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# Removal of Heavy Metal Nickel-Ions from Wastewaters Using Carbon Nanodots from Frying Oil

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**Abstract**

Heavy metals pollution becomes a serious environmental problem because heavy metals are non biodegradable and some heavy metal ion such as nickel is known as toxic metal. In this study, we investigated the natural sorbent materials for removing heavy metals nickel-ions in the wastewaters using carbon nanodots (C-Dots) from frying oil. C-Dots was resulted from frying oil by the hydrothermal method at temperature 300$^{o}$C for 2 h. The results showed that C-Dots could remove heavy metal nickel-ions in the solution. Electric current from the solution of heavy metal nickel-ion decreases with the number of C-Dots and time that used in the process of removal. The intensity of adsorption spectra from nickel ions contained in the wavelength 600-800 nm. C-Dots from frying oil have a great potential as a natural sorbent.



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*Keywords:* carbon nanodots; frying oil; nickel; wastewater; adsorption; electrical current

## 1. Introduction

The presence of heavy metal ions such as cadmium, cobalt, copper, nickel, chromium and lead in water that exceeds the threshold becoming a serious problem for the environment. Commonly, the properties of heavy metals are non biodegradable and toxic that can cause various negative impact on living organisms [1]. Water pollution due to heavy metals can be caused from many different of human activities such as mining and industrial waste [2]. Widely various techniques have been used for removal of heavy metal ions from water such as precipitation, ion exchange, membrane filtration and adsorption [3,4]. Recently, many reports shows on the development to remove the heavy metal in the water with a consideration about low cost and effective impact, such as adsorption technique [5,6].Various materials that have strong adsorption to remove any contaminants in the water, including heavy metal is from class of carbon materials such as activated carbon, carbon nanotubes and graphene oxide [5-7].Activated carbon has a wide surface area, whereas the carbon nanotubes and graphene oxide becomes material much studied in environmental applications include water purification due to the presence of function group is dominated by carboxyl and hydroxyl that forms graphitic structure. So it is very effective as an adsorbent materials because have strong interaction to cations through electrostatics mechanism [8].

Recent a new class material from carbon is carbon nanodots (C-Dots). It could be produced from the polymerization process with a simple hydrothermal method at low temperatures. Structure C-Dots contain of oxygen atoms that are abundant in the arrangement of function group carboxyl and hydroxyl which obtained from precursors form of carbon sources such as citric acid, soy milk, orange juice, ginger, food waste, waste paper and frying oil [9-15].Different from the carbon which usually black and has a weak fluorescence, C-Dots have properties such as strong fluorescence, non-toxic and insoluble in water. So that makes this materials have a high attractiveness to be assessed and used in various application fields such as bioimaging, photocatalyst and sensor [16]. In this work, we report a preliminary study for the use of C-Dots from frying oil for a new function to remove heavy metal nickel ions. The amount of C-Dots and time process is varied to investigate for derive the optimum condition to remove a heavy metal ions. The performance of the C-Dots from frying oil to remove a heavy metal nickel ions are estimated from electrical current and adsorption spectra.

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## 2. Experiment

### *2.1. Materials*

Used frying oil (Bimoli were obtained from Salim Ivomas Pratama Tbk. Indonesia) as precursor for the synthesize C-Dots. Meanwhile, C-Dots were obtained by heating them at temperature T = 300$^{o}$C for 2h and the properties of C-Dots were observed previously [15]. Heavy metal ions were obtained by dissolved nickel nitrate $Ni(NO_3)_2$ purchased from Merck-Germany.

### *2.2. Batch adsorption studies of C-Dots*

Removal heavy metal nickel ion from wastewates use batch method with C-Dots from frying oil as adsorbent materials. Batch adsorption experiment were performed in a magnetic stirrer at 32$^{o}$C using a 250 ml Beaker glass containing 100 ml solution of nickel 20 ppm and use various volume of C-Dots 5 ml, 10 ml, 15 ml, 20 ml, 25 ml and 30 ml. Then, the experiment set for various time process of 10 min, 20 min, 30 min, 40 min, 50 min and 60 min. The solution of heavy metal and C-Dots have different densities so easily separated after the removal process.

### *2.3. Characterization*

A solution of heavy metal removal process results were analyzed from electrical and optical properties. Due to the solution of heavy metal is electrolyte, so performance of removal process were estimated by electrical current that can be streamed. Scheme of electrical current measurements was shown in Fig 1. In addition, the other analysis was supported by measurements of the absorption spectra of heavy metal solution use UV-Vis-NIR Ocean Optics type USB 4000.

