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THE INITIAL ION EFFECT OF HEAVY METALS ADSORPTION BY USING HYDROTHERMAL CARBONIZATION BANANA PEELS.

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ABSTRACT

Accumulation of heavy metals in water is of particularly important because it can impact upon human health through possible contamination of food. The use of banana peel was investigated. Hydrothermal carbonization (HTC) was chosen as alternative process. The objective of this project is to synthesize banana peel hydrochars adsorbent via HTC process and to evaluate the heavy metals adsorption performance of banana peel hydrochars adsorbent. Conventional methods in removal of heavy metals require high operational cost, need highly skilled labour, and generate sludge at the end of the operation. Compared to other techniques, banana peel absorbent is a cost-effective adsorbent, easy to operate, environmentally safe and no health risk for the operator. Besides, large quantity of banana peel waste contributes to its significant disposal problem. Thus, this study is expected to solve problems of banana peel, by preparing banana peel adsorbent through hydrothermal carbonization. There are three phases in this project, phase 1 which is synthesis of banana peel based on hydrochars, banana peel was chopped the peels into small pieces. It was then soaked in KOH solution for 2hours and transferred into PTFE and heat for 2hours at 230°C. For phase 2, physico-chemical characterization of banana peels hydrochars by using FTIR. The result obtained shown that all of the content in banana peels will activate the surface of banana peel to enhance the adsorption of the heavy metals. For the final phase, by using AAS, the initial and final concentration of the metals was tested to determine the removal of heavy metals by the prepared hydrochars. The results showed that the removal capacity of the hydrochars increased when the initial concentration of the metals increased. From the research, it can be concluded that, as the initial concentration of the metals higher, the ability of the hydrochars to remove the metals also higher and stronger.

1. INTRODUCTION

The environmental issues due to globalization and rapid industrialization are becoming more and more nuisance for human being. Therefore efficient and effective methods are needed especially for chemical industries. Heavy metals present in wastewater and industrial effluent is major concern of environmental pollution. Heavy metals are generally considered those whose density exceeds 5 g per cubic centimetre. Most of the elements falls into this category are highly water soluble, well-known toxics and carcinogenic agents. [1]

They represent serious threats to the human population and the fauna and flora of the receiving water bodies. They can be absorbed and accumulated in human body and caused serious health effects like cancer, organ damage, nervous system damage, and in extreme cases, death.

Water pollution leads to damage to human health. Disease carrying agents such as bacteria and viruses are carried into the surface and ground water. Drinking water is affected and health hazards result. Direct damage to plants and animals' nutrition also affects human health. Plants nutrients including nitrogen, phosphorus and other substances that support the growth of aquatic plant life could be in excess causing algal gloom and excessive weed growth. This makes water to have odour, taste and sometimes colour. Ultimately, the ecological balance of a body of water is altered. Sulphur dioxide and nitrogen oxides cause algal gloom and excessive weed growth. This makes water to have odour, taste and sometimes colour. Ultimately, the ecological balance of a body of water is altered. Sulphur dioxide and nitrogen oxides cause acid rain which lowers the PH value of soil and emission of carbon dioxide cause ocean acidification, the ongoing decrease in the PH of the Earth's Oceans as CO2 becomes dissolved. [2]

In addressing these concerns, diverse methods of biomass utilization for energy recovery have been found to be economically viable and environmentally friendly. Hydrothermal carbonization (HTC) is a thermochemical conversion technique which is attractive due to its ability to transform wet biomass into energy and chemicals without pre-drying. The solid product, known as hydro char, has received attention because of its ability to prepare precursor of activated carbon in wastewater pollution remediation, soil remediation applications, solid fuels, and other carbonaceous materials. [4] In this study, the use of banana peel was investigated. The initial ion effect for the adsorption was also to determined.

2. MATERIAL AND METHODS

2.1. Synthesis of banana peel based on hydro chars.

Collection of banana peels follow by washing process with distilled water for several times to remove impurities. The cleaned banana peels are chopped into small pieces

(0.5cm-1.0cm), and then are used as the feedstock. The banana peels will be modified KOH solution; where the banana peel pieces are added into the solution and soaked for 2hours. After soaking, the mixture is transferred into PTFE and heated at 230℃ for 2 hours. Next the PTFE is taken out from the furnace and cooled to room temperature. The obtain product is vacuum filtered and washed with distilled water until neutral. Finally, the sample is dried in oven at 80℃ overnight.

2.2. Physico-chemical characterization of banana peel hydro chars.

Characterization of banana peel hydro chars adsorbent by: FTIR-characterize the surface functional group and the carbon structure on the synthesized banana peel hydro chars.

2.3. Evaluation of heavy metals adsorption

The adsorption tests are performed with three common heavy metals including copper(II) and chromium(II) ions. The adsorption experiments and carried out in the Erlenmeyer flasks containing 50mL of aqueous solution of M(II) ions. (M= copper, and chromium) and 0.1 g of the synthesized banana peel hydro chars. The influence of initial M(II) concentration of the solution are investigated. The mixture is mixed thoroughly until obtaining the adsorption equilibrium. The concentrations of heavy metals before and after the adsorption are analysed by atomic absorption spectroscopy (AAS). All experiments are conducted in triplicate and averaged results. Blank samples are run along with.

3. RESULTS AND DISCUSSION

3.1 Atomic absorption spectroscopy(AAS)

At the peak of 3030, it contain alkyl group, hydroxyl, and aromatic ring. All of this content will activate the surface of banana peel to enhance the adsorption of the heavy metals.

