



## Techno Science Africana Journal

Journal homepage: [www.technoscienceafricana.com](http://www.technoscienceafricana.com)



### REMOVAL OF COPPER FROM WASTE WATER USING ACTIVATED SUGARCANE BAGASSE AS AN ADSORBENT

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#### ARTICLE INFO

#### ABSTRACT

##### Keywords:

adsorbent, sorption, Langmuir adsorption, sugar bagasse, heavy metal ( $Cu^{2+}$ ), removal efficiency.

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This study describes the removal of Copper from waste water using sugarcane as an adsorbent. In present study bagasse from Tugalfur market was used to remove the copper from waste water. Batch studies were performed to evaluate the adsorption process, and it was found that the bagasse was found to adsorb up to 98% at optimum condition. UV spectrophotometer was used to measure the Cu(II) concentration in form of  $[Cu(H_2O)_6]^{2+}$  at the wavelength of 810 nm. This work proved that bagasse can be used as an efficient adsorbent material for removal of copper from wastewater.

#### INTRODUCTION

Water used in industries creates a waste water that has a potential hazard for our environment because of introduction various contaminants such as heavy metals into soil and water resources. Pollution by heavy metals, due to their toxic nature and other adverse effects, is one of the most serious environmental problems. Many heavy metal ions, such as lead, copper, mercury and others are commonly found in industrial waste waters. These heavy metals are not biodegradable and tend to accumulate in living organisms and causes serious problem to the body system and many diseases and disorders (Nada *et al.*, 2006). Therefore, there is a need to remove these metals from the aqueous solution before discharge. Among the heavy metals, copper is the major heavy metal in the aquatic environment. Copper in the blood system may generate reactive free oxygen species and damage the protein, lipids and DNA (Brewer, 2010). The excess copper compound in the body may also affects on aging, schizophrenia, mental illness, Indian childhood cirrhosis, Wilson's and Alzheimer's

diseases (Trans Van Thuan *et al.*, 2016; Hadi *et al.*, 2015; Haureau and Faller, 2009). Copper has damaged the marine ecosystem and damaged the gills, liver, kidneys, the nervous system and changing sexual life of fishes (Van Genderen *et al.*, 2005; Rathnakumar *et al.*, 2009). Recent awareness of toxicity originated from water and wastewater are attending the interest for environmental scientists and researchers. These heavy metal ions courses serious health implications to the vital organs of human beings and animals when consumed above certain threshold concentrations (Haureau and Faller, 2009). Copper is one of the toxic heavy metals discharged into the environment due to industrial operations and natural sources through exposure (Rathnakumar *et al.*, 2009). In order to have a pollution-free environment, the toxic heavy metals must be removed from waste water before its disposal. Removal of toxic heavy metals from industrial waste water has been practiced for several decades by the conventional physico-chemical removal methods, such as membrane separation, evaporation, resin ionic exchange, chemical

precipitation, removal using activated carbon, However, these methods are usually either inefficient or expensive, especially when treating wastewater with low concentration of heavy metals (El-Ashtoukhy *et al.*, 2008; ThiThuy *et al.*, 2015). Therefore, alternative method has been attempted using low cost materials such as sugarcane bagges

### MATERIALS AND METHODS

Copper sulfate ( $\text{CuSO}_4$ ) was used for the preparation of stock standard solutions of Cu(II) in distilled water. For pH adjustment throughout the experiment, dilute hydrochloric acid (HCl) and dilute sodium hydroxide (NaOH) were used as necessary. All chemical used in the study were of analytical grade. UV spectrophotometer was used to measure the Cu(II) concentration in form of  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  at the wavelength of 810 nm.

#### Preparation of Adsorbents

Adsorbent (Sugarcane bagasse) were collected from Tugalfur market Greater Noida U.P. The bagasse were washed with distilled water and dried at room temperature to avoid the release of color by adsorbent into the aqueous solution. It was then ground to a smaller size to pass through a 200 micro meter mesh. The sample was then activated by treating it with concentrated sulphuric acid (0.1N) and kept in an oven at a temperature of  $150^\circ\text{C}$  for 24hr. It was washed with distilled water to remove the free acid and put in to oven to dry and the adsorbent were collected for experimental use.

