Jurnal Akademika Kimia, 10(2): 59-63, May 2021
ISSN (online) 2477-5185 | ISSN (print) 2302-6030
http://jurnal.fkip.untad.ac.id/index.php/jak/

The Utilization of Candlenut Shell Active Charcoal as Absorbent of Lead Ions in Used Oil

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Received 02 March 2021, Revised 01 April 2021, Accepted 03 May 2021
doi: 10.22487/j24775185.2021.v10.i2.pp59-63

Abstract

Candlenut (Aleurites moluccana) shell is a waste produced from the processing of the plants having a fairly hard texture. This study aimed to determine the optimum weight and contact time for the candlenut activated carbon which can absorb lead metal in used oil. Analysis of lead levels was carried out using atomic absorption spectrophotometry (AAS). Determination of the optimum weight and contact time of activated charcoal was carried out on various weights of 3, 6, and 9 grams and various times of 1, 2, and 3 hours, respectively. The results showed that activated charcoal's optimum weight and contact time are 9 grams for three hours, with the percentage of lead concentration absorbed of 90.716%.

Keywords: Candlenut shell, used oil, lead metal ion, adsorption, atomic absorption spectrophotometry (AAS)

Introduction

Lubricants generally made from mineral oil are used in both vehicles and machines. The development of various industries can also increase the amount of lubricant consumption; as a result, the need for lubricants in Indonesia from year to year continues to increase. This is directly proportional to the amount of used lubricating oil waste produced (Jodeh et al., 2015).

Used lubricating oil or better known as used oil, is basically lubricating oil whose use has undergone various kinds of collisions and is mixed with dirt from engine components, combustion residues, or dust; this causes the effectiveness of lubricating oil to decrease and be contaminated where in it if left too long will become abrasive and harmful particles (Mara & Kurniawan, 2015).

Used lubricating oil, such as used oil, contains several heavy metals, one of which is lead (Pb) in where heavy metal contamination, especially Pb, is a problem in today's environment. This happens because of so many heavy metals in nature, the accumulation of Pb that reaches the food chain, and is very damaging to the environment, such as pollution to soil, water, and air (Pusat Pendidikan dan Pelatihan Kementerian Negara Lingkungan Hidup, 2008).

One way to reduce the heavy metal content of Pb contained in used oil is activated charcoal. Activated charcoal is a material in the form of amorphous carbon, which mainly consists of free carbon atoms and has a deep surface, so it has good absorption capacity (Lempang et al., 2012). Carbon is an element that is abundant in nature. This element can be found in organic materials such as wood, coal, coconut shells, and candlenut shells (Destyorini et al., 2010).

Candlenut plants are industrial plants because the products produced can be used for various industrial goods (Harsono et al., 2018). Both seeds and other parts of plants can be used as raw materials for the beauty, pharmaceutical, paint, and household furniture industries. In fact, recently, it is known that hazelnut wood has the potential to make matches and paper (Siallagan et al., 2012). So far, most of the hazelnut plants are taken for their seeds. The candlenut seeds consist of the seed coat (shell) and seed meat (carnel) which is obtained from the separation of the skin, and the content of the comparison is 3:7. People are used to selling candlenut seeds by separating the skin and flesh from the candlenut seeds. However, in the processing of hazelnut seeds, part of the meat of the seeds (carnel) is sold or used as spices by the local community while the skin of the seeds is discarded. The analysis of the bark and wood of the candlenut tree shows that the ash produced is more than a lot from the shell, which is eventually wasted so that it becomes waste that can worry the community (Gianyar et al., 2012). Based on the results of research by Lempang & Tikupadang (2013), it was found that candlenut shells contained 49.22 % hemicellulose, 54.64 % lignin, and 2.07 % ash.

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According to Sudradjat & Suryani (2002) the increase in yield every year of candlenut shells can be troubling for the community where the shell of candlenut becomes organic waste that can be broken down but with a texture that is hard enough so that it takes time to describe it naturally. The effort to overcome this is by using it as activated carbon. This is in accordance with the research of Surest et al. (2008), which states that the use of hazelnut shells is not only to overcome the accumulation of hazelnut shells but also to produce products that are safe and environmentally friendly. By paying attention to these environmental factors, candlenut skin is used as a raw material for making activated carbon. This process is carried out to convert charcoal organic matter through a heating process without oxygen so that complex compounds break down into charcoal with a higher carbon element content. (Destyorini, 2010).

