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Preface

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Abstract

The Faculty of Engineering of Universitas Negeri Semarang, Indonesia organized the 11th EIC. The conference this year, with the theme "Applied Green Technology for Environment Conservation Through Continuous Engineering Innovation," was successfully held on September 22nd, 2022. This year's annual conference was also held digitally through Zoom meeting and streamed on YouTube like in the previous year due to the effects of COVID-19 and government travel limitations.

The Academic Vice Rector of Universitas Negeri Semarang launched the conference and provided a quick overview of the institution. Next, in the plenary session, four keynote speakers from Taiwan, Malaysia, and Indonesia gave their speeches. Each of them spokes for 45 minutes, followed by a 15-minute Q&A period. Each speaker attended the Zoom meeting in order to present their speech. Also, this session was facilitated by knowledgeable and skilled

moderators from the Faculty of Engineering at UNNES. From the beginning of the opening ceremony to the conclusion of the plenary session, more than 900 attendees enthusiastically joined a Zoom meeting.

Following the plenary session, nine Zoom meeting rooms were assigned to the 128 presenters from Indonesia, Malaysia, Thailand, and Taiwan depending on the contents of the manuscript in order to hold a parallel session presentation. A moderator ran the presentation and the Q&A session in each room. Presenters were allotted 10 minutes for their presentation and 5 minutes for questions and answers. All of the presenters and participants in each room had excellent discussions thus increased participants' understanding of the subject delivered. Idea sharing was also promoted through the sessions.

The committee, partner, keynote speakers, presenters, participants, and everyone else who helped make this virtual conference a success were all thanked deeply despite the pandemic circumstances. Without any notable issues, all of the attendees joined in and participated throughout the entire session. The best presenter from each parallel room was named at the conclusion to recognize their tremendous effort in organizing the presentation. All keynote speakers, presenters, and conference attendees received a certificate from the committee following the conference as identification of their involvement.

List of Scientific Committee, Technical Committee are available in this pdf.

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This document is a compilation of the 53 presenters' accepted manuscripts. It presents the findings from research as well as concepts, data, and applications pertaining to green technology theory, design, development, implementation, testing, and evaluation. In this proceeding, various engineering-related subjects are presented. The following areas are where green technology is used:

1) Biodegradable Materials
2) Biomass Conversion
3) Biotechnology and Bioprocess
4) Disaster Resilience Infrastructure
5) Energy Efficiency
6) Energy Management System
7) Environmental Monitoring
8) Green Chemicals
9) Green Construction
10) Green Materials

11) Green Technology in Building
12) Green Technology System
13) Green Transportation
14) Intelligent Control System
15) Natural Disaster Mitigation
16) Renewable and Sustainable Materials
17) Renewable Energy
18) Renewable Resources
19) Sustainability in the Built Environment
20) Sustainable Architecture
21) Waste Treatment

The goal of this proceeding is to contribute to the advancement of green technology. Also, we wish everyone reading this proceedings pleasure and success in expanding an understanding of engineering research. We value everyone's dedication and hard work and anticipate that the conference will be even more successful the following year.

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Effect of Contact Time on The Adsorption Process of Activated Carbon from Banana Peel in Reducing Heavy Metal Cd and Dyes Using a Stirring Tub (Pilot Scale)

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Effect of Contact Time on The Adsorption Process of Activated Carbon from Banana Peel in Reducing Heavy Metal Cd and Dyes Using a Stirring Tub (Pilot Scale)

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Abstract. One of the most successful processes for extracting, recovering, and recycling metals from wastewater is adsorption utilizing natural activated carbon, such as banana peel waste. This is advantageous for a wastewater treatment sector since natural activated carbon is less expensive than conventional activated carbon. The aim of this research is to determine the optimum contact time at removing heavy metals and colour using a stirrer tub (pilot scale). Physically, banana peels would be burned at a high temperature of 300°C, and chemically, they would be activated with a 20% sulfuric acid (H2SO4) solution. A mixing tank with a volume of 30 L and a stirring machine spinning at 200 rpm was employed as a contact point between wastewater and activated carbon. Time variations of 15, 30, 60, 75, and 90 minutes were explored to find the best contact time. The ideal circumstances for 75 minutes obtained a Cd metal removal effectiveness of 98.63% with an adsorption capacity of 0.38 mg/g, according to the findings. At the optimum time of 90 minutes, the kepok banana peel was 97.38% successful in absorbing the color using a stirrer.

