to use Groundnut shell and Tea waste as natural adsorbent for removal of metal ions from waste water.

The objectives are:

a. To use groundnut shell and tea waste as natural adsorbent.
b. To remove heavy metal ions from waste water.
c. To analyze the kind of metal ions present in waste water.
d. To study the effect of different parameters such as contact time, adsorbent dose, PH and initial concentration of metal ions.

CHAPTER TWO

2.0 MATERIALS AND METHOD

2.1 MATERIALS

Table 2.1.1 :List of apparatus used

APPARATUS	CAPACITY	MANUFACTURER
Beaker	250cm^3	Pyrex Glass (England)
Conical flask	250cm^3	Pyrex Glass (England)
Volumetric flask	500cm^3	Pyrex Glass (England)
Measuring cylinder	100cm^3	Pyrex Glass (England)
Measuring cylinder	10cm^3	Pyrex Glass (England)
Pipette	25cm^3	Pyrex Glass (England)
Glass stirrer		GallenKamp (England)
Funnel		Mc. Rubber (Nigeria)
Filter paper	Size No 1	Whitman

Table 2.1.2: List of reagent and chemical used

Reagents	**Chemical formula**	**Grade**	**%purity**	**Manufacturer**
Copper	$CuSO_4.5H_2O$	Analytical Grade (A.G)	98.50	Lab/Tech/Chem (England)
Nickel sulphate	$NiSO_4.6H_2O$	Analytical Grade (A.G)	97.00	BakerLTD Dagenham (England)
Chromium sulphate	$Cr_2SO_4.7H_2O$	Analytical Grade (A.G)	98.30	Baker LTD Dagenham (England)
Lead sulphate	$PbSO_4.8H_2O$	Analytical Grade (A.G)	98.5	Tech chem. (England)
Zinc sulphate	$ZnSO_4.7H_2O$	Analytical Grade (A.G)	97.5	Titan Biotech LTD Rajasthan India

2.1.3 The equipment used

EQUIPMENT	PRODUCT
Digital Weighing balance	DT 1000
Orbital shaker	Edmund Buhler
Ph Meter	S 2C
AAS Machine	VGP 210
Oven	U. 30 Memert 854 Schwabach German
Hot Plate	PS G.O.A GERMANY

2.2 PREPARATION OF SAMPLE

The groundnut hell and tea bag were collected from the Sokoto Market. And the sample of the groundnut shell was washed with distilled water and dried it in hot oven at 105^0C for 12 hours. After drying the sample was grinded and then was sieved by the used of standard shell sieved and the unwanted particles was removed. While the tag bag was warmed with plate and distilled water at (85^0C) until the color removed. After the colour removed, it was dried in hot oven at 150^0C for 12 hours. The dried sample was grinded and converted into powder, the sample was stored in sealed polythene bags. These grinded two samples were used directly for the experiment without physical chemical treatment as an adsorbent.

2.3 PREPARATION OF WASTE WATER

The sample of waste water was collected from Sokoto metropolitan which is along the Kanwuri area, and we collected the sample of 2 liter. After the collection of the waste water was filtered by filter paper. The waste water was then prepared. By diluting the stock standard of each metal ions solution of Cu, Zn, Ni, Cr, Pb were prepared from stock standard of concentration 10000mg/L.

2.4 PREPARATION OF ADSORBENT

$CuS0_4$**.**5H0, $NiS0_4.6H_20$, Cr,SO_4**.**$7H_2O$, $PbSO_4.8H_2O$,$ZnSO_4.7H_2O$, were obtained in analytical grade and used without further purification synthetic 1000ppm stock solution prepared for each metal.

I. Copper Solution: 3927gram of $CuS0_4.5H_4O$ was added in the $100cm^3$ of distilled water in $1000cm^3$ volumetric flask. It was dissolved by shaking and the volume was made up to the mark copper concentration of this solution was 1000mg/L.

II. Nickel Solution: 4.477gram of $NiSO_4.7H_2{}^o$ was added the $100cm^3$ of distilled water in $100cm^3$ volumetric flask. It was dissolved by shaking and the volume was made up to mark. Nickel concentration of this solution was 1000mg/L.

III. Zinc Solution: 4.395gram of $znSO_4.7H_2$**O** was added in the $100cm^3$ of distilled water in 1000cm/L. it volumetric flask. It was dissolved by shaking

and the volume was made up to the mark. Zinc concentration of this solution was 100mg/L.

IV. Lead Solution: 4251gram of $pbSO_4.8H2^o$ was added in t5he 100cm3 of distilled water in $100cm^3$ of volumetric flask. It was dissolved by shaking and made up to the mark lead concentration of this solution was 1000mg/L.

V. Chromium Solution **4**. 527gram of Cr_2SO_4 $7H_2O$ was added in the $100cm^3$ of distilled water in $1000cm^3$ volumetric flask. It was dissolved by shaking and the volume was made up to mark, chromium concentration of this solution was 1000g/L.

2.5 ANALYSIS OF THE ADSORBENY

The general method was used for this study and is described as follows:

The tow sample adsorbent was weighed for 5g each and as equilibrated with $100cm^3$ of each meter (Zn, Cu, Cr, Pb and Ni) solution concentration of 10,20,50, and 100 ppm) in an stoppered borosil of a glass flask at a fixed temperature for ($3OC^O$) in an orbital shaker of a time which is 30-180m).