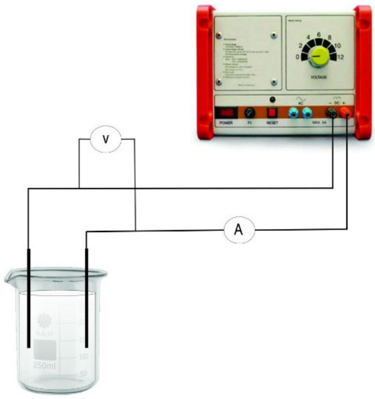



**Fig. 1.** Schematic illustration of electrical current on heavy metal solution.

## 3. Results and Discussion

### *3.1. Electrical current of heavy metal solution*

The results of electrical current measurements from heavy metal solution was shown in Fig 2. Electrical current that measured was decreases with the amount of volume C-Dots and time process. Electrical current is decreased shows that the electrolyte properties of heavy metal nickel-ions solution is reduced. It indicates that the amount of heavy metal-nickel ion is reduced due to adsorption process by the particles of C-Dots. The simple results show that C-Dots of frying oil could remove heavy metal nickel-ions.

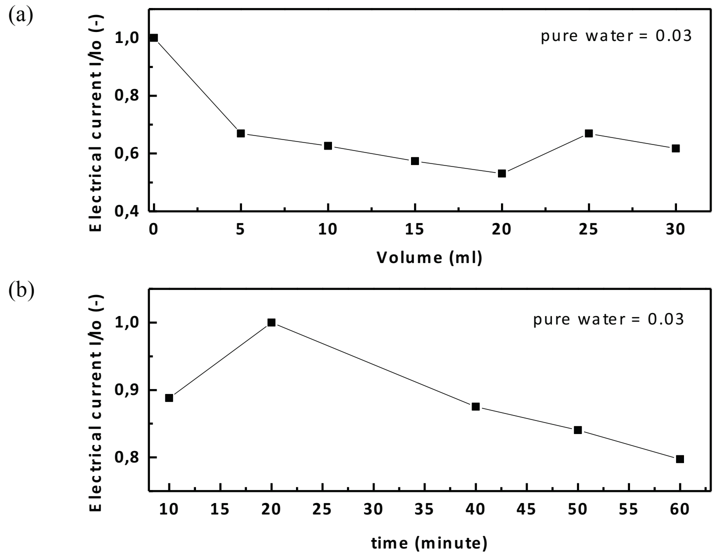



**Fig. 2.** Electrical current of heavy metal solution with various : (a). volume of C-Dots and (b). time process removal

The process of removal heavy metal nickel-ions occurs through the adsorption mechanism by electrostatic interaction between particle of C-Dots and nickel-ions. The surface of C-Dots has a negative charged ( Zeta potensial -28mV at pH 7) that derived from carboxyl and hydroxyl groups function [17]. This adsorption mechanism is similar with the interaction between C-Dots and cancer cells. The negative charge on the surface of C-Dots have an electrostatic interaction in the solution as shown in Fig. 3. Increasingly the amount of C-Dots and time process causes nickel-ions which bond is increase. The electrical current of heavy metal decreased that shows a simply phenomenon of removal nickel-ions with C-Dots from frying oil. Additional analysis is required to describe the heavy metal removal process. In this study, the measurement of absorption spectra from UV-Vis-NIR devices are used to analyze the process of removal because generally heavy metal-ions have a responds to the wavelength range of UV [18].

