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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◦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.

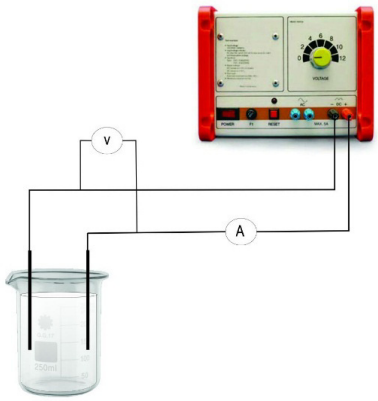

Fig. 1. Schematic illustration of electrical current on heavy metal solution.

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.