#### Preparation of waste water

A 4.992 grams of  $\text{CuSO}_4 \cdot 6\text{H}_2\text{O}$  powder were weighed and transferred to a standard 1000 ml volumetric flask. It was then filled with distilled water in order to prepare the solution of 0.02M/L solution of copper which is equivalent to 320 g/L. This solution was used for all the experiment as a stock solution.

etc.

#### Batch process

The batch process was conducted with maximum contact time of 70 minute; the concentration of the waste water was varied between 320 mg/L to 40 mg/L. The adsorbent dose was varied between 0.25 to 1 gram and the pH was varied from 5.4 to 8.5. The experiment were conducted at room temperature,  $32^\circ\text{C}$ . Sample was agitated at 150 rpm for 70 min. At different intervals 5ml of water samples were withdrawn and filtered for analysis. The kinetics data were evaluated using Langmuir adsorption isotherm.

#### Analysis

The collected water samples from different experiments were filtered with filter paper (Whatmann 5) and prepared For UV spectrophotometer analysis. The samples were analyzed for  $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$  by UV Spectrometer at the maximum absorption wavelength of 810nm . The pH was measured by Hanna HI 9025 (HANNA Instrument, Romania) pH meter. The adsorbent was characterize using scanning electron microscope SEM

#### Calculation

The amount of copper adsorbed by adsorbent ( $q$ ) in the adsorption systems were calculated using

$$Q_e = \frac{(C_0 - C_e)V}{m} \quad (1)$$

The percentage removal of copper was calculated using equation (2)

$$\text{Percentage removal} = \frac{(C_0 - C_e)}{C_0} \times 100\% \quad (2)$$

Where  $Q_e$  is the quantity of copper adsorbed from the solution,  $C_0$  is the initial concentration in mg/L,  $C_e$  is the copper equilibrium concentration,  $m$  is the mass of adsorbent and  $V$  is the volume of the solution in litter

