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Short Communication

Separation of heavy metal Nickel (II) using a new nano adsorbent string GZ-BAKI-TAC-Ni-88 from Ni contaminated Water using beshel tire activated Carbon

ABSTRACT

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Toxicity has occurred in workers exposed to nickel dust or nickel carbonyl formed in refining. Increased risk of nasal and lung cancers was linked to occupational nickel exposure before current workplace safety standards were set. Activated carbon with nano holes used for removing contaminants in environment. The purpose of this work is preparation a new nano-absorber, GZ-BAKI-TAC-Ni-88, for the adsorption of water soluble Nickel ions in polluted water. The adsorption capacity and the kinetic of maximum percent by metal concentrations in 50 and 100 and 150 ppm were studied. The amount of Nickel uptake was 52.0, 95.0 and 141.6, respectively. The maximum adsorption of Nickel achieved (q) 141.6 in 1200 minutes with 150ppm primary concentration of Nickel. Results indicate that the GZ-BAKI-TAC-Ni-88 with good absorbing water solution of Nickel separation and increasing Carbon Nano-holes and Active absorption of Sodium Alginate increased Nickel. According H-equation, the maximum adsorption of Nickel ions are calculated, the mg amount per gram absorber (TAC) is 55(mg/g) or 55000 ppm respectively. In comparison with published paper is highest capacity Ni, 17.21 mg/g or 17210ppm respectively. Kinetic adsorption of Ni indicated amount of 61.234%Ni occurs on 1320 min for Nickel. SEM images of this adsorber indicate the existence of micro and meso hole and occupation by Ni ions.

Keywords: *Alginate; Nickel; Separation; Activated carbon; Heavy metal; Contaminated water; SEM.*

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INTRODUCTION

Nickel is a non-biodegradable toxic heavy metal ion present in wastewater. The main source of nickel pollution in the water derives from industrial production processes such as galvanization, smelting, mining, batteries manufacturing and metal finishing. The presence and accumulation of nickel in industrial effluents have a toxic or carcinogenic effect on living species.

Thereby, it is of great crucial to eliminate nickel ions from wastewaters. As an economical and efficient method, adsorption technique has been widely applied to remove heavy metal ions from wastewaters.

Different adsorbents such as activated carbon [1], husk of Lathyrus sativus [2], olive stone waste [3], bagasse [4], mordenite [5] and crab shells [6] have been reported as nice adsorbents for Ni (II) removal from wastewater. However, further applications for these adsorbents are limited because of their low adsorption capacities. Therefore, researchers are still making great efforts to investigate new adsorbents with high adsorption capacities and efficiencies.

The heavy metals in the wastewater are also toxic to the bio-sludge of biological treatment process. However, bioremediation of heavy metals from above wastewaters is of major importance, as it offers a potential alternative to chemical precipitation (conventional process) for the recovery of the toxic as well as valuable metals.

Toxic heavy metal contamination of the environment is a significant worldwide problem and conventional methods for removing toxic metals from contaminated water include chemical precipitation, chemical oxidation or reduction, ion exchange, adsorption, filtration, membrane technologies, and evaporation recovery [1–5]. An alternative metal removal method, biosorption has been widely considered which is based on metal sequestering properties of certain natural materials of biological origin. Biosorption processes [6–8] can be based on plant biomass or animal polymers. However, biosorption studies typically have used microbial biomass. Of all the microbial species, algae [9–11] have received the most attention in connection with metal biosorption and they have been extensively studied due to their ubiquitous occurrence in nature.

The increase of industrial activities has intensified environmental pollution and deterioration of ecosystems such as heavy metal, synthetic compounds, nuclear wastes, etc. In recent years, increasing concern about the effect of toxic metals in the environment has resulted in more strict environmental regulations for industrial applications that discharge metal bearing effluents [1,2]. Biosorption is a proven technology for the removal of heavy metal ions from synthetic and real industrial effluents [3]. A wide range of adsorbents is manufactured, the choice of which depends mainly on the type of metal being recovered and the chemical composition and characteristics of the solution being treated. Properly matching the ion exchange sorbent and the process chemistry should result in efficient operation, quality of by-products and lower operation costs.

Low cost adsorbents include bark, lignin, chitin/chitson, dead biomass, seaweed, zeolite, clay, wood, etc., and have been used for the effective removal of heavy metals from dilute aqueous metal steams [4,5]. Seaweed has proven to be one of the most effective heavy metal sorbents and has been proposed for use in industrial applications (low-cost biosorbents). One of the main components of brown seaweed (Phaeophyta) is the salt of alginic acid (AA) ,a copolymer of 1,4 linked β-D-mannuronic and α-L-guluronic acid residues , each containing one carboxylate group per monomeric unit (Figure 1).

