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Investigation of Zn^{2+} heavy metal handling ability by macadamite activated by H_3PO_4

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ABSTRACT

Investigate the possibility of treating wastewater containing heavy metals Zn^{2+} with activated carbon material prepared from macadamia shell with chemical activating agent H_3PO_4, showing high efficiency of adsorption of Zn^{2+}. The results of the study showed that activated carbon with H_3PO_4 activating agent has high adsorption capacity, capable of handling Zn^{2+} best at pH = 4.5, dosage 1.8 g/L and time is 120 minutes. . The results show similarities with other research results and are capable of treating wastewater containing heavy metals Zn^{2+}.

Key word*: Macadamia, metal processing, H_3PO_4, activated carbon.*

1. Introduction

According to the Wikipedia, industrialization and modernization have put a heavy burden on water sources, especially water sources affected by heavy metal content. This directly affects human health if there is no timely intervention. In particular, Zn^{2+} metal, zinc can be derived from plating, welding, battery manufacturing, painting, dyeing industries, etc. The acute toxicity of Zn^{2+} causes symptoms such as vomiting,

dehydration, drowsiness, coma, Electrolyte imbalance, abdominal pain, lack of coordination between muscles and kidney failure. Chronic toxicity of Zn^{2+} increases the risk of anemia, pancreatic injury, etc.

According to Okman, Karagoz, Tay and Erdem, (2014) and Le Huy Du and partner, (1981) activated carbon is a carbon-shaped material that has been treated to yield a porous structure, thus having a very large surface area. Research results from Okman, Karagoz, Tay and Erdem, (2014) and Hameed and Ahmad, (2009) and Minamisawa, Minamisawa, Yoshida and Takai, (2004) and Kamib, Kabbani, Holail and Olama, (2014) ,the main component of activated carbon is carbon element in amorphous form, content of about 85% - 95%. As a material used in many fields such as wastewater treatment, removal of toxic gases in the atmosphere of solvent recovery, removal of colors and heavy metal ions (Cr^{3+}, Ni^{2+}, Cd^{2+}, Zn^{2+}, Pb^{2+} and Cu^{2+}).

Research results from Yan-Juan, Zhen-Jiao, Zheng-Kang, Meng, and Yin, (2014) and Kwaghger and Ibrahim, (2013), the adsorption properties of activated carbon are often affected by many factors such as structural characteristics, surface functional groups, surface area, ash content,.. Research results from Kavitha and Namasivayam, (2007) and Trinh Van Dung and partner, (2011) materials used to produce activated carbon often use two main sources: coal and agricultural residues with high hardness and porosity like coir, rice husks.

Research results from Ministry of agriculture and rural development, (2015) in Viet Nam, macadamia trees are planted stretching from the south to the north. It is estimated that by 2020, the area used to grow macadamia will be up to 10,000 ha, for every ton of macadamia seeds producing 70-77% of the bark.

Research results from Daud and Ali, (2004) in macadamia bark there are many active ingredients to make activated carbon such as: Carbon content (47-49%) is higher than the amount of Carbon contained in bamboo (45.53%) and is equivalent to the amount of Carbon in coconut shells 48 , 63% according to Kobya, (2004). Research results from Toles, Marshall and Johns, (1998), the shell contains oxygen content 46.52%, Hidro 6.10%, nitrogen 0.36% and relatively low ash content only 0.22%, this shows that macadamia nuts have Potential of producing activated carbon thanks to the above characteristics.

Therefore, bioactive carbon is made from macadamia shell chemically using the agent H_3PO_4 to activate. In addition, bioactive activated carbon investigated the adsorption capacity of Zn^{2+} heavy metal ions in the assumed wastewater treatment.

2. Research methods

***Research facilities*:**

- Study object: The assumed wastewater sample contains heavy metal Zn^{2+}
- Research materials: Macadamia husk is harvested in Lam Dong province
- Research chemicals: H_3PO_4 (China, 99%), HCl 1N (China), NaOH 1N (China)

***Experimental arrangement*:** Experimental arrangement of activated carbon prepared from macadamia shell by chemical agent H_3PO_4 handling heavy metals Zn^{2+} in the assumed wastewater (survey pH, dosage, time).