## RESULTS AND DISCUSSION

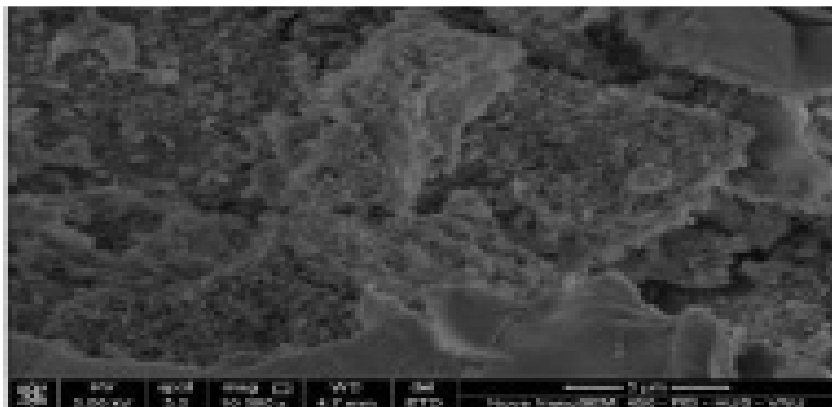


Fig. 1 SEM Of Activated Sugarcane Baggasse before adsorption

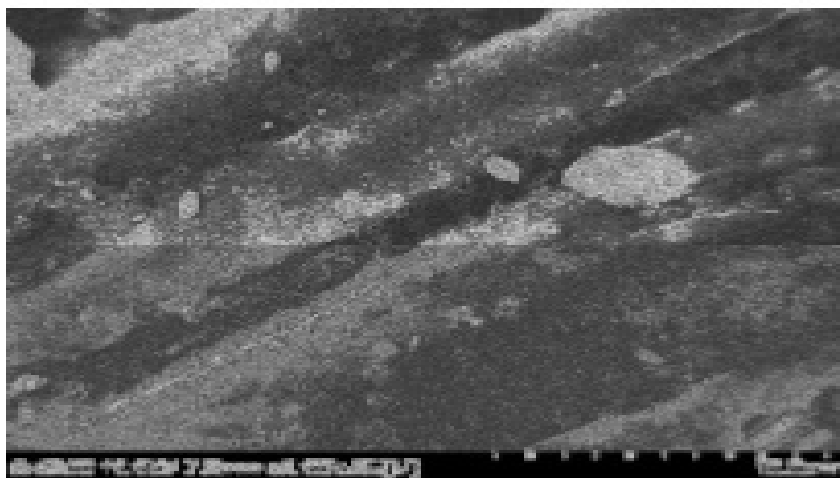


Fig 2. SEM image of activated Sugarcane Baggasse after adsorption

SEM analysis Show high level of porosity for the activated sugarcane bagasse before adsorption. After adsorption, the porosity decreases and this is due to the fact that as the copper ion get adsorbed at the surface of the adsorbent in filled some of the pores on the adsorbent

#### Effect of dosage:

The adsorption of Cu(II) on sugarcane bagasse was studied by changing the quantity of sugarcane bagasse in the test solution while keeping the initial Cu(II) concentration (160 mg/L) constant temperature of 32°C was used at equilibrium time. Increase in adsorbent dosage increased the percent removal of Cu (II), as shown in Fig.1, which is due to the increase in adsorbent surface area of the adsorbent this result was in agreement with the result obtained by Renge *et al.* (2012). But after a particular dose the change in concentration is decline. Due to high

sugarcane bagasse concentration; leading to a very fast superficial adsorption onto the sugarcane bagasse surface that produces a lower solute concentration in the solution than when adsorbent dose is low. Thus with an increase in adsorbent dose, the amount of Cu(II) adsorbed per unit mass of adsorbent is reduced; thus caused a decrease in equilibrium uptake value (Kaushik *et al.*, 2007). The maximum removal of the Cu(II) molecules were adsorbed very quickly on the outer surface, but further increases in initial Cu(II) concentrations led to fast saturation of sugarcane bagasse and thus most of the Cu adsorption took place slowly inside the pores (Ossman and Mansour, 2013). In this experiment dosage vary between 0.25 – 1.0 gram per 50 ml of the waste water. As dosage increases % removal increases. Effect of adsorbent dosage was clearly shown in figure 3.

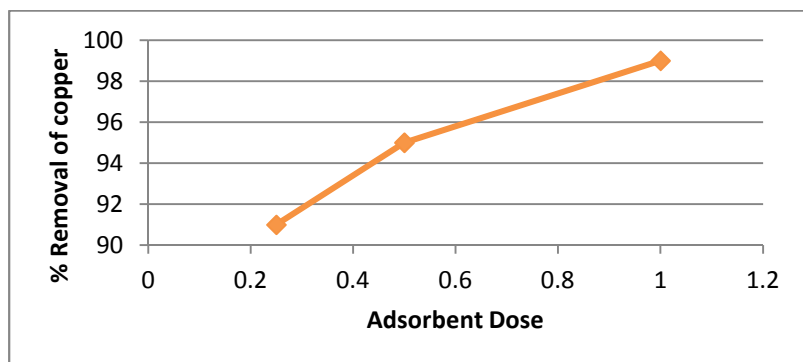


Fig. 3 effect of adsorbent dose

**Effect of pH:**

The pH values were varied between 4.5-8.5. The result shows that the capacity of adsorption increases with increases in pH value. The maximum removal of copper was

observed at pH 8.5 which is 99% showing a good interaction with OH<sup>-</sup>, indicating that, the highest adsorption occurred in basic medium. The effect of pH was shown in the figure 4

