Removal of Copper from Simulated Wastewater by Applying Electromagnetic Adsorption for Locally Prepared Activated Carbon of Banana Peels

Hayder Mohammed Abdul-Hameed
Associate Professor
Engineering College - Baghdad University
email: hayderabdul_hameed@yahoo.com

Israa Nazeh Abeed
Engineering College - Baghdad University
email: Israa717@gmail.com

ABSTRACT

The adsorption of copper ions onto produced activated carbon from banana peels (with particle size 250 µm) in a single component system with applying magnetic field has been studied using fixed bed adsorber. The fixed bed breakthrough curves for the copper ions were investigated. The adsorption capacity for Cu (II) was investigated. It was found that 1) the exposure distance (E.D) and strength of magnetic field (B), affected the degree of adsorption; and 2) experiments showed that removal of Cu ions and accumulative adsorption capacity of adsorbent increase as the exposure distance and strength of magnetic field increase.

Key words: banana peels**;** adsorption; magnetic field

إزالة النحاس من المياه بأستخدام تقنية الأمتزاز الكهرومغناطيسي باستخدام مادة ممتزة منتجة محليا من قشور الموز

حيدر محمد عبد الحميد
استاذ مساعد
كلية الهندسة - جامعة بغداد

اسراء نزيه عبد
كلية الهندسة - جامعة بغداد

الخلاصة

تمت دراسة أمتزاز ايونات النحاس على الكاربون المنشط المنتج من قشور الموز (قطر الجزيئات 250مايكرو) في عملية دفعية وفي عمود الحشوة الثابتة بتسليط المجال الكهرومغناطيسي. تم ايجاد قابلية الأمتزاز التراكمية للمادة المازة .وتم أيجاد أن 1) مسافة التعرض للمجال المغناطيسي وشدة المجال المغناطيسي تؤثر على عملية الأمتزاز ،2) التجارب لهذه الدراسة أظهرت أن إزالة أيونات النحاس وقابلية الأمتزاز التراكمية للمادة المازة تزداد بزيادة مسافة التعرض للمجال المغناطيسي وشدة المجال المغناطيسي.

الكلمات الرئيسية : قشور الموز، أمتزاز، مجال مغناطيسي.

1. INTRODUCTION

The contamination of the environment has become a prime concern since the last few decades. Massive industrialization is continuously releasing wastewater to the ecosystem and the environment, causing contamination and toxicity to all living and non-living species **Hossain, et al., 2012**. The presence of heavy metals in the environment is a major concern due to their hazardous impact **Dragan, et al., 2009**.

Heavy metals will not degrade into harmless end products and are considered toxic for many life forms. Unlike organic pollutants, the majority of which are susceptible to accumulate in living organisms, causing various diseases and disorders. Therefore, the removal of heavy metals from water and wastewater is important to protect public health and ecosystem **Cheung et al., 2001**.

Among the heavy metals, copper is the major available type of heavy metal in the aquatic environment **Hossain et al., 2012**. In 1991, the U.S. Environmental Protection Agency (EPA) established rules for controlling copper level in public water supplies, Maximum Contaminant Level Goal MCLG = 1.3 mg/l according to EPA **EPA, 2013.**

The adsorption process is being widely used by various researchers for the removal of heavy metals from waste streams **Van Lier, 1998.** The purpose of this study was to investigate the effect of exposure distance and strength of magnetic field on the adsorption of Cu (II) on the produced activated carbon from banana peels. The influence of experimental conditions, such as exposure time, strength of magnetic field on the adsorption was studied. This information might be useful for further application in the treatment of waste effluents.

2. EXPERIMENTAL PROCEDURE

2.1 Preparation of Adsorbent

The banana peels were collected from kitchen, washed with tap water to remove external dirt. The wetted banana peels were dried naturally by exposure to the sun light for 14 day in June **Jaishankar, et al., 2014.**

The dried banana peels were grounded in (Agate mortar, Retsch, Type BB1A, Masch.Nr.4323, Germany) and sieved to a size of (250 µm) by using (Sieves, S/N:03007314, Body200 mm×500mm, Germany). Samples with (250 µm) particles size were weighted (20 gm) using (Electrical balance, BL210S, Sartorius, Germany) and placed in the furnace (BARNSTEAD/ THERMOLYNE FURNACE 62700, 1.5KW) as in **Fig.1**. The samples were heated at a rate of (5 ^oC/min) where heating rate range was (5-25 ^oC/min).