After the equilibration each sample of $10m^3$) was collected from each flask. In a time interval of 30,60, 120, and 180 minute, the suspension of the adsorbent was separated from the solution by filtration using a filter spectrophotometer (AAS) determinations.

CHAPTER THREE

3.0 RESULT AND DISCUSSION

3.1 RESULT

Initial, Concentration and absorbance of the standard solution of Zinc, copper, Nickel, Lead and Chromium.

3.1.1 Table (1): Absorbance for zinc (Zn) standard.

INITIAL CONCENTRATION		ABSORBANCE
A	10PPM	0.003
B	20PPM	0.017
C	50PPM	0.81
D	100PPM	0.24

3.1.2 Table 2: Absorbance for copper (CU) Standard.

INITIAL CONCENTRATION		ABSORBANCE
A	10PPM	0.003
B	20PPM	0.002
C	50PPM	0.004
D	100PPM	0.004

3.1. Table 3: Absorbance for Nickel (Ni) standard.

INITIAL CONCENTRATION		**ABSORBANCE**
A	10PPM	0.003
B	20PPM	0.004
C	50PPM	0.005
D	100PPM	0.005

3.1.4 Table 4: Absorbance for chromium (Cr) standard.

INITIAL CONCENTRATION		**ABSORBANCE**
A	10PPM	0.004
B	20PPM	0.004
C	50PPM	0.003
D	100PPM	0.002

3.1.5 Table 5: Absorbance for lead (Pb) standard

INITIAL CONCENTRATION		**ABSORBANCE**
A	10PPM	0.003
B	20PPM	0.002
C	50PPM	0.004
D	100PPM	0.005

3.2 DISCUSSION

3.2.1 EFFECT OF CONTACT TIME

Fig 1 shows the variation in the percentage removal of heavy metal with contact time using 5g/100cm^3 of tea waste and groundnut shell adsorbent ion concentration ranging from 10ppm – 100ppm. It is observed that the percentage of Cu from table 2 is 99.2%, Zn from table 1 is 95.2% Ni, from table 3 is 99% Pb from table 5 is 99% and Cr from table 4 99.6 respectively at 180 mint. These shows that contact time required to attain equilibrium which is depending on the initial concentration of heavy metals. The percentage removal of heavy metal increase with increase of contact time till equilibrium is obtained. The optimal contact time to attain equilibrium with groundnut shell and tea waste adsorbent is 120 minute.

3.2.2 EFFECT OF pH

Fig. 2 show pH variation is one of the most important parameter controlling uptake of heavy metal from waste water and aqueous solution. These studies were conducted at an initial metal ion concentration of 10ppm^3 – 100ppm in 100cm^3 solution, and constant adsorbent dose 5g/100cm^3 solution & period of 120minute, for all heavy meter ion at varying the pH in each solution.

The percentage of Adsorbent increase with pH to attain a maximum at 6.7pH and there after the decrease with further increase in pH. The maximum removal of Cu 84% Zn Ni80%, Pb98 and Cr 96% respectively.

3.2.3 EFFECT OF ADSORBENT DOSE

Fig 3 show the result for Adsorptive of removal of heavy metal with respect to adsorbent in the range of 5g/100cm3 at pH 6.7 and 120 minute contact time adsorbent dose in the percentage removal of heavy metal is see to increase with adsorbent dose and it is observed that there is a sharp increase in percentage adsorbent dose Cu, Ni, Pb, and Cr. The maximum removal of Cu 94%, Zn heavy metal increase rapidly with in the dose of the adsorbent doe to the greater availability of the exchange site or surface area.

3.2.4 EFECT OF INITIAL CONCENTRATION OF HEAVY METAL

Fig 2.4 show the effect of concentration at 5g/100cm3 adsorbent dose 6.7pH and contact time 120 minute, the percentage removal decrease with the increase in initial heavy metal concentration for Cu, Zn Ni, pb, and Cr.

Ta lower initial metal concentration, sufficient adsorption site are available for adsorption of the heavy metal ions. Therefore the at higher concentration the independent of initial metal ion concentration. However at high concentration the number of heavy metal ions is relatively higher compared to availability of

adsorption site, the maximum removal of Cu 98% Zn83%, Ni96%, pb 84% and Cr 84%. Hence the percentage removal of removal metal ion depend on the initial metals ions concentration and decrease with removal in initial metal ion concentration.

The difference in percentage removal of different heavy metal ion at same initial metal ions concentration, adsorbent dose & contact time may be attributed to their chemical affinity and ion exchange capacity with respect to the chemical functional group on the surface of the adsorbent.

CHAPTER FOUR

4.0 CONLUSION AND RECOMMENDATION

4.1 CONCLUSION

The present research showed that groundnut shell and tea waste can be effectively used as excellent adsorbent for the removal of Cu, Zn, Ni, pb, and Cr from aqueous solution. This also highlights the affect of different parameters such as, contact time pH, initial concentration, and adsorbent dose, in removal of metal ions from waste water.

4.2 RECOMMENTATION.

These research studies on adsorbent would be quite useful in developing appropriate technology for the removal of metal ions from contaminated industrial effluent.

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