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STUDY ON ADSORPTION CAPACITY OF CORN STALKS IN DECREASING THE TURBIDITY OF BABURA RIVER WATER WITH BATCH OPERATION

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Abstract

The adsorbent is a solid substance that can absorb certain components from the liquid phase. Most of the adsorbents are porous materials and the adsorption process takes place, especially in the porous wall or certain location inside that particle. The main objective of this research is to study the influence of the adsorbent's surface area based on shape variation from corn stalk with adsorption ability to reduce the water river's turbidity, the influence of time with adsorption capacity in reducing river water's turbidity, the influence of adsorbent with water river and adsorption capacity, and defining adsorption kinetics from corn stalks. The shape of corn stalks that have been used such as spherical, half of spherical shape, and quarter of spherical shape. The volume of the sample is 250 mL. The measurement time is 300 minutes. The mass variations that have been used are 10 g, 15 g, and 20 g. The variation of sample takeover in the morning, afternoon, and evening. The measurement of adsorbent adsorption capacity in term of decreasing the turbidity of Babura River's water is done by inputting the adsorbent into the sample, then the measurement of the water's turbidity proceed by using a turbidity meter. The analysis result for the influence of the adsorbent's surface area in decreasing Babura River's water in the shape's variation from spherical, half of spherical shape, and quarter of spherical shape is obtained in quarter of spherical shape. The highest amount of adsorbent in decreasing the turbidity of Babura River's water is 20 g. Adsorption kinetics that has been used in the measurement of decreasing Babura River's water turbidity is second order kinetics.

Keywords: Adsorbent, Corn Stalks, Adsorption, Babura River, Kinetics, Solid Substance, Particle, Surface Area, Turbidity, River Water.

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1. Introduction

The river is filled with water, including non-biological nature resources, and a water stream network from the water source to the ditch, confined to the right and left of the street, along the streamline by line [1]. Inside the river contains suspended solid substances, usually brown color, which cause a high level of turbidity that contains a high level of pH [2, 3]. One of the resources that are needed by humankind to accompany their daily life is water. One of the water resources that have always been used by Indonesian citizens is river water and clean water. However, according to the Ministry of Environment, in 2014, river water located in 33 provinces in Indonesia was contaminated by 70–75 %. Those water rivers are contaminated because of household waste. To fulfill the clean water consumption of Indonesian citizens, it needs proper technology by advanced level of technical mastery from the city itself [4]. Easy handmade technology with a cheap cost is a simple technology that has been waited by citizens to overcome that issue. There are a few methods that can be used to overcome that water processing, one of them is by using an adsorbent that can fulfill the parameters of water content [5].

The adsorbent is a solid substance that can adsorb certain components from the liquid phase. Usually, adsorbents are made up of very porous materials and adsorption continues, especially in the porous wall [6]. Adsorption is a general procedure that has been widely used because having a simple concept and is quite economical. The one that plays the most role in the adsorption process is called the adsorbent. Few examples of adsorbents that have usually been used are zeolite, corncob, diatomic soil, sand, and active charcoal. The adsorption method has been developed by using plant biomass, which can be called fitofiltration. Fitofiltration is by using dead plant biomass as a metal ion binder [7]. The plant can be used as a natural purifier because the plant is biodegradable and the plant also saves human life because it not contaminating the environment [8].

Adsorption is a process of adsorbing substances, ions, and molecules that are attached to the surface of the adsorbent. Water purifying process and materials purifying process from adsorption, in which colloid particle that has surface area cause a high level of adsorption. Adsorption on the solution surface occurs because of the pull and push force on the surface of the solution [9]. **Table 1** shows the previous research related to adsorption on various water turbidity.

Table 1 is the result of research conducted by several researchers on the adsorption ability of several materials in water purification applications. Based on the results of **Table 1**, there are similarities in the testing tools used, namely based on turbidity. In natural adsorption studies, turbidity may be an appropriate parameter [12, 13]. In addition, these studies in **Table 1** used activated carbon as the adsorbent. This is considered excessive effort. Corn stalks are rarely used, so it was chosen because of the need to use local potential sources that are around and can add value. **Fig. 1** show the corn stalks that used in this research.