This was stated by Yuniar et al. (2015) from the burning of 21 kg of candlenut shells to produce 12.4 kg of activated charcoal. Based on this, the yield of activated charcoal produced was 59.04 %; this yield was higher than the yield of activated charcoal using raw materials for coconut shell and sawdust, namely 50.55 - 52.22 and 36.75 - 42,79 %, respectively (Sudradjat & Suryani, 2002).

This paper describes research on the use of candlenut shell-activated charcoal (*Aleurites moluccana*) as an absorber of lead metal in used oil.

Methods

The tools used in this research were furnace, beaker, oven, Erlenmeyer, measuring cup, 100 mesh sieve, stirring rod, funnel, burette, analytical balance, shaker, hot plate, atomic absorption spectrophotometry (AAS), stopwatch, drop pipette, measuring pipette, porcelain cup, measuring flask.

The materials used in this study were candlenut shells (*Aleurites moluccana*), 10 % $ZnCl_2$ activator (*Merck*), 6 N HCl (*Merck*), distilled water, filter paper, used lubricating oil (used oil), 0.1N HNO_3 (*Merck*), pH meter, Pb standard solution.

Sampling

The samples used in this study were candlenut shells (*Aleurites mollucana*) which were obtained from Dolo Barat, Sigi Regency, and used Quartz 7000 oil obtained from Toyota car dealership Jusuf Kalla Juanda Street no. 45 Palu, used for seven months.

Activated charcoal preparation

This procedure follows Bukasa et al. (2012). Candlenut shells were carbonized using a furnace for 2 hours with a burning temperature of 700 ºC. The resulting charcoal is weighed to determine its weight. The resulting charcoal is mashed using a blender and sieved with a 100 mesh sieve to get charcoal in the form of flour. Furthermore, it was soaked with 10 % $ZnCl_2$ solution for 24 hours, filtered using filter paper, and then put into a crucible plate and heated again in the furnace for 2 hours at 300 ºC. After heating, the activated charcoal is washed with distilled water to neutral pH, then dried in an oven at 110 ºC for three hours.

Characteristics of activated charcoal

Water content

The candlenut shell activated charcoal was weighed carefully as much as 1 gram and placed in a known weight plate, then heated in an oven at 105 ºC for ± 3 hours, after that it was cooled in a desiccator and weighed, then repeated until a constant weight was obtained. Then the water content is determined using the following equation (Sudarmadji et al., 1989):

$$\% \text{ water content} = \frac{B-F}{B-G} \times 100\ \%$$

Ash content

Candlenut shell activated charcoal is weighed carefully as much as 1 gram and placed in a plate that has known its weight, then healed by using a furnace at a temperature of 600 ºC for ± 1 hour until it becomes ash, after that it is cooled in a desiccator and weighed, then repeated until a fixed weight is obtained. Then the ash content is determined using the following equation (Sudarmadji, et al., 1989):

$$\% \text{ ash content} = \frac{F-G}{B-G} \times 100\ \%$$

Preparation of Pb standard solution

The standard solution of Pb was made by weighing 1 gram of $Pb(NO_3)_2$, then the solution was put in a 1000 mL volumetric flask, then distilled water was added to the limit mark and shaken until the solid dissolves. Furthermore, 10 ppm Pb solution pipette 0.0 ppm; 0.5 ppm; 1.0 ppm; 1.5 ppm; 2.0 ppm and 2.5 ppm were prepared by removing 0.0; 0.5 m; 1.0; 1.5; 2.0; and 2.5 mL; 10 ppm standard solution into a 10 mL volumetric flask then diluted.