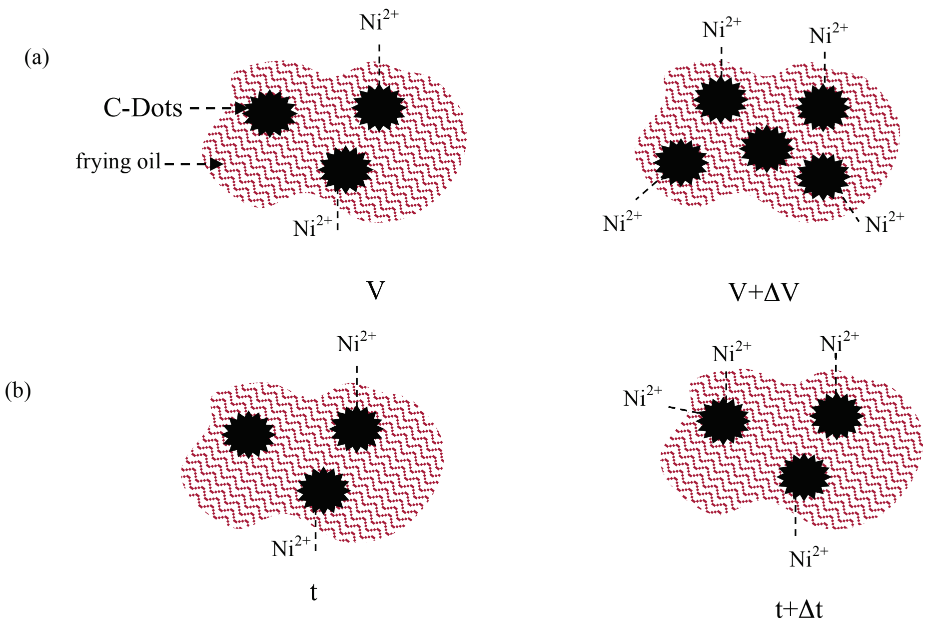
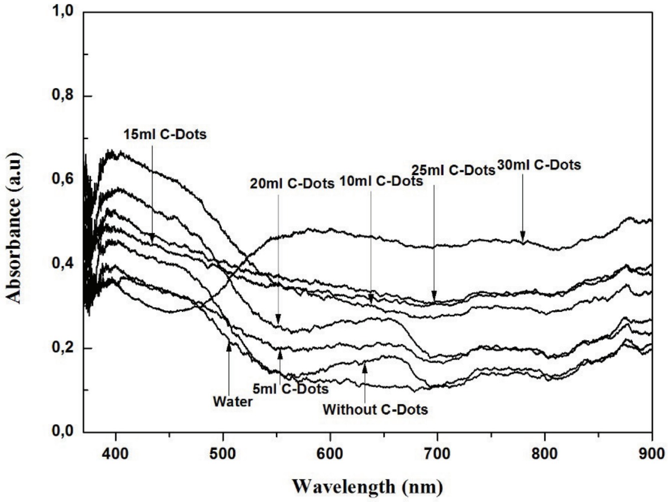



**Fig. 3.** Schematic illustration of adsorption mechanism with various: (a). volume of C-Dots and (b). time process

### *3.2. Adsorption spectrum of heavy metal nickel solution*

The result of measurement from adsorption spectrum of heavy metal nickel solution was shown in Fig. 4. Heavy metal nickel solution has absorption spectrum in the wavelength range of 600-800 nm [18].The absorption spectra appears in a solution of heavy metal nickel without C-Dots, 5 ml C-Dots, 10 ml C-Dots and 15 C-Dots. The intensity of absorption spectrum decreases until the same as absorption spectrum of water with increasing the amount of C-Dots are used in the removal process. In addition, the absortion spectrum of heavy metal solution with various time process are decreased too. The results of absorption spectrum measurement of heavy metal nickel solution corresponds to the results of electrical current. Thus, C-Dots of frying oil capable to remove heavy metal nickel-ion.

(a)




(b)

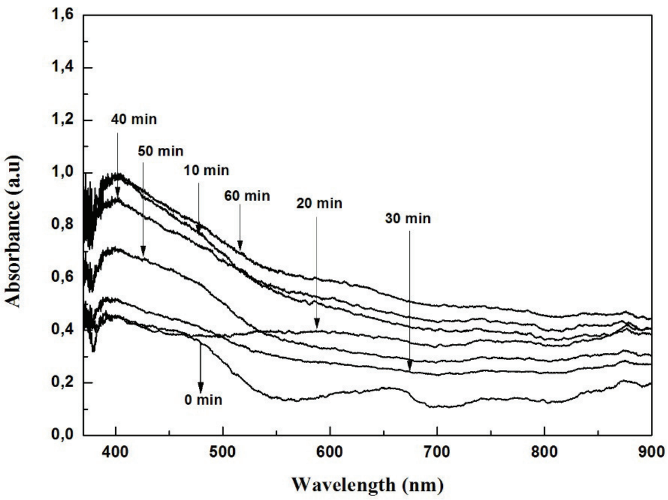



**Fig. 4.** Adsorption spectrum of heavy metal nickel ions with various : (a) volume of C-Dots and (b) time process

## 4. Conclusion

In this preliminary study, for the first time, C-Dots from frying oil could remove heavy metal nickel-ions. The removal process of nickel-ions is strongly influenced by the amount of C-Dots and time process. Electrical and optical properties from the solution of heavy metal ions decreases with increasing the amount of C-Dots and the time process. Furthemore, C-Dots from frying oil have a great potential as a sorbent materials.

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