1. Introduction

Wastewater is one of the substances that can pollute the environment, one of the factors for increasing pollution is the increasing population and industrial growth to meet human needs. Screen printing wastewater is one of the wastes that can contaminate water, including synthetic dyes and metal ions [1]. Heavy metal waste such as cadmium Cd is used as a catalyst in the process of making dyes in the textile industry which can pollute the environment. Heavy metals if consumed by humans can cause mucosal irritation, damage to the liver and kidneys, and damage to capillaries. In the environment high levels of heavy metals have also damaged marine life [2].

Krendang Village is one place in West Jakarta that manufactures screen printing. Heavy metal-containing synthetic dyes are used in screen printing processes. Environmental pollution may occur from screen printing industry activities that have not been controlled. One of the efficient methods for extracting, recovering, and reusing metals from wastewater is the adsorption method utilizing activated carbon [3].

One of the most widely utilized adsorbents in the adsorption process to remove metals is activated carbon, which has a specific surface area and a strong affinity for metals. However, additional adsorbents with comparable features have been created a new adsorbent with comparable characteristics due to the high cost of preparation. There is therefore room to develop a substitute adsorbent that is both affordable and effective. To remove heavy metals, many researchers have looked into the genesis of low-cost adsorbents from agricultural wastes. Agricultural wastes, including banana peels, have been used in this aspect as bioadsorbents for copper adsorption. Banana peels are an affordable source of biomaterials that are also environmentally beneficial. Indonesia is the largest producer in Asia. Banana plants (Musa paradisiaca) thrive and spread throughout Indonesia. growth is increasing from year to year [4] (Suhartini, 2012). Banana waste in Indonesia reached 8.27 kg per population per year in 1999, according to the Directorate General of Horticulture, and increased to 4,384,384 tons in 2002. The potential for the availability of bananas is quite abundant which also contributes to banana peel waste. Activated carbon can be produced naturally from kepok banana peels from the banana processing industry [5].

The use of kepok banana peels as activated carbon in the reduction of heavy metals in the domestic screen printing business was studied by Delearoza R. [6]. From this research, the effectiveness of heavy metal absorption is 98.13% and in dye absorption is 99.99%. The research was conducted on a laboratory scale. According to Siringgo [7], activated kepok banana peels can remove Cd metal by 88.8% efficiency. In Kusumadewi's study [8], it was demonstrated that banana peel waste could be used as a biosorbent for heavy metal with a very high efficiency (more than 98%) in a small amount (5-15 grams), in a relatively short amount of time (30-60 minutes), and the effluent quality meet the requirement of allowance quality standard, justifying the use of an adsorbent for financial reasons.

The use of banana peel waste as an adsorbent in extracting metals from the wastewater from the screen printing industry on a pilot scale will be performed in this study as a continuation of Delaroza's research [6] utilizing a stirrer. The effectiveness of using banana peels to remove heavy metals on a pilot scale or under real-world circumstances in the screen printing industry needs to be studied.

2. Methodology

The stages of labor in this study were divided into three main categories: preparation, adsorption, adsorption kinetics calculation, and reaction order.

2.1 Preparation of Making Adsorbent from Banana Peel

The first step in the preparation process is to make an adsorbent from banana peels. Banana peels can be purchased from fried banana sellers and markets. After being cleaned with distilled water, the banana peel was rinsed under running water. To get rid of dirt, banana peels should be washed in clean water. To reduce the amount of water adhering to the banana peel, the banana peel is washed, cut into small pieces, and dried in the sun for five days. The banana peels were dried for 5 days before being fired for 30 minutes at 300 degrees Celsius to make charcoal. The banana peels were roughly chopped and sieved through a sieve with a mesh size of 100. A desiccator is used to store crushed charcoal. H2SO4 solution with a concentration of 20% was used to activate the carbonized banana peel adsorbent. The proportion of active adsorbate and adsorbent is 2 milliliters/gram. This comparison is based on previous research by Miranti [9], which found that the use of activated charcoal in a 2:1 ratio in the activation process resulted in a substantial increase in surface area. The adsorbent is activated by soaking banana peels in H2SO4 solution for 24 hours. After being cleaned with distilled water, the activated carbon was dried for two hours at 110°C in the oven.

