USING LOW-COST AGRICULTURE MATERIAL FOR HEAVY METALS REMOVAL FROM AQUEOUS SOLUTIONS

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By

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Increasing the discharge of heavy metals into water streams is of special concern due to their effects on human health and the environment. Most conventional methods for removing heavy metals from water and waste water became inefficient and extremely expensive. Moreover, these methods have many disadvantages such as incomplete removal of contaminants, high reagent and energy requirements and the generation of toxic sludge/waste products that need further disposal treatments. The aim of this research is to investigate the potential of the agriculture waste materials for heavy metals removal from aqueous solutions as they are low cost, eco-friendly, and available in abundance. To achieve the research objective, the low-cost agriculture waste namely rice husk and sunflower husk are utilized as adsorbents for several heavy metals; copper (Cu), iron (Fe), and zinc (Zn). The research follows experimental approach to investigate the effect of husk particle size distribution, husks weight, contact time, pH, and mixing rate of the removal efficiency on the absorption process. The results are compared to the activated carbon, as the common adsorbent, under the same conditions to test their credibility. According to the experiments, the best parameters values are: Weight =20 g, Mixing rate =150 rpm, Contact time=90 min, pH=6.5 and Particle size= 300 μm for various concentrations. The rice husk achieved high percentages removal than sunflower husk, where it

achieved 90%, 90%, and 86% for copper, iron, and zinc respectively for low concentrations. The absorption percentage decreased with the increase of aqueous solution concentrations. The ability of the unmodified rice husk and sunflower is promised compared with activated carbon. Comparing with other studies, the research experiments conditions provide better results. In general, the rice and sunflower husks prove their ability for heavy metals removal and can be considered as a good solution for water treatment.

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APPROVAL

This thesis was submitted to Senate of Infrastructure University Kuala Lumpur (IUKL) and has been accepted as partial fulfillment of the requirement for the degree of Master of Science in Water Resources. The members of the thesis Examination Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Infrastructure University Kuala Lumpur or at any other institutions.

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TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Overview

Around 97.5% of the total available water on earth is salty and is not usable as such; of the remaining 2.5% of fresh water, only a marginal part, 1%, is available for human consumption. Since the distribution of water across the globe is not regular, parts of world are increasingly facing water scarcity. The origin of water scarcity can be natural in some regions because of reduced rainfall or climate changes. The human factor, however, is most critical in aggravating this problem by wasting water, polluting water resources, and/or in appropriately managing water. The world statistics reveal that the total wastewater combining sewage, industrial, and agricultural discharged globally is tens of millions of cubic meters per day. Sadly, a significant portion of all waste water in developing countries is discharged untreated, resulting in large pollution of rivers and other water bodies (Ranade, and Bhandari, 2014).

The water quality has severely deteriorated globally in last few decades, mainly due to the anthropogenic activities, population growth, unplanned urbanization, rapid industrialization and unskilled utilization of natural water resources (Bhatnagar et al., 2015).

As the result of technological development the growth of industries, is an indicator of increased pollution, and a contamination source of continuous environment degradation including air, water, soil and biosphere. Water pollution is one of the global issues that need urgent and effective solutions for healthy environment. The rapid growth of various industries, such as fertilizer, metal plating, tanneries, mining, and textile industries, has increased the discharge of toxic heavy metals into water streams poses significant problems for both human health and the environment. Dyes, paints, printing, photography, paper, and petroleum refining industries also contribute to the presence of heavy metals in effluents (Lesmana et al., 2009; Anbia

REFERENCES

Abbas, M. N., & Abbas, F. S. (2013).Utilization of Iraqi Rice Husk in the Removal of Heavy Metals from Wastewater. Research Journal of Environmental and Earth Sciences, 5(7), 370-380.

Abdelhafez, A. A., & Li, J. (2016). Removal of Pb (II) from aqueous solution by using biochars derived from sugar cane bagasse and orange peel. Journal of the Taiwan Institute of Chemical Engineers, 61, 367-375.

Abood, M. M., Rajendiran, J., &Azhari, N. N. (2013). Agricultural Waste As Low Cost Adsorbent For The Removal Of Fe (Ii) Ions From Aqueous Solution. Research JournaL, 29.

Aeslina, A. K., Alida, A., & Lee, K. W. (2013). Study on Ferum (Fe) and Zinc (Zn) Removal by using Rice Bran at Sungai Pelepah, Kota Tinggi, Johor.

Ahmaruzzaman, M. (2011).Industrial wastes as low-cost potential adsorbents for the treatment of wastewater laden with heavy metals. Advances in Colloid and Interface Science, 166(1), 36-59.

Ahmed, M. J. K., & Ahmaruzzaman, M. (2016).A review on potential usage of industrial waste materials for binding heavy metal ions from aqueous solutions. Journal of Water Process Engineering, 10, 39-47.