Experiment 1: Investigate a suitable pH for activation

According to Madhava Rao, Chandra Rao, Seshaiah, Choudary, Wang (2008) and Nguyen Thi Ha, Tran Thi Hong, Nguyen Thi Thanh Nhan, Do Thi Cam Van, Le Thi Thu Yen (2007) the optimal processed pH: The Zn^{2+} heavy metal processing pH is investigated in the range 2 - 5 (25ppm concentration, 50ml volume, fixed dose 0.3g/l, fixation time 60 minutes)

Experiment 2: Investigate the appropriate dosage for activation

According to MadhavaRao, Chandra Rao, Seshaiah, Choudary, Wang, (2008) and Nguyen Thi Ha, Tran Thi Hong, Nguyen Thi Thanh Nhan, Do Thi Cam Van, Le Thi Thu Yen, (2007) optimal dosage: The Zn^{2+} heavy metal treatment dose is in the range of 0.2 - 2 g/l (Δ = 0.2g/l) (concentration of 25ppm, volume of 50ml, optimal pH, time fixed time 60 minutes).

Experiment 3: Surveying the appropriate time for activation

According to Madhava Rao, Chandra Rao, Seshaiah, Choudary, Wang (2008) and Nguyen Thi Ha, Tran Thi Hong, Nguyen Thi Thanh Nhan, Do Thi Cam Van, Le Thi Thu Yen (2007) optimal processing time: The processing time of heavy metal Zn^{2+} ranges from 0 - 120 minutes (Δ = 10 minutes) (concentration of 25 ppm, 50 ml volume, optimal pH, optimal dosage).

***Evaluation methods*:**

- Determination of functional group in molecule by FT-IR (Fourier Transformation Infrared Spectrometer).
- Determine the surface observation by scanning SEM (Scanning Electron microscope).
- Determination of pH is directly measured by Mettler Toledo pH meter (2017)
- Determine the atomic absorption by atomic absorption spectrometer AAS / Analytik Jena - Germany.

3. Results and discussion

3.1. Investigate the proper pH that affects activation

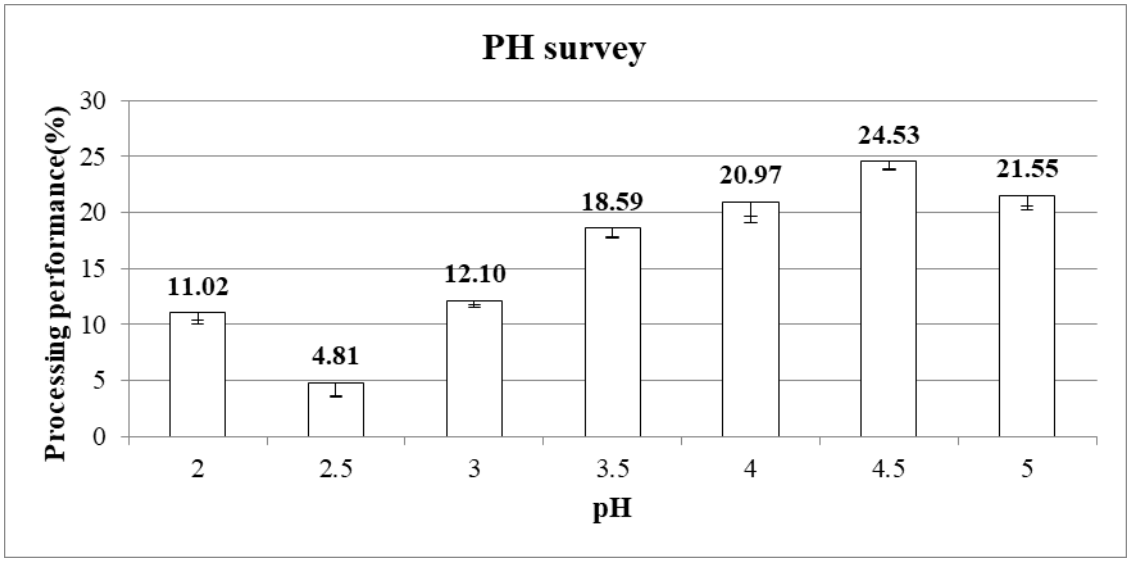

Figure 1. Result of determining the effect of pH on Zn^{2+} treatment efficiency of H_3PO_4 activated carbon

Research results on the adsorption capacity of Zn^{2+} from the research materials showed that the pH range ranged from 2 -5; processing efficiency is not high, respectively 11.02%; 4.81%; 12.10%. When the pH ranges from 4 to 5, the processing efficiency is high; the highest treatment efficiency is 24.53% at about pH = 4.5.