2.2 Preparation of Manufacture of stirred tank reactor for Adsorbent stirred tank reactor

The stirred tank reactor is made of a finished drum which is attached to the top of the stirring rod and the stirrer machine is installed which can be adjusted in speed. The manufacture of the stirred tank reactor begins with planning the design of the equipment such as the height of the tub, the diameter of the tub, and the width and height of the paddle. The tool is made using a plastic- based barrel with a height of 94 cm and a diameter of 40 cm. According to Reynold & Richard [10] the dimensions of the paddle are 50-80% of the width of the tub, while the width is 1/6 - 1/10 of the diameter of the paddle. By referring to the design criteria, a paddle dimension design was made with a height of 5.3 cm and a width of 28 cm. From the tub, it is planned that an outlet with a height of 25 cm for water discharge after processing is installed with a valve that can be opened and closed. Design drawings can be seen in Figure 1.

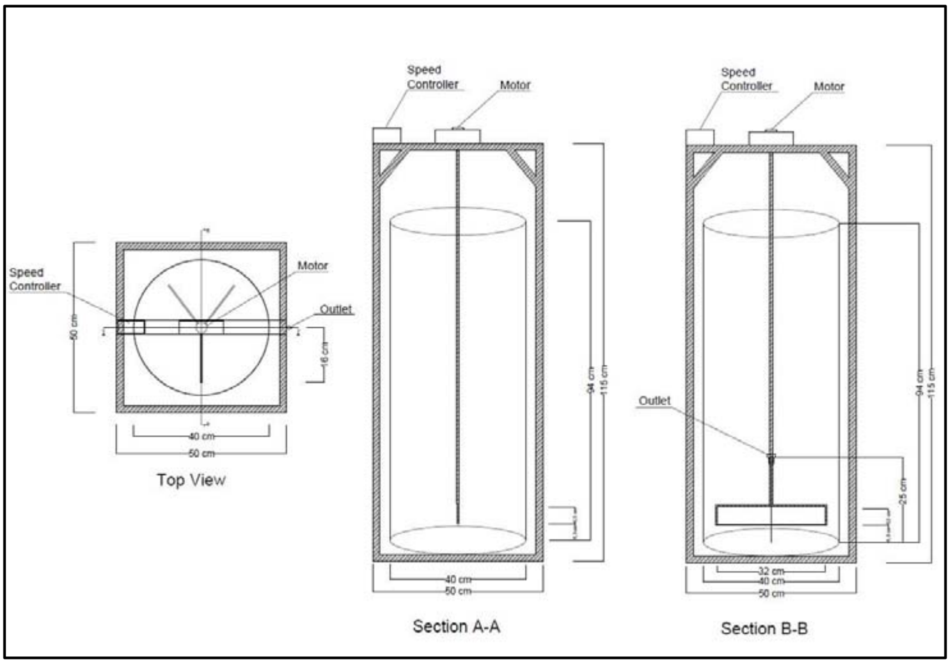


Figure 1. Stirred reactor design drawing

2.3 Characteristics of Screened Wastewater.

Water sample preparation is the first step in the water characteristics stage. The screen printing wastewater sample was accommodated in a 50 mL Erlenmeyer then transferred to a 250 mL Erlenmeyer. Then 5 mL of concentrated HNO3 was added, and everything was mixed together. Boil the sample with a heater until it is reduced to about 10-15 mL. At a wavelength of 228.8 nm, heavy metal content of Cd was also examined using an Atomic Adsorption Spectrophotometer. Table 1 contains the findings from the examination of the metal concentration in wastewater from screen printing.