Ahmad Khan, N., Ibrahim, S., &Subramaniam, P. (2004).Elimation of Heavy Metals from Wastewater Using Agricultural Wastes as Adsorbents.Malaysian Journal of Science, 23(1).

AjayKumar, A. V., Darwish, N. A., & Hilal, N. (2009). Study of various parameters in the biosorption of heavy metals on activated sludge. World Applied Sciences Journal, 5(5).

Akar, S. T., Akar, T., Kaynak, Z., Anilan, B., Cabuk, A., Tabak, Ö., ...&Gedikbey, T. (2009). Removal of copper (II) ions from synthetic solution and real wastewater by the combined action of dried Trametesversicolor cells and montmorillonite. Hydrometallurgy, 97(1), 98-104.

Albadarin, A. B., Mo, J., Glocheux, Y., Allen, S., Walker, G., &Mangwandi, C. (2014). Preliminary investigation of mixed adsorbents for the removal of copper and methylene blue from aqueous solutions. Chemical Engineering Journal, 255, 525-534.

Al-Degs, Y. S., El-Barghouthi, M. I., El-Sheikh, A. H., & Walker, G. M. (2008).Effect of solution pH, ionic strength, and temperature on adsorption behavior of reactive dyes on activated carbon.Dyes and pigments, 77(1), 16-23.

Ali, R. M., Hamad, H. A., Hussein, M. M., &Malash, G. F. (2016). Potential of using green adsorbent of heavy metal removal from aqueous solutions: Adsorption kinetics, isotherm, thermodynamic, mechanism and economic analysis. Ecological Engineering, 91, 317-332.

Alyüz, B., & Veli, S. (2009). Kinetics and equilibrium studies for the removal of nickel and zinc from aqueous solutions by ion exchange resins. Journal of Hazardous Materials, 167(1), 482-488.

Anbia, M., Kargosha, K., &Khoshbooei, S. (2015). Heavy metal ions removal from aqueous media by modified magnetic mesoporous silica MCM-48. Chemical Engineering Research and Design, 93, 779-788.

Asamoah, E. (2012). The Impact of Small Scale Gold Mining Activities on the Water Quality of River Birim in the Kibi Traditional Area (Doctoral dissertation).

Babel, S., & Kurniawan, T. A. (2003). Low-cost adsorbents for heavy metals uptake from contaminated water: a review. Journal of hazardous materials, 97(1), 219-243.

Barakat, M. A., & Schmidt, E. (2010).Polymer-enhanced ultrafiltration process for heavy metals removal from industrial wastewater. Desalination, 256(1), 90-93.

Bartczak, P., Norman, M., Klapiszewski, Ł., Karwańska, N., Kawalec, M., Baczyńska, M., ...&Jesionowski, T. (2015). Removal of nickel (II) and lead (II) ions from aqueous solution using peat as a low-cost adsorbent: A kinetic and equilibrium study. Arabian Journal of Chemistry.

Benaissa, H., & Elouchdi, M. A. (2007). Removal of copper ions from aqueous solutions by dried sunflower leaves. Chemical Engineering and Processing: Process Intensification, 46(7), 614-622.

Bernard, E., Jimoh, A., &Odigure, J. O. (2013). Heavy metals removal from industrial wastewater by activated carbon prepared from coconut shell. Res. J. Chem. Sci, 3(8), 3-9.

Bhatnagar, A., Sillanpää, M., &Witek-Krowiak, A. (2015). Agricultural waste peels as versatile biomass for water purification–A review. Chemical Engineering Journal, 270, 244-271.

Bilal, M., Shah, J. A., Ashfaq, T., Gardazi, S. M. H., Tahir, A. A., Pervez, A. & Mahmood, Q. (2013). Waste biomass adsorbents for copper removal from industrial wastewater—A review. Journal of hazardous materials, 263, 322-333.

Bouhamed, F., Elouear, Z., Bouzid, J., &Ouddane, B. (2016).Multi-component adsorption of copper, nickel and zinc from aqueous solutions onto activated carbon prepared from date stones. Environmental Science and Pollution Research, 23(16), 15801-15806.

Cavaco, S. A., Fernandes, S., Quina, M. M., & Ferreira, L. M. (2007). Removal of chromium from electroplating industry effluents by ion exchange resins. Journal of Hazardous Materials, 144(3), 634-638.

Chávez-Guajardo, A. E., Medina-Llamas, J. C., Maqueira, L., Andrade, C. A., Alves, K. G., & de Melo, C. P. (2015). Efficient removal of Cr (VI) and Cu (II) ions from aqueous media by use of polypyrrole/maghemite and polyaniline/maghemite magnetic nanocomposites. Chemical Engineering Journal, 281, 826-836.

Dada, A. O., Olalekan, A. P., Olatunya, A. M., & Dada, O. (2012). Langmuir, Freundlich,

Temkin and Dubinin–Radushkevich isotherms studies of equilibrium sorption of Zn2+ unto

phosphoric acid modified rice husk. Journal of Applied Chemistry, 3(1), 38-45.