Table 1

Previous research on adsorption and water turbidity

Source	Research result	Reference
Activated Charcoal	Raw water before filtration had a turbidity level was 39.0 NTU, the color 22 TCU, and total dissolved solids (TDS) 796 mg/l to turbidity level 2.02 NTU, the color 18 TCU, and TDS 227 mg/l in the first filtration and turbidity level 7.64 NTU, the color 2 TCU, and TDS 176 mg/l in the second filtration.	[10]
Corn Cob as Activated Carbon	The average turbidity level before treatment was 75 NTU, and after filtration using activated carbon obtained an average turbidity level of 19.84 NTU on a 12 g.	[5]
Shell Activated Carbon Oil Palm	The water turbidity has a turbidity level of 100.04 NTU. After filtering by adding activated charcoal of oil palm shell (*Elaeis guineensis*) 10 cm, there was a decrease in turbidity with an average of 40.04 NTU.	[11]

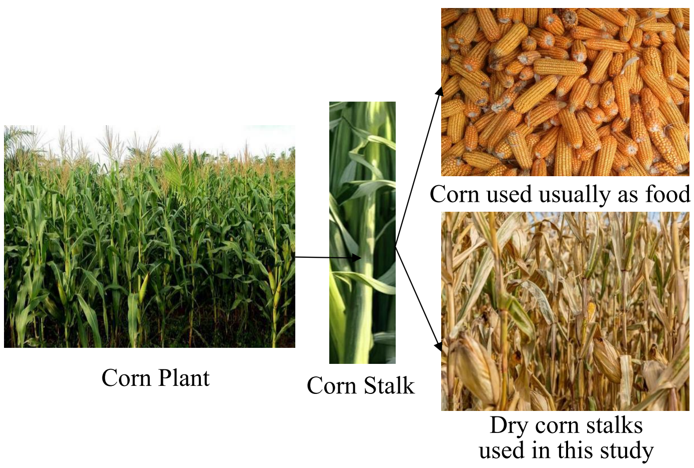


Fig. 1. Corn stalks raw materials for the production of the adsorbent

The Babura river's water sample are taken in the morning, afternoon and evening with its turbidity value. Therefore, the objective of this research is to define the influence of the corn stalks raw materials for the production of the adsorbent in shape and amount comparison to adsorption in decreasing the turbidity along time of Babura river's water. In this research, also provide the kinetic adsorption modeling from corn stalks.

2. Materials and methods

2. 1. Materials

Materials that have been used in this research are corn stalks as raw materials for the production of the adsorbent, obtained from corn farmers in Medan, Indonesia, Babura River's water flow in the Medan section, Turbidity meter (ORION AQ4500) for measuring Babura river's water turbidity and Oven which used in Chemical Engineering Operation Laboratory, Universitas Sumatera Utara, Medan, Indonesia, Scanning Electron Microscope-Energy Dispersive X-Ray (SEM-EDX) for analyzing adsorbent surface which interacting with dirt in Babura river water that located in Politeknik Negeri Batam, Batam, Indonesia.

2. 2. Sampling of Babura River's Water

Babura River's water has taken 5 liters in the morning (09:00 AM), afternoon (13:00 PM), and evening (17:00 PM) conditions. All times used are based on Western Indonesian Time (GMT+7). Water that wants to be analyzed is brought to Chemical Engineering Operation Laboratory, Universitas Sumatera Utara, Medan, Indonesia. Measure the initiated turbidity level of the Babura river's water every 20 minutes for 300 minutes. The research is conducted in the laboratory at ambient temperature and standard pressure. Babura river's water was then contained in the bottle and stored at a temperature ±2 °C for analysis using adsorbent.

2. 3. Corn stalks as adsorbent preparation

Corn stalks are cleaned from dirt and other components, such as leaves or roots that are attached to the stalks. Then, corn stalks are washed with clean water and cut with shape variation of spherical, half spherical, and quarter spherical with a thickness of 0.3 cm and diameter of 1–2 cm. Then, it dried in the oven at 55 °C until a constant amount of mass (achieve 3 weight measurements of at least constant weight).

2. 4. Adsorption process

The Adsorption process has been done by batch process. First, Babura river's water in 100 mL is poured into the Erlenmeyer flask. Then, the corn stalks with shape variation (spherical, half spherical, and quarter spherical) and mass variation of 10 g, 15 g, and 20 g are added into the erlenmeyer flask. A net is attached to entangle the adsorbent. This prevents the adsorbent from floating. Finally, the turbidity level was measured by taking 5 mL samples every 20 minutes for 300 minutes. The whole scheme of batch adsorption using different shapes is shown in **Fig. 2.**