Physical activation method was used, using CO_2 as the activation agent with flow rate of (0.1L/min). Samples were heated to the desired temperature of about (800 ^oC) within the range of (500- 900 ^oC) and kept for (30min.) **Rashidi, et al., 2012**. Then activated carbons were cooled to room temperature under the nitrogen gas flow rate of (0.1L/min).

2.2 Methods

A glass cylinder of length (80cm) and inner diameter of (3.5cm) was used. A mesh, before and after produced activated carbon was placed to prevent loss of produced activated carbon from the bed and to ensure a good distribution of it then the solution of (copper sulfate) was introduced through it as shown in **Fig 2.**.

A plastic cylindrical container with the volume of (120L) was used to contain the wastewater. One rotameter was used to measure the flow rate of a range of (5- 100 L/h). The copper ions solution was prepared with required concentration (1mg/L) by dissolving (0.0787gm) in each (20L) of distilled water by using Eq. (1):

$$W = C * V * \frac{\mathcal{M}_{wt}}{At_{wt}} \qquad (1)$$

Copper ions solution was introduced in the cylindrical plastic container and pumped through the bed by two pumps (Reshan, UN 130017, 2.5m, 1400L/hr). In flow was controlled by rotameter.

Continuous system was achieved to measure the breakthrough curve for Cu (II) with applying magnetic field and carried out at various conditions. Experiments were carried out at various E.D and B, keeping the other variables constant for a given run. The experimental procedures for continuous system are listed below:

1. The optimum exposure distance was obtained by conducting three values of exposure distances of (10, 25, 40 cm) (different exposure distances were achieved by inserting or removing number of electrical relays). The wastewater was passed through magnetic field with different exposure distance. Samples were taken from the exit every (10min) and analyzed.
2. The magnetic field strength B was obtained by conducting different values of magnetic field strength B by changing voltage. DC type of electrical current was used. The values of it were (0.05, 0.12, 0.21, 0.27Am) and the values of B for the Dc current used were (50,170, 260, 325 Gauss) respectively.

The breakthrough curves were determined by plotting relating effluent concentration (C_e/C_o) against time**.**

4. ANALYSIS

Dissolved metal concentrations in solution were determined by a flame atomic absorption spectrophotometer AAS (GBC 933, Australia) in the environmental engineering lab. The characteristic wavelength used in analysis for Cu^{+2} is equal to (324.7 nm) used by AAS for studied metal.

5. RESULTS AND DISSCUSIONS

1. Effect of Magnetic Field Strength (B Gauss)

The breakthrough curves of the Cu^{+2} adsorbed onto produced activated carbon were shown in **Fig.3** at different magnetic field strength (50, 170, 260 and 325Gauss) by keeping all the other parameters constant. E.D=40cm, pH=7, C_o=1 mg/l, particle size=250μm, weight of adsorbent$_c$ = 6gm, flow rate=0.25L/min.

Investigation of these curves clears that the breakpoint is increased with increasing magnetic field strength (B), this is because increasing in B gives more reduction in Zeta Potential for Cu^{+2} by exposure for magnatic field effect which enhanced adsoption process by increasing the capacity, **Ni'am, et al., 2006** as in table 1.

2. Effect of Exposure Distance for Magnetic Field

The breakthrough curves of Cu^{+2} present in solution adsorb on produced activated carbon were shown in **Fig.4** at different exposure distances (10, 25, 40 cm) and fixing other parameters, C_o and weight of adsorbent$_c$ of (1mg/l) and (6gm) respectively. B=325 Gauss, pH=7 , particle size=250 µm and flow rate=0.25L/min.