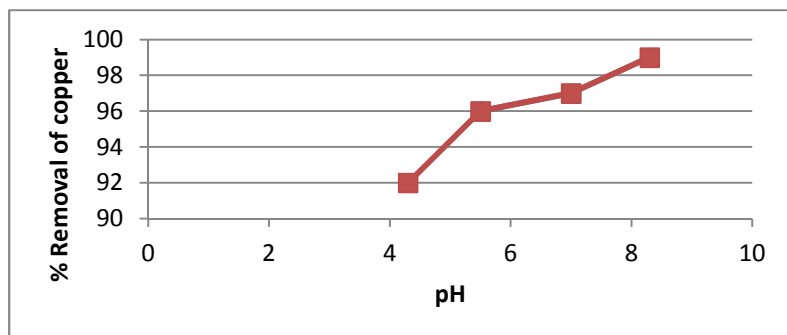


Fig. 4 effect of pH

**Effect of contact time:**

In this experiment contact time was varied between 15 to 70 minute, the result shows that the % removal increased with increased in contact time. At the early stage the adsorption was fast and when it reached certain time the adsorption became almost constant. This is

due to the fact that as the time increased the surface of the adsorbent is getting occupied until it reached saturation level, therefore when the time is extended for long time then the adsorption reached equilibrium. The adsorption level at 70 minute was found to be 99%. This effect was shown in the figure 5

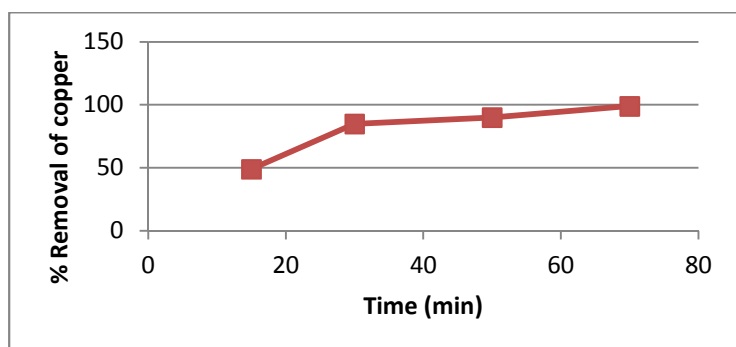


Fig. 5 effect of contact time

**Effect of concentration:**

Effect of concentration studied between 320 mg/L to 49mg/L. Reveals that increase in concentration leads to decrease in % removal

of the Cu (ii), this is due to the decrease in the rate of adsorption when the concentration is increased. This can be observed in Fig. 6.

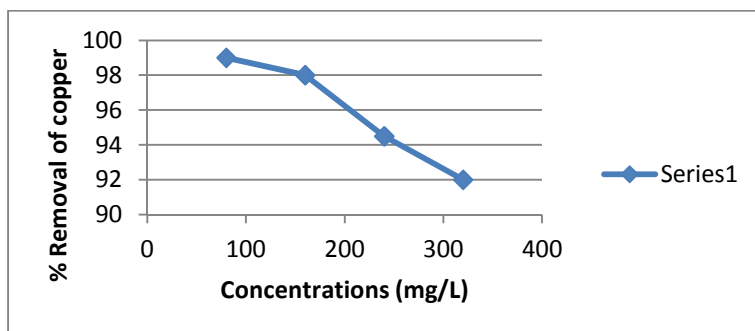


Fig. 6 effect of concentration

**Effect of temperature**

The effect of temperature were determined by measuring the adsorption capacity at different temperature range from 32 to 60 °C,

and the result shows that the rate of adsorption decreases as the temperature increases, this effect is shown in the figure 7