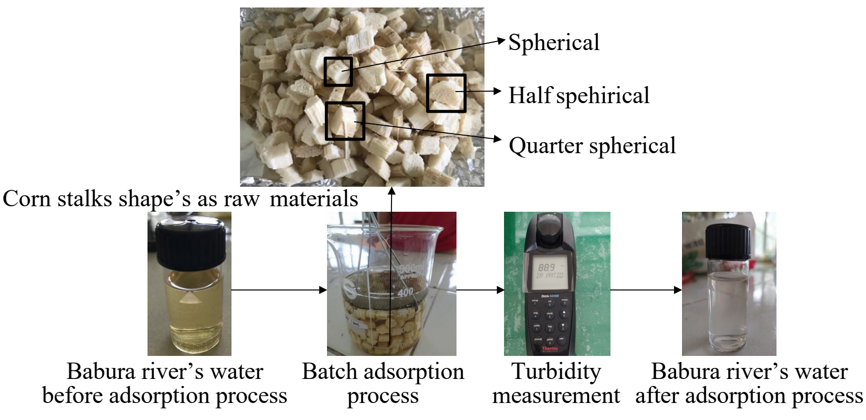


Fig. 2. Batch adsorption scheme using different shapes of adsorption of Babura river's water

Use Scanning Electron Microscopy and Energy Dispersive X-Ray (SEM-EDX) to analyze the adsorbent.

3. Results and discussion

3. 1. Defining initial water river turbidity in the morning, afternoon, and evening

The process of defining initial water turbidity is executed to know the Babura water river's turbidity level before it has been adsorbed by using an adsorbent. The process of measuring the initial Babura River's water turbidity level executed when river water sampling in the morning, afternoon, and evening is shown in **Fig. 3**.

Based on **Fig. 3**, the highest turbidity of the Babura River water is reached in the morning. Turbidity describes the clarity of water based on optical properties as a parameter for Babura River water to lose transparency. Water turbidity is influenced by river activities through suspended solids. Water turbidity is caused by various types of dissolved and suspended substances such as silt, tripton, organic and other mineral compounds [14].

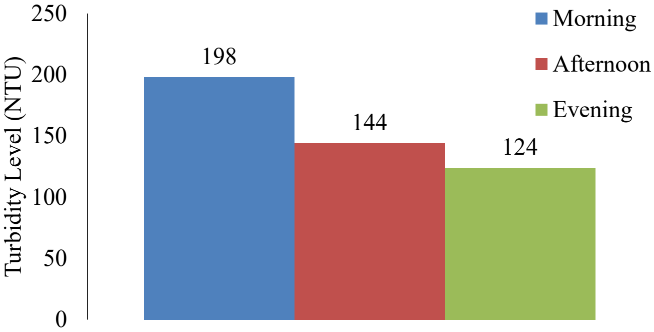


Fig. 3. Initial Babura River's Water Turbidity Level in the Morning, Afternoon, and Evening

3. 2. The influence of the corn stalks adsorbent on river water's turbidity

Surface area is one of the factors that affect the adsorption process. The surface area of the adsorbent is defined by particle size and the amount of the adsorbent [15]. Surface area is inversely proportional to the size of the particle. Therefore, the surface area will increase along with the decrease in particle size [16]. Many substances that have been adsorbed are inversely proportional to the size of the particle. The more substance is adsorbed, the less of the particle's size [17]. This research uses corn stalks as one of its materials with shape variation of spherical, half spherical, and quarter spherical and also the variation in adsorbent's mass, which are 10 g, 15 g, and 20 g. The result of the adsorbent surface area can be seen in **Table 2**.

Based on **Table 2**, it can be concluded that the increasing mass of the adsorbent will affect the adsorbent's surface area. Therefore, the highest adsorbent surface area is achieved by 20 g in every shape variation. Turbidity results over time with 20 g adsorbent mass with every adsorbent shape with the Babura river's water samples taken in the morning shown in **Fig. 4**.

Table 2

Corn stalks adsorbent's surface area with the variation in mass and adsorbent's shape

Adsorbent Shape	Adsorbent Mass (g)	Adsorbent Surface Area (cm^2)
	10	429.4
Spherical	15	644.1
	20	858.8
	10	581.522
Half Spherical	15	872.328
	20	1,162.952
	10	915.952
Quarter Spherical	15	1,373.928
	20	1,831.904

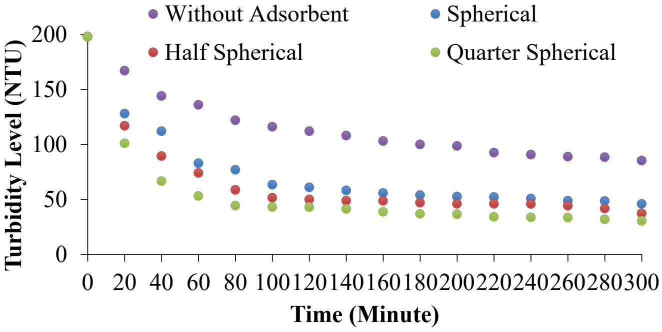


Fig. 4. Turbidity results along time with the mass of adsorbent for 20 g and river water's sample in the morning

Fig. 4 is the relation result between turbidity and time in various adsorbent shapes with the adsorbent mass of 20 g, which is the sampling time of river water in the morning. Although there is a significant difference in the variation of the adsorbent's shape with treatment without adsorbent, it can be seen from the **Fig. 4** that along time for 300 minutes, the turbidity becomes 45.9 NTU in spherical shape, 37.2 NTU in half spherical and 30.4 NTU for quarter spherical.