Investigation of these curves clears that the breakpoint is increased with increasing exposure distance for magnetic field, this occurs because the increased exposure distance gives sufficient contact time for Cu^{+2} to be exposured for magnatic field. Consequently this behavior would result in more reduction in Zeta Potential **Ni'am, et al., 2006.**

Fig.4 reveals clearly that the optimum exposure distance found (40cm). Because more magnetic field act on Cu^{+2} then less repulsed from each other by the magnetic force exerted on them resulting for lowering the Zeta Potential for the ions and adsorption process enhanced by this behavior and the total accumulative capacity value increase as the exposure distance increases **Fadhil, 2015.**

REFREANCE

- Cheung, C. W., Porter J. F., Mckay, G., 2001, *Sorption kinetic analysis for the removal of cadmium ions from effluents using bone char*, Water Research, Vol. 35, PP. 605-621.

- Dragan, E. S., and Dinu, M. V., 2009, *Removal of copper ions from aqueous solution by adsorption on ionic hybrids based on chitosan and clinoptilolite*, Ion Exchange Letters 2. vscht.cz, Vol. 2, PP. 15-18.

- EPA,2013,http://water.epa.gov/drink/contaminants/basicinformation/copper.cfm, Environmental Protection Agency.

- Fadhil, S. H., 2015, *The Usage of Electromagnetic Field for the Removal of Suspended Solids from Municipal Wastewater*, University of Baghdad, College of Engineering, M.Sc. Thesis.

- Hossain, M. A., Ngo, H. H., Guo, W. S., Nguyen, T. V., 2012, *Removal of Copper from Water by Adsorption onto Banana Peel as Bioadsorbent*, International Journal of GEOMATE, Vol. 2, No. 2, PP. 227-234.

- Jaishankar, M. , Mathew B. B., Shah, M. S., Murthy, K. T. P., Gowda, S. K. R., 2014, *Biosoption of Few Heavy Metal Ions Using Agricultural Wastes*, Journal of Environment Pollution and Human Health, Vol. 2, No. 1, PP. 1-6.

- Ni'am, M. F., Othman, F., Sohaili, J., Fauzia, Z., 2006, *Combined Magnetic Field and Electrocoagulation Process for Suspended Solid Removal from Wastewater*, Putrajaya, Malaysia, PP. 384-393.

- Rashidi, N. A., Yusup, S., Ahmad, M. M., Mohamed, N. M., Hameed, B. H., 2012, *Activated Carbon from the Renewable Agricultural Residues Using Single Step Physical Activation: A Preliminary Analysis*, APCBEE Procedia, Vol. 3, PP. 84 – 92.

- Van-lier, B. M., 1998, *Modeling and Prediction of Specific Compounds Adsoption by Activated Carbon and Synthetic Adsorbents*, Water Research, 14, PP.1719-1728.

NOMENCLATURE

AAS = flame atomic absorption spectrophotometer.

B= strength of magnetic field, Gauss.

C_o= initial concentration.

E.D= exposure distance, cm.

$q_{accu.}$= accumulated capacity, mg/gm.

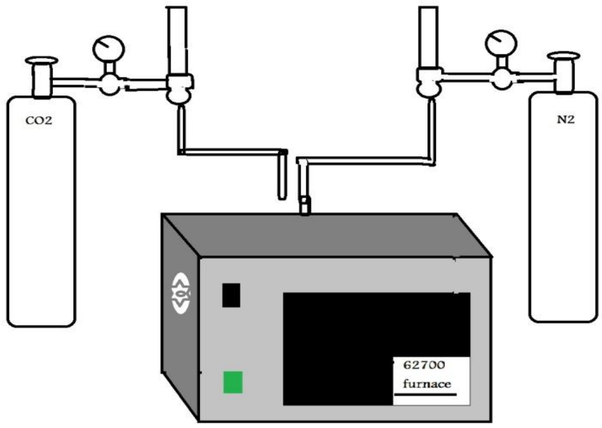

Figure 1. Diagram of the carbonization and activation process furnace.