Different species of alga contain different percentages of mannuronic acid (M) and guluronic acid (G) : Laminaria digitata shows an average content of M and G of 60 and 40%, respectively , with an M:G ratio of 1:5 [6]. Because of the different in conformation of the two different residues, gellation with divalent clay ions can be attributed mainly to the G residue (especially to the pure polyguluronic (GG) chains), while the M residue contributes mainly to the clay ion exchange capacity of this naturally occurring polymer. However, hydroxyl groups have been found to play an important role not only to clay ion exchange capacity but also to the affinity of the material towards different metal ions [7-9].

In this research the metal investigated was nickel, which is toxic even at low concentration (concentration limit: 380-730 ppb for drinking water), entering aquatic environments through various anthropogenic sources.

The aim of this research is investigating on the potential use of calcium alginate with activated carbon and nano tube carbon, for the remove of nickel from dilute aqueous metal solution with use a fixed-bed.
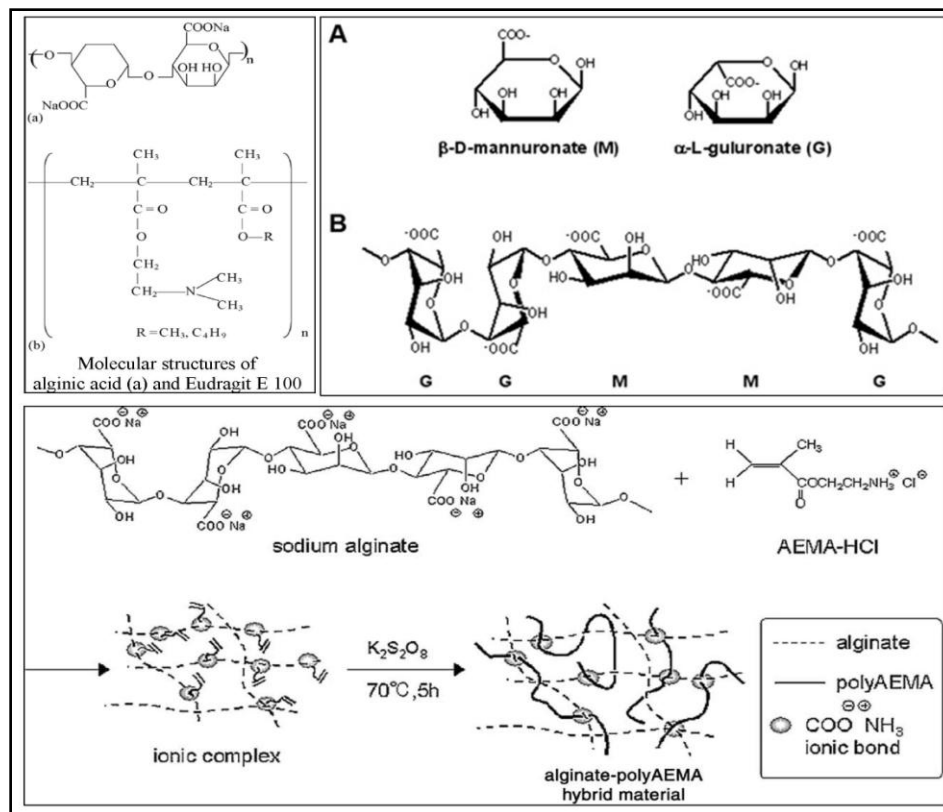
Fig. 1. Two monomer of alginic acid

EXPERIMENTAL

Reagents

All of the solutions used for the metal sorption experiments were prepared using NiCl2.6H2O purchased from Merck. Sodium Alginate (NaC6H7O6) and Calcium Chloride CaCl2 with 99% purity were made by Merck. The Activated Carbon was prepared Beshel with diameter about 0.125nm .All of the solutions were made by using distilled water.

Alginate bead preparation

The solution of 4% w/v of Sodium Alginate was prepared by dissolving 4 g of it in 100cc of distilled water. By using magnet, Sodium Alginate is dissolved with Activated Carbon nano powder without water, after that a jelly solution is made slowly in water.

The solution was left 25min in degas and 50ml of the Alginate, and Activated Carbon solution was added filament into 250ml 0.5 Mol/l CaCl2. The 0.5 Molar solution of Calcium Chloride

is prepared from dissolving 13.8 g of it in 250 ml distilled water at room temperature. The diameter and length of these filaments will be about 3mm &10 cm. We call these beads GZ-BAKI-TAC-Ni-88(Figure 2).