Fig. 5 shows the relation between turbidity and time in various adsorbent shapes and the adsorbent mass of 20 g, which is the sampling time of river water in the afternoon. There is a significant difference in the variation of the adsorbent's shape with treatment without adsorbent, it can be seen from the graphic above that along time for 300 minutes, the turbidity becomes 30.2 NTU in spherical shape, 27.1 NTU in half-spherical and 19.3 NTU for quarter spherical.

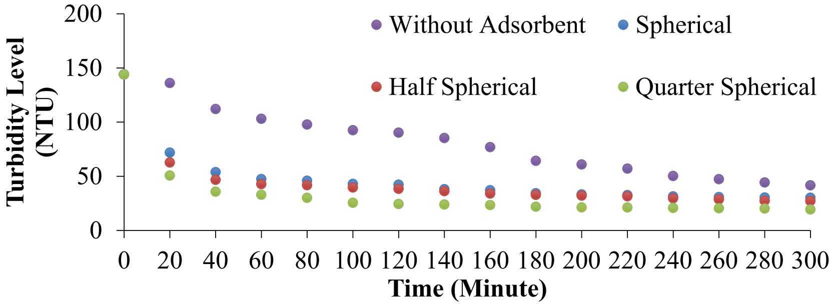


Fig. 5. Turbidity results along time with the mass of adsorbent for 20 g and river water's sample in the afternoon

Fig. 6 shows the relation between turbidity and time in various shapes of adsorbents and the mass of adsorbent of 20 g, which the sampling time of river water in the evening. There is a significant difference in the variation of the adsorbent's shape with treatment without adsorbent, it can be seen from the graphic above that along time for 300 minutes, the turbidity becomes 37.8 NTU in spherical shape, 20.1 NTU in half spherical and 16.7 NTU for quarter spherical.

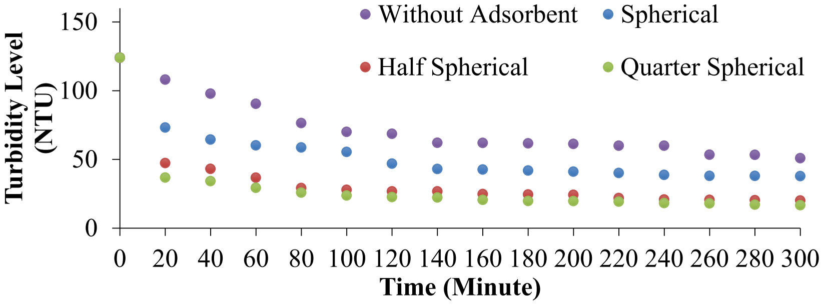


Fig. 6. Turbidity results along time with the mass of adsorbent for 20 g and river water's sample in the evening

Based on **Fig. 4–6**, the turbidity results decrease with time. These are due to the adsorption process of the corn stalks as adsorbent material can effectively adsorb the particles responsible for turbidity, remove them from the water and reduce the turbidity levels [18].

3. 3. The influence of adsorbent's amount comparison to adsorption ability in decreasing the turbidity of river water

Determining the adsorbent's weight needs to be executed to know if adding weight can increase adsorbing capacity from adsorbent to pigment. Substances that are adsorbed are increased along with the rise of the adsorbent's weight. These phenomena occur because with the addition of the adsorbent's amount, then there is an addition of active side that can be found on the surface of the adsorbent [19].

Fig. 7 shows the relation between turbidity and time in the variation of the adsorbent's mass and the shape of the adsorbent is quarter spherical for the sampling time of river water is in the morning. Although there is a significant difference in the variation of the adsorbent's shape with treatment without adsorbent, it can be seen from the graphic above that along time for 300 minutes, the turbidity becomes 34.5 NTU in the adsorbent's mass of 10 g, 32 NTU in the adsorbent's mass of 15 g and 30.4 NTU in the adsorbent's mass of 20 g.