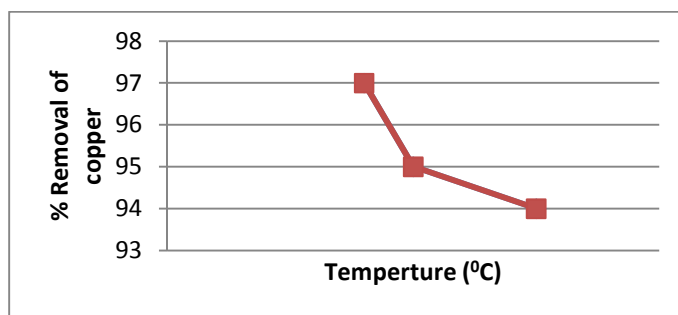


Fig. 7 effect of temperature

**Langmuir Adsorption isotherm**

Langmuir equation was applied for adsorption equilibrium. The Langmuir absorption is based on the assumption that maximum adsorption corresponds to monolayer of adsorbate molecules on the adsorbent surface that the energy of adsorption is constant and that

there is no transmigration of adsorbate in the plane of the surface and it is single layer adsorption (Suresh *et al.*, 2012). It is expressed by plotting the amount of solute adsorbed on the adsorbate against the concentration as shown in the figure 8.

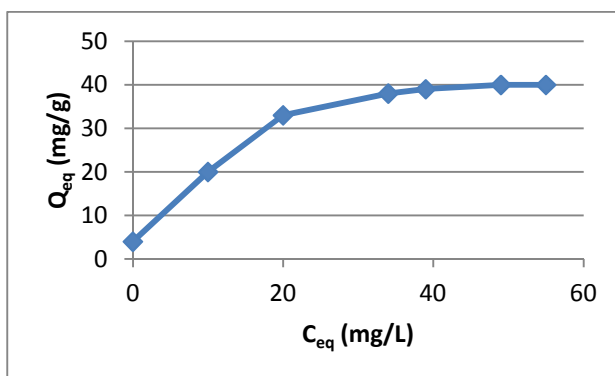


Fig. 8 Langmuir adsorption isotherm

$$C_e/q_e = 1/Q_0b + C_e/Q_0 \quad (3)$$

Where  $C_e$  is the equilibrium concentration of solute in the bulk solution (mg/L),  $q_e$  is the amount of solute adsorbed per unit weight of adsorbent (mg/g),  $Q_0$  is the monolayer adsorption capacity (mg/g) and  $b$  is a constant which is related to the free energy of adsorption. The plot of  $C_e/q_e$  vs.  $C_e$  gives linear slope which shows that the adsorption obeys Langmuir adsorption model.  $Q_0$  and  $b$  respectively were determined from the Langmuir plots and found to be 193 mg/g and 0.342 mg/L. the result was supported by the result obtained by Suresh kumar et al. (2015).

### CONCLUSION

Pollution control boards, has very strict rules for the effluents which are discharge by the industries, because some of the constituents of these effluents are harmful. They affect human beings and leaving organisms negatively. Also effluent with high concentration of Cu(ii) causes poisoning of agro lands and natural water sources like river, ponds etc. This method is good for Copper removal, because sugarcane bagasse is readily available & they can reduce the cost of expensive chemicals, machineries for removal of heavy metal from industrial waste. From the above results we can say that the removal

of copper ( $Cu^{2+}$ ) by activating sugarcane bagasse is satisfactory. The study indicated that adsorbent prepared from sugarcane bagasse could be used as an effective adsorbent material for the treatment of Industrial waste containing copper. The adsorption of Copper onto sugarcane bagasse is found to be time, concentration and pH dependent. So it can be varied as per the industrial requirement to achieve more removal of heavy metals. The present investigation shows that the low cost of adsorbent (sugarcane bagasse) can be used as an effective adsorbent for the treatment of waste waters containing copper metal ion. Adsorption dynamics, isotherms, pH effect and adsorbent dosage on the removal of copper ion for all the adsorbates were examined. The effect of adsorbent dosage and pH on the adsorption of metals showed that the percentage of metal removed increased with increase in pH and adsorbent dosage due to increased adsorption surface area but the percentage removal of copper was decreased with increase in temperature. The adsorption capacity reached up to 99 % within 70 minutes of contact time. The sugarcane bagasse is a cheap material and thus it is cost effective to use it in industrial waste water treatment plants for removal of Cu(ii).

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