Table 1. Screen Printing Wastewater Characterization

Heavy Metal	Concentration mg/L
(Zn)	0.8000
(Cu)	0.3203
(Cr)	0.0117
(Cd)	1.5430
(Ni)	0.5148
(Pb)	0.0053

2.4 Langmuir Isotherm.

Langmuirr isotherm occurs because the adsorbent has a homogeneous surface so that the energy produced can bind heavy metals constant in all directions [11].

The mathematical equation for the Langmuir isotherm is:

$$\frac{1}{x/m} = \frac{1}{b} + \frac{1}{abc} \quad (1)$$

Information:
x/m = amount of adsorbate adsorbed per unit weight of adsorbent (mg/g)
a = constant that rises as size grows
b = amount absorbed to form intact layer (mg/g)
c = the concentration of the substance in solution following adsorption (mg/L).

2.5 Freundlich Isotherm.

According to the Freundlich equation, adsorption takes place in several layers on the surface of the adsorbent and becomes faster as concentration rises [12]. According to Tchobanoglous [13], the derivation of the formula for the Freundlich isotherm is as follows:

$$\log\frac{x}{m} = \log K_f + \frac{1}{n}\log C_e^2 \quad (2)$$

Information:
x/m = amount of adsorbate that is absorbed per gram of adsorbent
Ce = Adsorbate solution equilibrium concentration following adsorption (mg/L)
Kf = empirical constant

2.6 Adsorption kinetics

A linear regression approach to the equations of zero order, first order, second order, and third order can be used to determine the adsorption kinetics [14]. A reaction that only depends on one ingredient or is proportionate to one of the reactants is referred to as a first order reaction. The following is the first order linear equation [15].

$$\text{Ln}\,(q_e - q_t) = \text{Ln}\,q_e - K1.t \quad (3)$$

Information:
q_e = Number of metal ions adsorbed at equilibrium (mg/g)
q_t = Number of metal ions absorbed at time t (mg/g)
t = time (minutes)
K_1 = reaction rate constant (minute^{-1})

A second order reaction is a reaction whose speed is directly proportional to the square of the concentration of one of the reactants. The second order linear equation is as follows:

$$\frac{t}{qt} = \frac{1}{K_2 q_e^2} + \frac{t}{qe} \quad (4)$$

Information:

q_e = Number of metal ions adsorbed at equilibrium (mg/g)
q_t = Number of metal ions absorbed at time t (mg/g)
t = time (minutes)
K_2 = Reaction rate constant (g.mg^{-1}.min^{-1})

3. Result and Discussion

3.1 Effect of Contact Time on Removal of Heavy Metal Cd & Dyes Using Banana Peel Adsorbent

Determination of contact time aims to obtain the optimum time to adsorb heavy metals and colors. In this study, 5 time variations were used, namely 15 minutes, 30 minutes, 60 minutes, 75 minutes and 90 minutes, which were taken from previous studies. Relationship of adsorbent contact time to percent removal of heavy metal Cd can be seen in Figure 2.

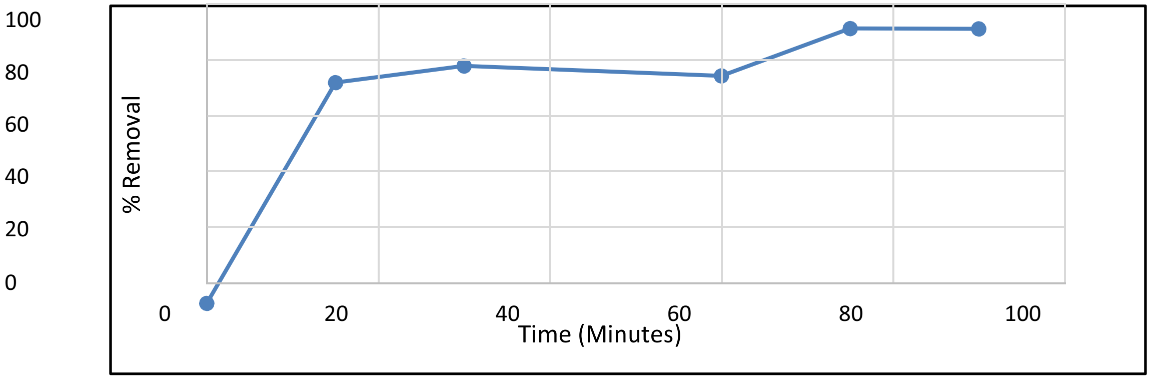


Figure 2. Relationship of Adsorbent Contact Time to Percent Removal of Heavy Metal Cd