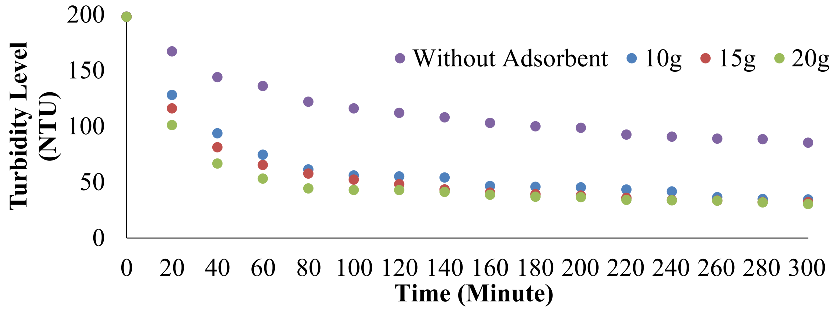


Fig. 7. The turbidity result along time with the variation of adsorbent's mass with quarter spherical as the adsorbent's shape and river water sample in the morning

Fig. 8 is a relation graphic between turbidity and time in the variation of the adsorbent's mass and the shape of the adsorbent is quarter spherical for the sampling time of river water is in the morning. There is a significant difference in the variation of the adsorbent's shape with treatment without adsorbent, it can be seen from the graphic above that along time for 300 minutes, the turbidity becomes 25.4 NTU in the adsorbent's mass of 10 g, 23.2 NTU in the adsorbent's mass of 15 g and 19.3 NTU in the adsorbent's mass of 20 g.

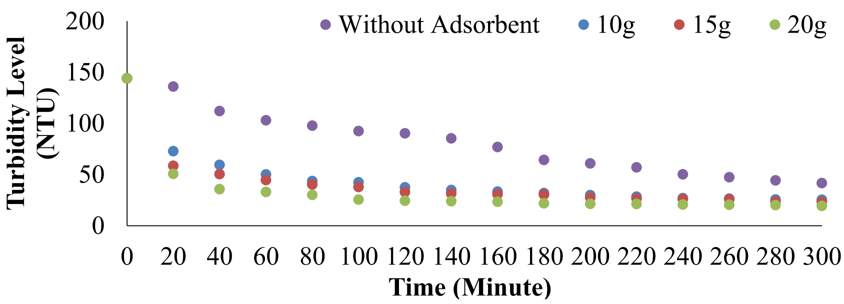


Fig. 8. Turbidity result along time with the variation of adsorbent's mass with quarter spherical as the adsorbent's shape and river water sample in the afternoon

Fig. 9 is a relation graphic between turbidity and time in the variation of the adsorbent's mass and the shape of the adsorbent is quarter spherical for the sampling time of river water is in the morning. There is a significant difference in the variation of the adsorbent's shape with treatment without adsorbent, it can be seen from the graphic above that along time for 300 minutes, the turbidity becomes 19.1 NTU in the adsorbent's mass of 10 g, 17.6 NTU in the adsorbent's mass of 15 g and 16.7 NTU in the adsorbent's mass of 20 g.

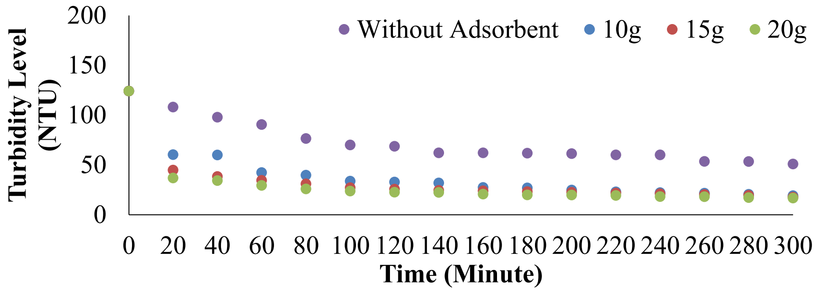


Fig. 9. Turbidity result along time with the variation of adsorbent's mass with quarter spherical as the adsorbent's shape and river water sample in the evening

3. 4. The determination of adsorption kinetics modelling

Adsorption kinetics is one of many aspects which usually been researched to evaluate the characteristic of adsorbents that have been used, especially in environmental rehabilitation [20]. Many other models from various complexity have been developed to predict the rate of adsorbate's adsorption to adsorbent [21]. The study of adsorption kinetics pictures how the rate of solute adsorption and this rate controls the contact time of adsorbate on the solution's interface. This is the most important rate when designing an adsorption system and this rate can be calculated from a kinetics study [22]. The characteristic of the adsorbent's adsorbing ability to adsorbate can be seen from its rate of adsorption. The rate of adsorption can be obtained from the rate of adsorption constants (*k*) and reaction order produced from an adsorption kinetics model. The testing phase of the adsorption rate can be executed by assuming the reaction's order [23]. Adsorption characteristics can be studied with various types of theoretical approaches, which are kinetics model pseudo-first-order and kinetics model pseudo-second order. The kinetics model first-order adsorption rate of the Lagergren plot explains adsorption in the solid-liquid system based on the solid's capacity for adsorbing [24]. The Lagergren kinetics model equation shown in (1). This kinetics model explains the limit of the adsorbate's ability that is adsorbed by the adsorbent who controls the equilibrium time:

$$\log(qe - qt) = \log qe - \frac{k_1}{2.303}t, \quad (1)$$

where qe is the concentration of adsorbate in equilibrium, qt is the concentration in time, k_1 is the adsorption constant rate and t is the adsorption time (minute). The condition for $t=0$, then $qt=0$ and when $t=t$, then $qt=qt$. The value of k_1 can be obtained by making a relation of (qe–qt) and time as shown in **Fig. 10**.

The kinetics model of the second order depends on the ability to adsorb each solid phase. The kinetics model of the second order can be expressed in (2):

$$\frac{t}{qt} = \frac{1}{k_2 qe^2} + \frac{1}{qt}t. \quad (2)$$

Fig. 10 is the result of first order pseudo modeling and **Fig. 11** is the result of second order pseudo modeling that uses a variation of the adsorbent's shape, which is quarter of spherical and the sampling time in Babura's River is in the morning. **Fig. 8** shows the value of the correlation coefficient (R^2) for adsorbent 10 g, $R^2=0.5672$, adsorbent 15 g with $R^2=0.6461$ and adsorbent 20 g with the value of $R^2=0.521$. **Fig. 9** shows the value of the correlation coefficient (R^2) to adsorbent 10 g, $R^2=0.9665$, adsorbent 15 g with $R^2=0.9814$ and adsorbent 20 g with the value of $R^2=0.9859$. These two graphics show that the second order of pseudo modeling causes adsorption data to become more exact. This thing can be seen from the value of the correlation coefficient (R^2) of the second order is higher than the first order.

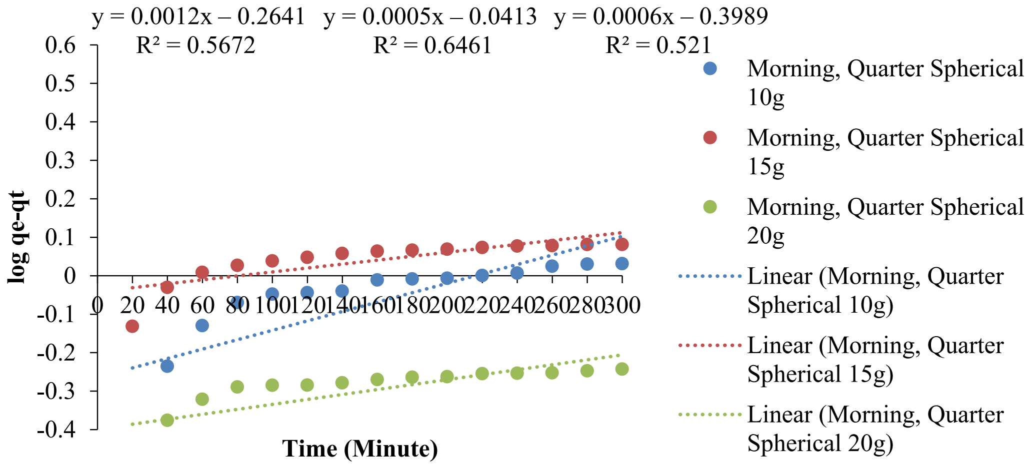


Fig. 10. The modelling of first order pseudo in the variation of adsorbent's mass quarter spherical and river water sample in the morning