Research results show that activated carbon with H_3PO_4 activating agent is capable of adsorption. Compared to the research results of activated carbon from Ceiba's Pentiba hull MadhavaRao, Chandra Rao, Seshaiah, Choudary, Wang, (2008) which removed 99.1%, activated carbon with H_3PO_4 activating agent has lower Zn^{2+} adsorption capacity. However, compared with the results saccharomyces cerevisiae fermentation research of Nguyen Thi Ha, Tran Thi Hong, Nguyen Thi Thanh Nhan, Do Thi Cam Van, Le Thi Thu Yen, (2007) with an efficiency of 21%, the efficiency of the research material is 24.53% higher.

Research results show that activated carbon with H_3PO_4 activating agent has the best ability to adsorb Zn^{2+} at about pH = 4.5. However, additional dose and time factors must be investigated to increase the material's ability to process Zn^{2+}

3.2. Investigate the appropriate dosage that affects the activation process

Research results on Zn^{2+} adsorption capacity from activated carbon with H_3PO_4 activating agent showed that Zn^{2+} metal processing performance changed with

increasing dose of processed coal. Especially when the dosage is 0.2 g/l; with a processing efficiency of 22.59%. The highest processing efficiency is 65.56% with a dosage of 1.8g /l.

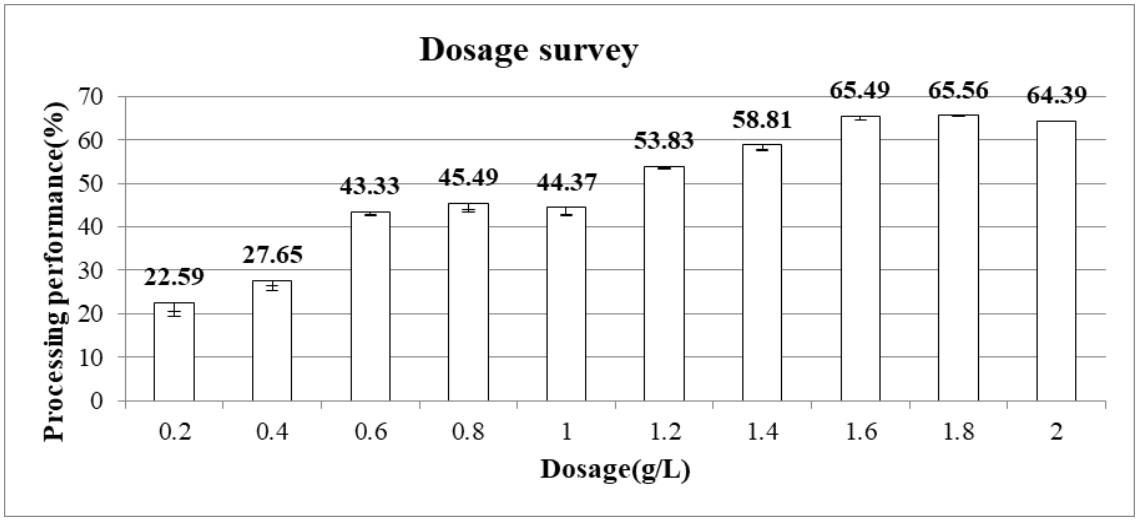

Figure 2. Result of determining the effect of dosage on Zn^{2+} treatment efficiency of H_3PO_4 activated carbon

As a result of this study, Zn^{2+} metal processing efficiency is higher than other research results, results of Saccharomyces cerevisiae fermentation Nguyen Thi Ha, Tran Thi Hong, Nguyen Thi Thanh Nhan, Do Thi Cam Van, Le Thi Thu Yen, (2007) with an efficiency of 21%, the research results are quite good. However, it is still lower than the research result of activated carbon from Ceiba's pentiba hull of M. MadhavaRao, G.P. Chandra Rao, K. Seshaiah, N.V. Choudary, M.C. Wang, (2008) with an efficiency of 99.1%.