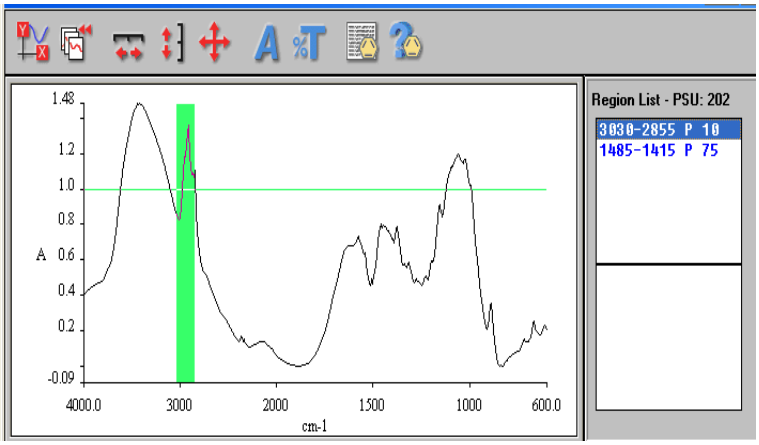

Figure 3. 1

This peak is intended to cover most organic compounds with an alkyl substituent in a molecule containing another major functional group. It is possible, however, that certain aromatic compounds or aliphatic compounds without an alkyl substituent may interfere, especially where hydrogen bonding between hydroxyl or amino group occurs. Also interference can be expected where (paraffin oil) is used in sample preparation.

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Adsorption capacity for the heavy metals

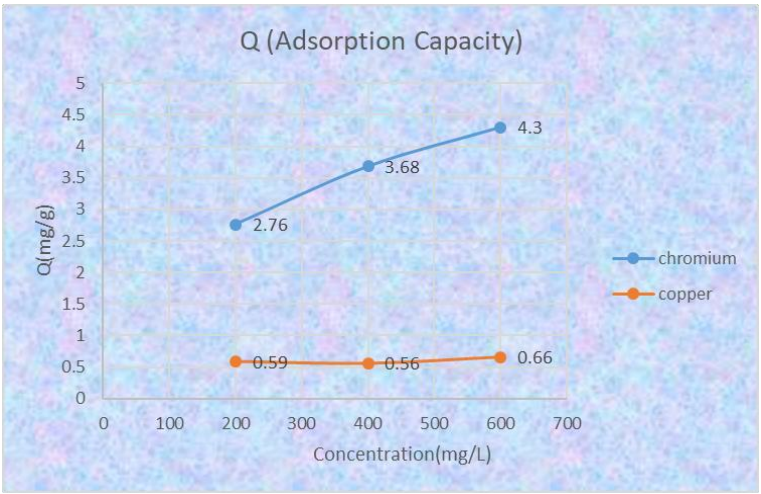

Figure 3. 2

The graph shows the adsorption capacity for the both metals. The result shown that the adsorption capacity for the Chromium is increasing as the initial concentration increased. From this results, it can be concluded that the pre-treatment of potassium hydroxide (KOH) solution during the preparation of banana peels hydrochars increased the strength of the adsorbed amount of heavy metals. This is because KOH solution increases the surface area of the banana peels hydrochar adsorbent. Hence, the adsorbent will adsorb more heavy metals that means more metals were being removed.

Removal Efficiency of Heavy Metals

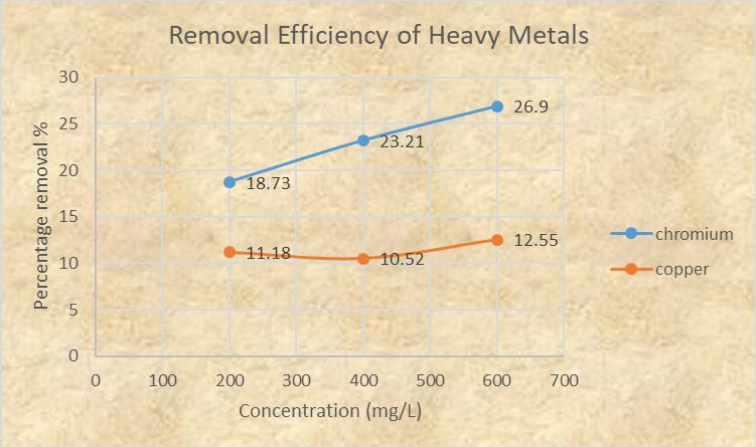

Figure 3. 3

The result show that the removal efficiency of heavy metals was also increasing at the highest concentration. This is because at a higher concentration, the heavy metals were absorbed by the adsorbent which is hydrochars. The highest percentage for Chromium removal was 26.9% while Copper was 12.55%. From the previous case study, the graph should be increase as the initial concentration of the metals increased. [3]

Calculation method

The removal efficiency and the adsorption capacity are calculated as follows:

$$M(II)\ \text{removal}\ (\%) = (Co - Cf)/Co * 100 \qquad (1)$$

Where Co and Cf are the initial and equilibrium M(II) concentrations (ppm) respectively.

$$QF(mg/g)=(Co-Cf)/W*V=(Co-Cf)/dAC \quad (2)$$

Where V(mL) is the volume of the M(II) solution, W(g) is the weight of the adsorbent, dAC (g/L) is the dosage of the hydrochars.

4. Conclusion

From the result that have been obtained, the objective was achieved. The initial ion effect of the heavy metals also affects the removal efficiency. Hence, at a higher concentration, the removal efficiency or adsorption capacity also increased.

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