Lead metal concentration at variation in contact time

20 mL of used oil was added with candlenut shell activated carbon 3, 6, and 9 grams respectively, then put into the Erlenmeyer tube and cover with aluminum foil paper. The mixtures were then stirred using a shaker each 1, 2, and 3 hours, then filtered to produce filtrate and residue. The residue obtained was weighed, as much as 5 mL of the filtrate produced from the filter was put into a porcelain dish. The cup containing the sample was placed on a hot plate and heated. Then proceed with ashes in the furnace (± 450 ºC) until the white ash was free of carbon.

Dissolved white ash in 5 mL 6 N HCl while heated over an electric bath, then dissolved with 30 mL HNO_3 0.1 N and put into a 50 mL volumetric flask then added distilled water until the limit mark. The solution was filtered using filter paper into a polypropylene bottle. The blank solution was stored with the addition of reagent. Then read the adsorption of the solution using AAS at a maximum wavelength of about 283.3 nm.

Results and Discussion

Water content

Water content is one of the foodstuff parameters that most determines its character and shelf life. In general, the higher the water content of a material, the shorter the shelf life of a food item (Winarno, 2004). Determination of water content aims to determine the hygroscopic properties of candlenut shell-activated charcoal (Wijayanti, 2009). The water content of the candlenut shell-activated charcoal obtained was 0.198 %. The low water content indicates that the bound water content contained in the candlenut shell-activated charcoal has evaporated during the carbonization process. This water content is also influenced by the amount of water vapor in the air, the length of the cooling process, and the hygroscopic nature of the candlenut shell-activated charcoal. The activated candlenut shells still contain water, so that drying at a temperature of 105 ºC is required for 3 hours. The purpose of drying at 105 ºC is because at that temperature, water can evaporate because the boiling point of water is 100 ºC.

Ash content

The ash content of the candlenut shell-activated charcoal obtained in this study was 5.59%. The ash content is very influential on the activated candlenut shell charcoal produced. The presence of excess ash can clog the pores of activated charcoal so that the surface area is reduced. One of the constituents of ash is silica. This very high ash content can reduce the quality of activated charcoal so that the candlenut shell-activated charcoal is ignored in an electric furnace at a temperature of 600 ºC for approximately 1 hour.

Candlenut shell activated charcoal on lead metal in used oil

The weight of candlenut shell-activated charcoal used in this study acts as an adsorbent. This is a factor that significantly affects the lead metal adsorption process. Based on the research results in **Figure 1** shows the absorption of lead metal is influenced by the weight of the candlenut shell-activated charcoal (adsorbent). The absorption process increased from 9 grams to 16.34 gram. This happens due to the increasing number of adsorbents that interact with the lead metal ion. The increase in absorption is also due to the density of cells in the activated charcoal in used oil, resulting in reasonably effective interaction between the active center of the candlenut shell activated charcoal cell wall and lead metal; the more adsorbents, the more activated charcoal centers react (Setiawan et al., 2018).

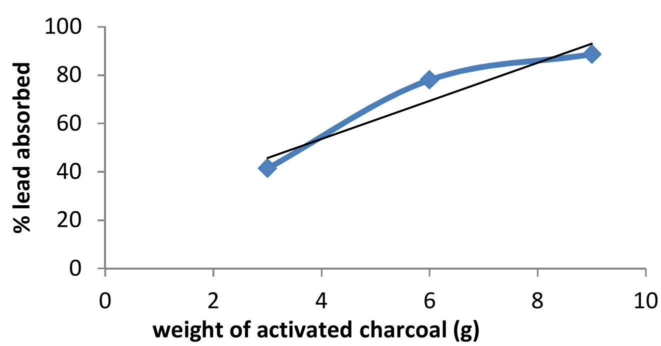

Figure 1. Relationship between weight of activated charcoal to% lead absorbed in used oil

Odubiyi et al. (2012) stated that the adsorption increases in capacity with an increase in the adsorbent because the number of particles increases and the surface area is able to absorb more lead metal. Whereas at 3 grams, the absorption of lead metal is relatively less than 9 grams. This is because the lead metal ions contained in the used oil have been completely absorbed by the charcoal. In addition, this can also occur because the surface of the charcoal is saturated with lead metal ions. So that the increase in weight of candlenut shell-activated charcoal relatively no longer affects the increase in absorption of metal ions by the charcoal (Setiawan et al., 2018).