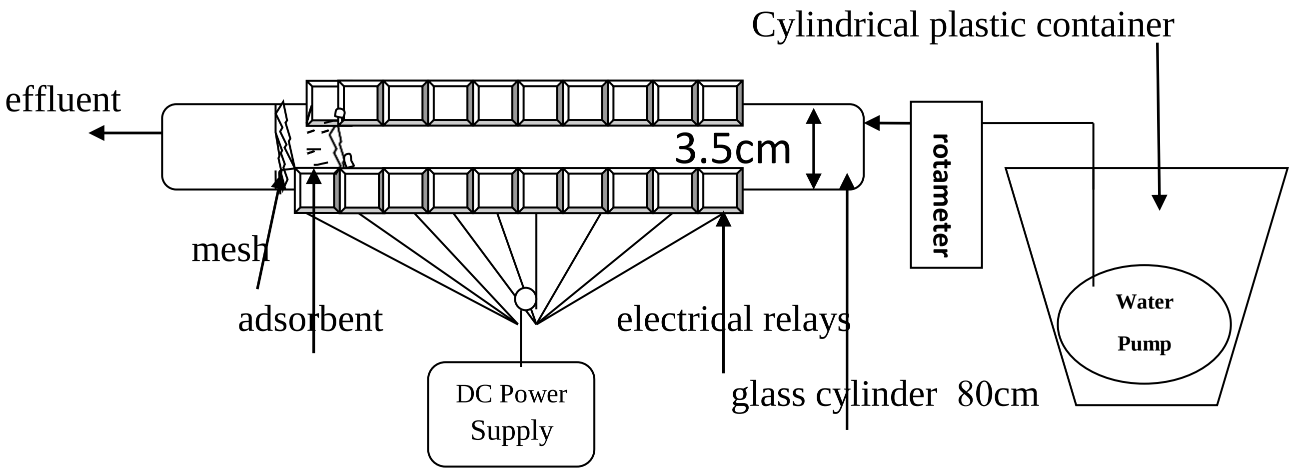

Figure 2. Schematic diagram of the system.