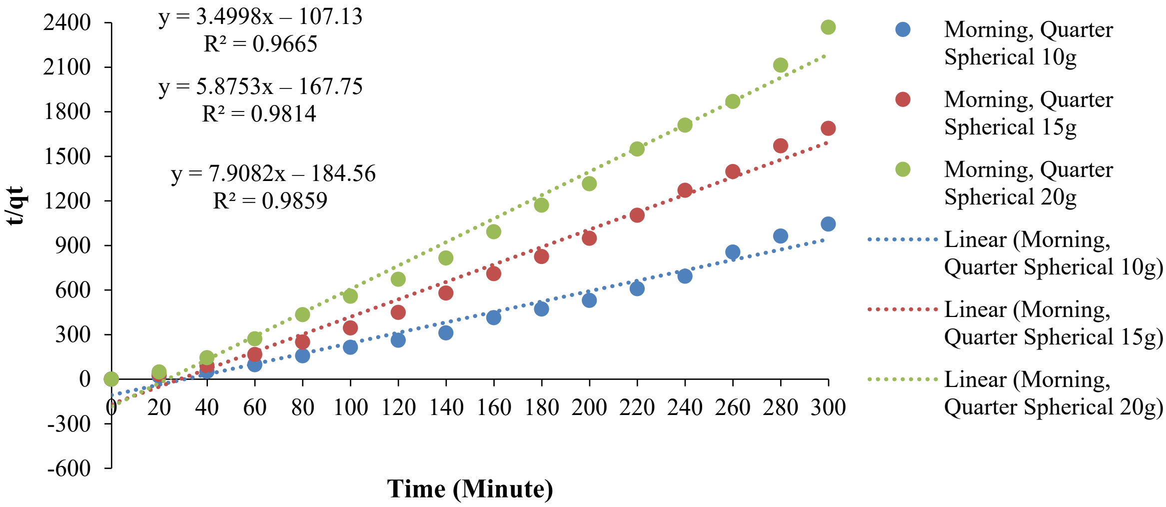


Fig. 11. The modelling of second order pseudo in the variation of adsorbent's mass quarter spherical and river water sample in the morning

Fig. 12 is a graphic of first order pseudo modeling and **Fig. 13** is a graphic of second order pseudo modeling that uses variation of the adsorbent's shape, which is quarter of spherical and the sampling time in Babura's River is in the afternoon. **Fig. 10** shows the value of the correlation coefficient (R^2) to adsorbent 10 g, $R^2 = 0.7364$, in adsorbent 15 g with $R^2 = 0.4433$ and in adsorbent 20 g with the value of $R^2 = 0.6435$. **Fig. 12** shows the value of correlation coefficient (R^2) to adsorbent 10 g, $R^2 = 0.9801$, to adsorbent 15 g with $R^2 = 0.9791$ and adsorbent 20 g with the value of $R^2 = 0.9919$. These two graphics show that the second order of pseudo modeling causes adsorption data to become more exact. This thing can be seen from the value of the correlation coefficient (R^2) of the second order is higher than the first order.

Fig. 14 is the result of first order pseudo modeling and **Fig. 15** is a second order pseudo modeling graphic that uses a variation of the adsorbent's shape, which is quarter of spherical and the sampling time in Babura's River is in the evening. **Fig. 14** shows the value of the correlation coefficient (R^2) to adsorbent 10 g, which is $R^2 = 0.7597$, in adsorbent 15 g with $R^2 = 0.8044$ and adsorbent 20 g with the value of $R^2 = 0.8133$. **Fig. 14** shows the value of the correlation coefficient (R^2) to adsorbent 10 g, $R^2 = 0.9672$, to adsorbent 15 g with $R^2 = 0.9774$ and adsorbent 20 g with the value of $R^2 = 0.9862$. These two graphics show that the second order of pseudo modeling causes adsorption data to become more exact. This thing can be seen from the value of the correlation coefficient (R^2) of the second order is higher than the first order.

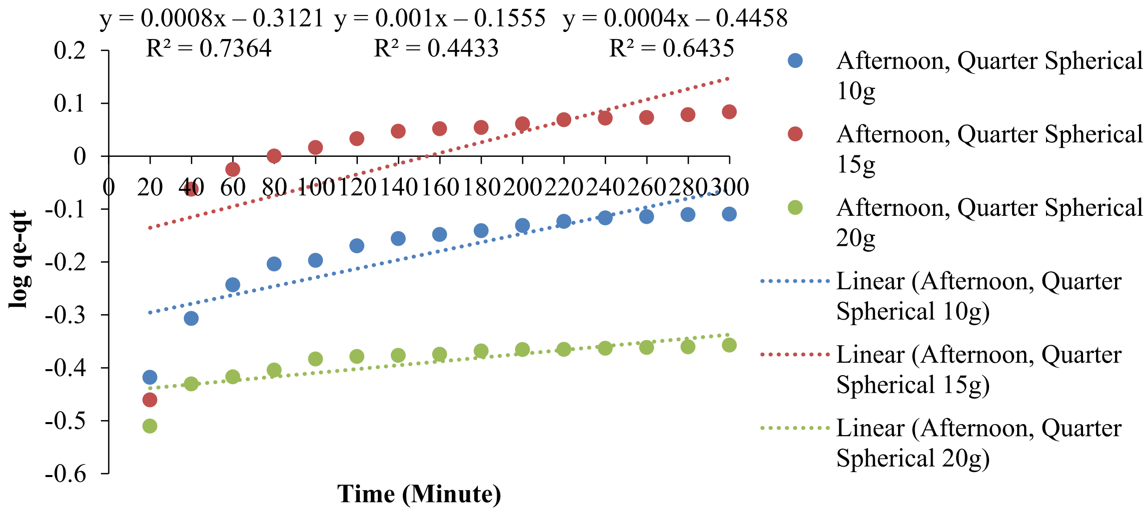


Fig. 12. The modelling of first order pseudo in the variation of adsorbent's mass quarter spherical and river water sample in the afternoon