The best conditions for metal removal in the pilot scale experiment were 75 minutes, a metal removal percentage of 98.63%, and an adsorption capacity of 380.45 mg/g with a final concentration of 0.0212 mg/g. contact between metal ions and the adsorbent that causes metal ions to adhere to the surface of the adsorbent [16]. The removal efficiency of cadmium metal and adsorption capacity both increase with the amount of time the adsorbent and adsorbate are in contact. The efficiency and adsorption capacity of the adsorbent will, however, decline after it has reached the point at which it should be removed. This is owing to the fact that the desorption process might be triggered by contact times between the adsorbent and adsorbate that are longer than the ideal contact times. If the pilot scale concentration of effluent is directly discharged into water bodies, the quality criteria has been met. The maximum level of cadmium metal (Cd) was 0.08 mg/g, while the initial concentration of Cd metal in the pilot scale investigation was 1.543 mg/g after processing to 0.0212 mg/g. Figure 3 shows the relationship between adsorbent contact time and the percentage of dyes removed.

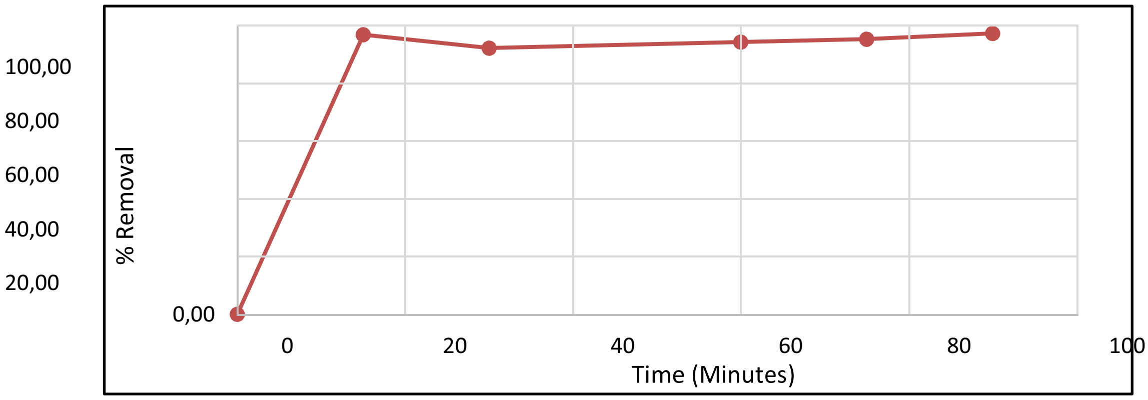
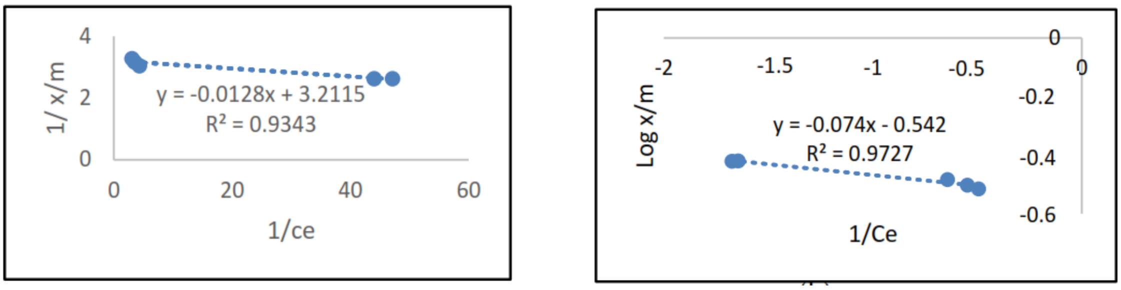


Figure 3. Relationship of Adsorbent Contact Time to Percent Removal of dyes

In the pilot-scale experiment, the ideal contact period was 90 minutes, with a 97.38% efficiency and a 0.092 mg/g adsorption capacity, and a 1.174 PtCo final concentration. The physical shape of the waste after processing by swirling and adding adsorbent from banana peels, which were originally hazy and the color became clearer, can show a decrease in dyestuff.