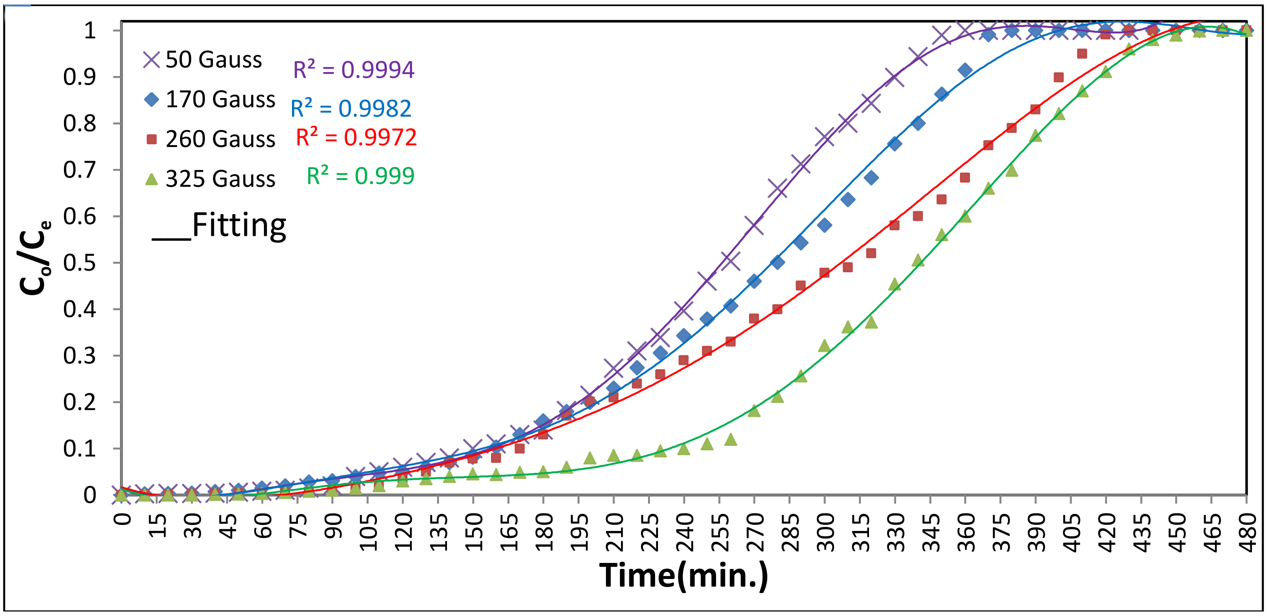

Figure 3. Breakthrough curves for adsorption of Cu^{+2} onto produced activated carbon at different magnetic field (B Gauss)

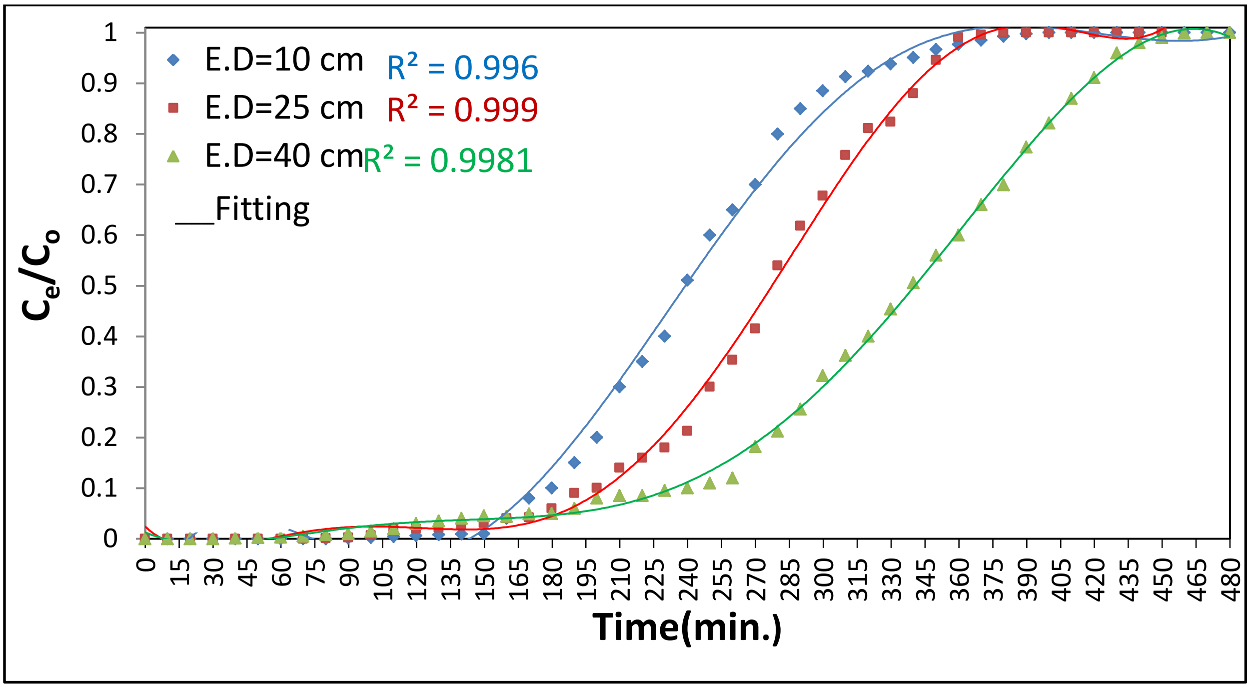

Figure 4. Breakthrough curves for adsorption of Cu^{+2} onto produced activated carbon for different exposure distances.

Table 1. Total accumulated capacity applying magnetic field.

Variable parameter in experiments		Total $q_{accu.}$ (mg/gm)
Exposuer distance	E.D=10cm	9.04
	E.D=25cm	11.14
	E.D=40cm	13.49
Magnetic field strength	B=50 Gauss	10.1
	B=170 Gauss	10.8
	B=260 Gauss	12.05
	B=325 Gauss	13.5