The results of the study showed that activated carbon with H_3PO_4 activating agent has adsorption capacity, capable of handling Zn^{2+} at the best dose of 1.8g/l. However, more time must be investigated to increase the material's ability to process Zn^{2+}.

3.3 Survey of the appropriate time affecting activation

Research results on Zn^{2+} adsorption capacity from activated carbon with H_3PO_4 activating agent showed that low processing time ranged from 0 - 40 minutes, with efficiency from 49.65% - 54.29% . According to the research results, high processing performance ranges from 60 minutes to 120 minutes with processing efficiency ranging from 65.92% - 67.41%, when the time is 120 minutes, the processing efficiency the highest is 67.41%.

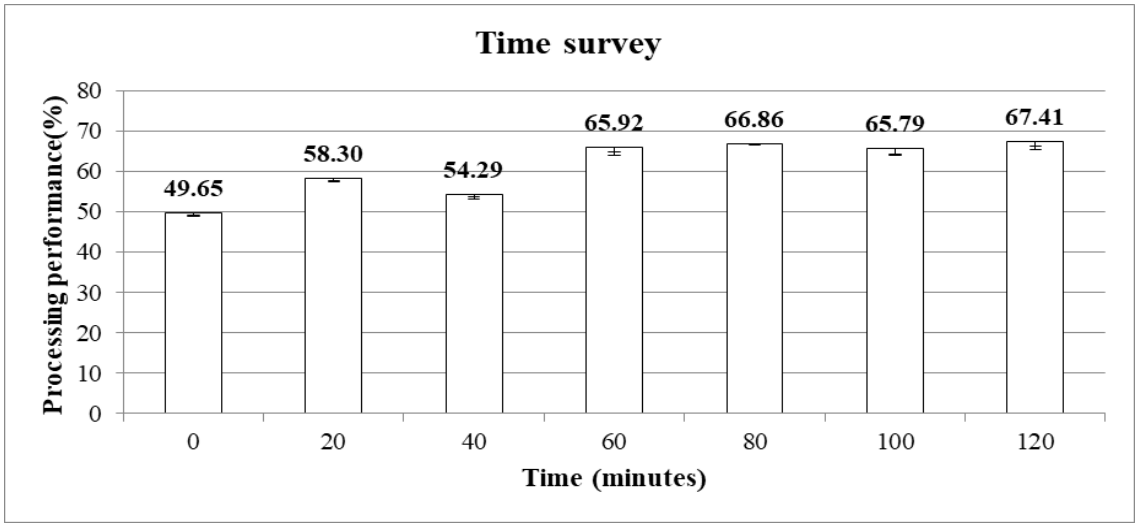

Figure 3. Results determine the effect of time on Zn processing performance of activated carbon H_3PO_4

The results of this study showed that the efficiency of treating Zn^{2+} metal was higher than that of Saccharomyces cerevisiae of Nguyen Thi Ha, Tran Thi Hong, Nguyen Thi Thanh Nhan, Do Thi Cam Van, Le Thi Thu Yen, (2007) with an efficiency of 21%. However, when compared with other research results; Research results of activated carbon from Ceiba's pentiba hull of MadhavaRao, Chandra Rao, Seshaiah, Choudary, Wang, (2008) with an efficiency of 99.1%, the research results of adsorption capacity of Zn^{2+} from activated carbon with activating agent H_3PO_4 is still lower.

The results of the study showed that activated carbon with H_3PO_4 activating agent has adsorption capacity, capable of handling Zn^{2+} best at a time of 120 minutes with a processing efficiency of 67.41%. However, additional heavy metals should be investigated to find the optimal treatment performance of activated carbon with H_3PO_4 activating agent.

4. Conclude

The results of the study show that the bioactive coal material successfully prepared from agricultural residues is macadamia shell by chemical method using H_3PO_4 activating agent with optimal activation conditions such as ratio 1: 1: 10ml, temperature 650^0C for 60 minutes. The results of the study showed that activated carbon with H_3PO_4 activating agent has the ability to adsorb, has the best ability to handle Zn^{2+} at pH = 4.5, dose 1.8g/l and 120 minutes duration. Achieve treatment efficiency of 67.41% for wastewater containing heavy metals Zn^{2+}. However, additional heavy metals should be investigated

to find the optimal treatment performance of activated carbon with H_3PO_4 activating agent..

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