3.2 Adsorption isotherm

Graph of the Langmuir isotherm and the Freundlich isotherm at a speed of 200 rpm on the pilot scale is shown in Figure 4.



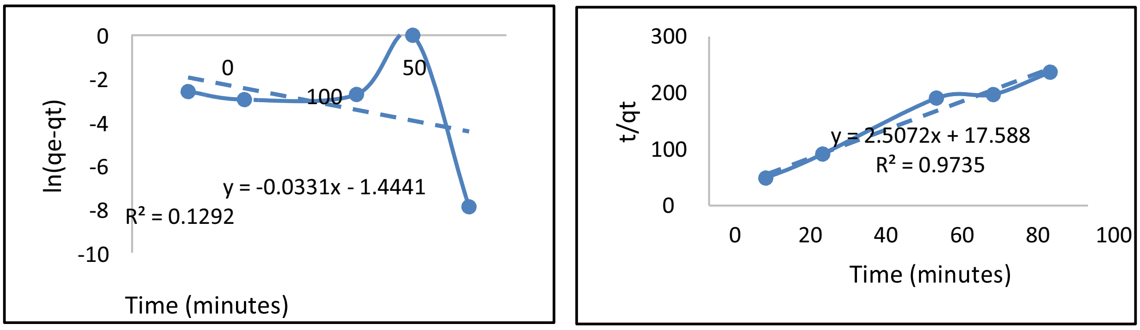
(a) (b)

Figure 4. (a) Langmuir Isotherm, (b) Freundlich Isotherm

Figure 4 displays the outcomes of a pilot-scale experiment using the Langmuir isotherm at a stirring speed of 200 rpm, with the equation of the curve y = -0.0128 + 3.2115 and a regression coefficient (R2) of 0.9343. While the Freundlich isotherm's results display the curve's results, y = -0.074 - 0.542 with an R2 regression coefficient of 0.9727, Freundlich adsorption is a type of physical adsorption in which the adsorbent's surface is the only place where absorption takes place. In addition, the Freundlich isotherm construction uses the equilibrium constant (Kf) as a measure of adsorption capability. A multilayer arises in the Freundlich isotherm, with the layer becoming thicker at higher pollutant concentrations. The amount of metal molecules that interact and collide with the adsorbent increases with the concentration of the metal solution, increasing the adsorption capacity [17].

3.3 Adsorption kinetics

Figure 5 is a graph of order 1 and order 2 kinetics at a speed of 200 rpm on a pilot scale.



(a) (b)

Figure 5. (a) Pseuedo 1, (b) Pseuedo 2

Figure 5 demonstrates that order 2 is followed by the stirring speed that results in the best contact time of 75 minutes. The highest linear regression value is used to determine the order of each adsorption kinetic, which implies that the higher the linear regression value, the more linear the curve based on each order's linear regression equation will be. easy to accomplish This work demonstrated the second order adsorption kinetics using kepok banana peel as the adsorbent. Conclusion: The sample contains less Cd metal the faster it is operated, the longer the contact duration, and the larger the constant value.

4. Conclusion

According to the research, kepok banana peel can effectively absorb the heavy metal Cd using a stirrer at an ideal contact time of 75 minutes, at a rate of 98.63%, with an adsorption capacity of 0.38 mg/g, and can effectively absorb the dye at an ideal contact time of 90 minutes, at a rate of 97.38%. The Freundlich isotherm was followed by the isotherm method selected to remove heavy metal Cd by the adsorbent of kepok banana peel using a stirrer (pilot scale), with an R2 value of 0.9727, a n value of 12.8 and a kf value of 26.29. The chosen kinetics model has an R2 value of 0.9735 and an absorption rate of 0.398851 g.mg-1.minute-1 while removing heavy metal Cd utilizing a stirrer and kepok banana peel as the adsorbent (pilot scale).

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