Fig. 2. GZ-BAKI-TAC-88

By increasing of adsorption rate, the diameter of the beads will be decreased. In this research we used a sampler for preparation of the

beads (with joining the sampler to the burette). The remaining CaCl2 solutions were removed by filtration and the product beads were washed by distilled water several times.

RESULTS AND DISCUSSION

Empirical method

Ni (II) solution that was prepared by using Merck salt were dissolved in ultrapure water, was poured in six 100ml erlens.

The absorption method that was used in these experiments was discontinues system (batch).

In order to determinate the optimum pH, the experiments were conducted in 3 different pH (pH= 4,5,6) . 0.04 g of GZ-BAKI-TAC-Ni-87 was added to 3 solutions with different pH (pH= 4, 5, 6) and 0.03 g of GZ-Ni-87 was added to 3 solutions with different pH.

(pH= 4,5,6). The results had shown in Figure 2 and (Table 1 & Figure 3).

Table 1. Effect of pH

absorbent	pH	Ci (ppm)	Ce (ppm)	Qe (mgNi/gACC)	Y(%absorption)
GZ-Ni-88	4	50	39.635	2.726	20.73
	5	50	43.436	1.726	13.128
	6	50	44.111	1.549	11.778
GZ-BAKI-TAC-Ni-88	4	50	45.286	1.240	9.428
	5	50	45.519	1.179	8.962
	6	50	38.839	2.935	22.322

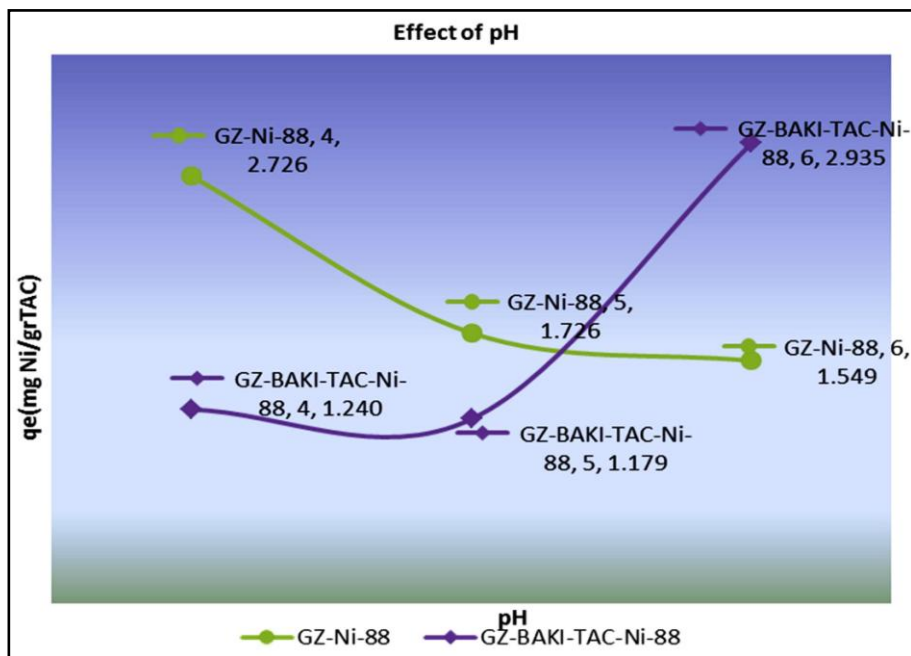**Fig. 3.** Effect of pH

Effect of Retention Time

The results of the different experiments showed that by increasing retention time, the remained concentration of heavy metals in the solution was reduced. 1200 minutes retention time for removing the metal was enough. However increase in retention time from 10 min to 1200 min resulted in decrease the remained concentration of heavy metal .Kinetic studies (at pH 6) showed that about 141.6 of the total metal ions adsorption occurred within 1200 min.

Also by increasing initial concentration, the metal uptake was being increased .The maximum uptake for Ni with initial concentration of 50 ppm and pH=6 with using GZ-Ni-88 were obtained 32.3ppm at 90 min and with using GZ-BAKI-TAC-Ni-88 were obtained 141.6 at 1200 min (Figure 4).
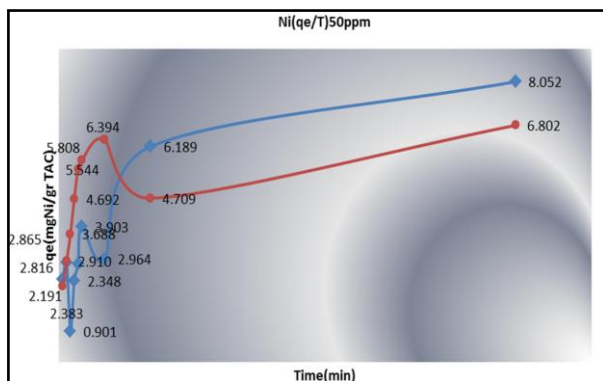