Based on research by Wahjuni & Kostradiyanti (2008), it was stated that lead metal is trapped in the adsorbent cavities or pores. This is because activated charcoal has a broader surface and open pores so that it can absorb lead metal. The larger the surface area of the pores, the higher the adsorption power.

Contact time by activated charcoal candlenut on lead metal in used oil

The results of the study in **Figure 2** showed that lead absorption is influenced by the contact time of the adsorbent with the adsorbate.

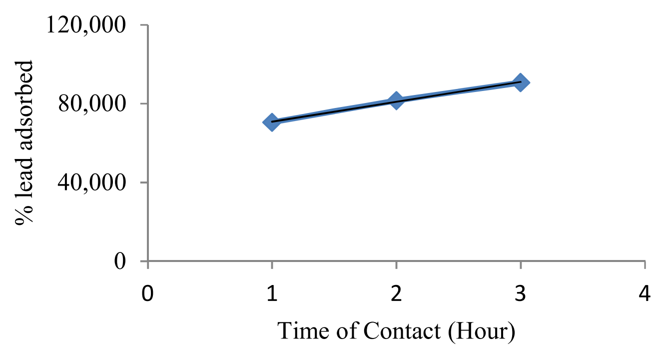

Figure 2. Time of contact to% lead absorbed in used oil

The optimum absorption of activated charcoal occurred at 3 hours of contact time with 90.716 % of absorbed lead metal. The data from the results of this study showed that the adsorption efficiency (%) of lead ion by candlenut shell activated charcoal at each time variation was 70.564 % at 1 hour. At 2 hours, the amount is 81.522, and at 3 hours, the amount is 90.716%. This is because the metal ions contained in used oil have been fully adsorbed by activated charcoal. In addition, it can occur because the adsorbent surface no longer affects the absorption of metal ions by the adsorbent. This happens because the candlenut shell-activated charcoal is undergoing an adsorption process. Desorption is the re-release of metal ions that have been adsorbed which is caused by several factors returning to metal ions that have been adsorbed due to several factors, including the bond that occurs between the adsorbent and the adsorbate is very weak so that the adsorbent and adsorbate are easily released. The next factor is that the candlenut shell-activated charcoal is saturated so that it is able to adsorb more ions in the solution. In a study by Sud et al. (2008), it was shown that candlenut shell-activated carbon absorbed lead metal more than the others in the study, which resulted in a percentage of 98%.

Conclusions

The optimum weight required for candlenut shell-activated charcoal to absorb lead metal in used oil is 9 grams with an absorption percentage of 88.645 %, and the weight of lead ion absorbed is 7.34 grams. Furthermore, the optimum contact time required for candlenut shell-activated charcoal to absorb Lead metal in used oil is 3 hours with a percentage of absorbed lead of 90.716 %.

Acknowledgments

The author's gratitude goes to the Regional Health Laboratory of Central Sulawesi Province and all those who helped me a lot in completing this research.

References

Bukasa, D. A., Koleangan, H. S. J., & Wuntu, A. D. (2012). Adsorpsi toluena pada arang aktif tempurung kemiri. *Jurnal Ilmiah Sains*, *12*(2), 93-99.

Destyorini, F., Suhandi, A., Subhan, A. & Indayaningsih, N. (2010). Pengaruh suhu karbonisasi terhadap struktur dan konduktivitas listrik arang serabut kelapa. *Jurnal Fisika*, *10*(2), 122-132.

Gianyar, G. B. I., Nurchayati., & Padang, A. Y. (2012). Pengaruh persentase arang tempurung kemiri terhadap nilai kalor briket campuran biomassa ampas kelapa-arang tempurung kemiri. *Dinamika Teknik Mesin: Jurnal Keilmuan dan Terapan Teknik Mesin*, *2*(2), 67-74.

Harsono, D., Yusran, & Umar, H. (2018). Pengaruh perbandingan tanah dan serbuk arang tempurung kemiri sabagai media tumbuh terhadap pertumbuhan semai kemiri (Aleuritas moluccana Willd). *Jurnal Warta Rimba*, *6*(1), 39-47.