Fig. 4. Effect of time (GZ-BAKI-TAC-NI-88, GZ-Ni-88)

Calculation of Adsorption Capacity

The adsorption capacity is calculated according to the following H-equation:

$$X/M = V*C*P(AC)*P(Ni)/m$$

m= A*F
A= [(B+C)/B]*100
X=Amount of adsorbed Ni [mg]
M=Amount of Tire Activated Carbon [g]
V=Used volume of Ni in experiment [mL]
C=Concentration of Ni [mg/mL]
P (Ni) = Adsorption percentage of Ni
P (AC) = 1/Percentage of activated carbon on the surface (In this experiment calculated for 50% activated carbon response for adsorption, P (AC) =2)

m= mass of tire activated carbon in the surface of filament [g]
A=Percentage of tire activated carbon on filament
B= mass of alginate in filament [g]
C= mass of tire activated carbon in filament[g]
F= mass of used filament [g] (In this experiment 0.125 g)

CONCLUSIONS

Results of new absorber Calcium Alginate filamentary containing Activated Carbon with nano-holes has good adsorbing character for 61.234% removal of Nickel with concentration of 50 ppm. That means the maximum adsorption capacity of Nickel with considering of 1% Activated Carbon from 125 mg filament and 50% affectivity of absorber surface is 55000 mg Ni/g Activated Carbon.

By increasing of Activated Carbon in Sodium Alginate the amount of Nickel will be increased.

Scanning Electron Microscope Images from Filamentary Nano Absorber made of Activated Carbon powder (obtained from Tire) and Sodium Alginate shows that the adsorption effect is more on the surface (Figures 5 and 6).
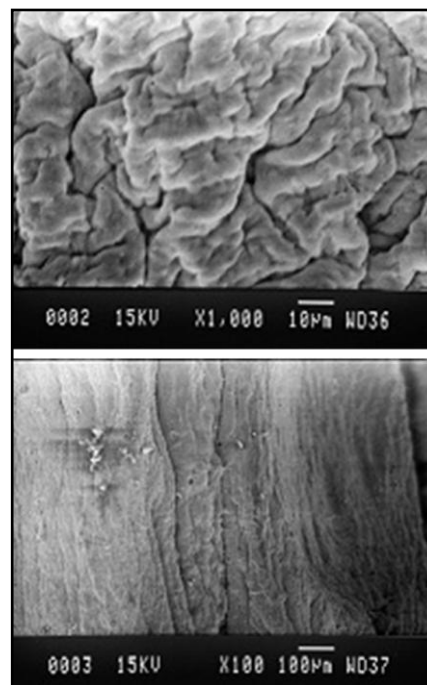

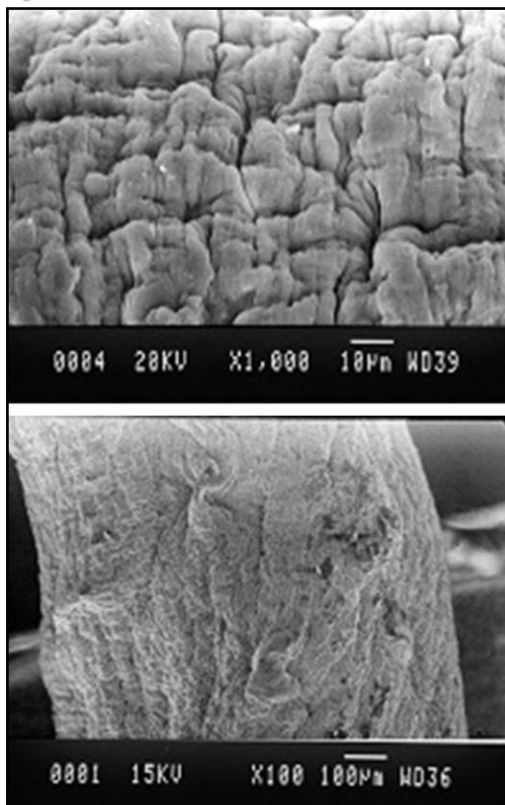**Fig. 5.** GZ-BAKI-TAC-88.SEM before Adsorption

Fig. 6. GZ-BAKI-TAC-88.SEM after Adsorption

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