Jodeh, S., Odeh, R., Sawalha, M., Obeid, A. A., Salghi, R., Hammouti, B., Radi, S., & Warad, I. (2015). Adsorption of lead and zinc from used lubricant oil using agricultural soil: equilibrium, kinetic and thermodynamic studies. *Journal Materials Environmental Science*, *6*(2), 580-591.

Lempang, M., Syafii, W., & Pari, G. (2012). Sifat dan mutu arang aktif tempurung kemiri. *Jurnal Penelitian Hasil Hutan*, *30*(2), 100-113.

Lempang, M., & Tikupadang, H. (2013). Aplikasi arang aktif tempurung kemiri sebagai komponen media tumbuh semai melina. *Jurnal Penelitian Kehutanan Wallacea*, *2*(2), 121-137.

Mara, I. M., & Kurniawan, A. (2015). Analisis permurnian minyak pelumas bekas dengan metode acid and clay. *Jurnal Teknik Mesin*, *5*(2), 1-4.

Odubiyi, A. A. Awoyale, & Eloka-Eboka, A. C. (2012). Wastewater treatment with activated charcoal produced from cocoa pod husk. *International Journal of Environment and Bioenergy*, *4*(3), 162-175.

Pusat Pendidikan dan Pelatihan Kementerian Negara Lingkungan Hidup (P3KNLH). (2008). *Modul diklat pengelolaan limbah bahan berbahaya dan beracun, identifikasi jenis dan karakteristik limbah bahan berbahaya dan beracun* Jakarta: Pusat Pendidikan dan Pelatihan Kementerian Negara Lingkungan Hidup.

Setiawan, I. K. A., Napitupulu, M., & Walanda, D. K. (2018). Biocharcoal dari kulit rambutan (Nephelium lappaceum L.) sebagai adsorben zink dan tembaga. *Jurnal Akademika Kimia*, *7*(4), 193-199.

Siallagan, Y. A., Daulay, B. S., & Harahap, A. L. (2012). Pemecahan cangkang kemiri (Alleuirites mollucana) menggunakan sistem ripple mill dengan berbagai suhu perendaman. *Jurnal Rekayasa Pangan dan Pertanian*, *1*(1), 70-76.

Sud, D., Mahajan, G., & Kaur, M. P. (2008). Agricultural waste material as potential adsorbent for sequestering heavy metal ions from aqueous solutions – A review. Department of chemistry. *Bioresource Technology*, *99*(14), 6017-6027.

Sudarmadji, B., Haryyono, & Suhardi. (1989). *Analisis bahan makanan dan pertanian*. Yogyakarta: Liberty.

Sudradjat, R., & Suryani, A. (2002). Pembuatan dan pemanfaatan arang aktif dari ampas daun teh. *Jurnal Penelitian Hasil Hutan*, *20*(1), 1–11.

Surest, H. A., Kasih, F. A. J., & Wisanti, A. (2008). Pengaruh suhu konsentrasi zat aktivator dan waktu aktivasi terhadap daya serap karbon aktif dari tempurung kemiri. *Jurnal Teknik Kimia*, *15*(2), 17-22.

Wahjuni, S., & Kostradiyanti, B. (2008). Penurunan angka peroksida minyak kelapa tradisional dengan adsorben arang sekam padi IR 64 yang diaktifkan dengan kalium hidroksida. *Jurnal Kimia*, *2*(1), 57-60.

Wijayanti. (2009). Fakta penting seputaran kesehatan reproduksi wanita. Yogyakarta: Book marks.

Winarno, F. G. (2004). *Kimia pangan dan gizi*. Jakarta: PT. Gramedia Pustaka Utama.

Yuniar., Mappiratu., & Nurhaeni. (2015). Kajian daya serap arang tempurung kemiri (*Aleorites moluccana*) terhadap ion besi(III) dan ion timbal(II) pada waktu kontak. *Kovalen: Jurnal Riset Kimia*, *1*(1), 1-5.