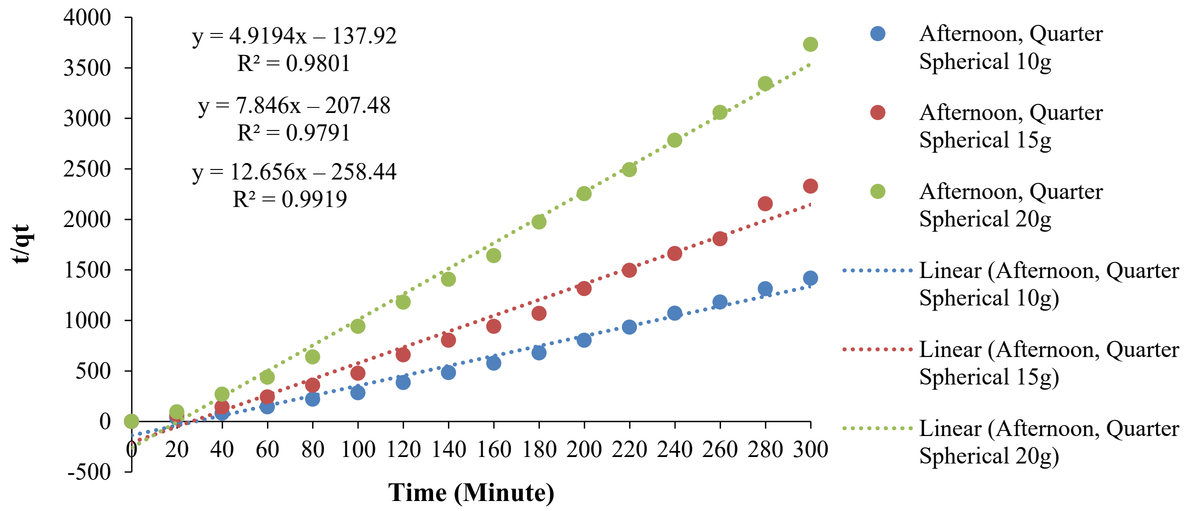


Fig. 13. The modelling of second order pseudo in the variation of adsorbent's mass quarter spherical and river water sample in the afternoon

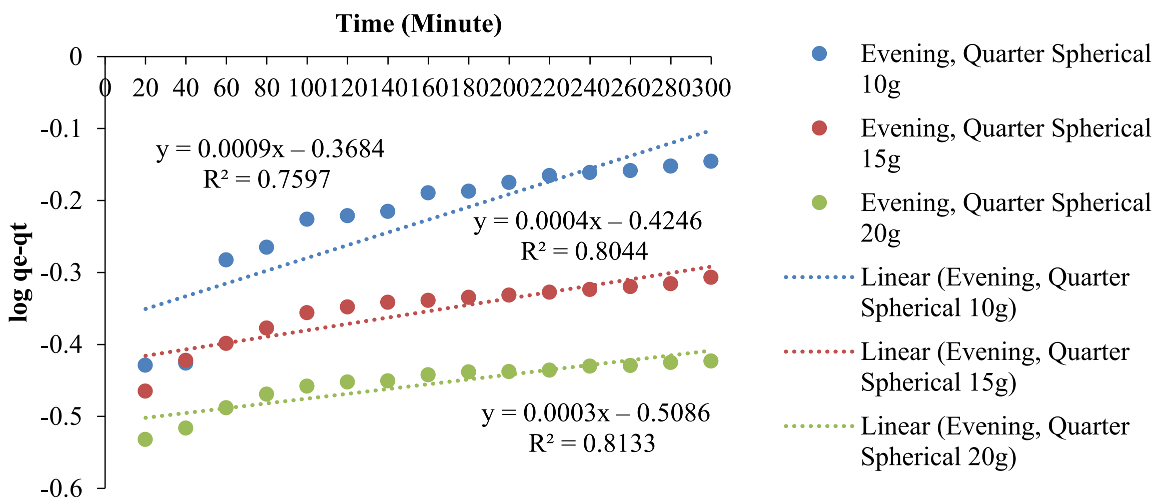


Fig. 14. The modelling of first order pseudo in the variation of adsorbent's mass quarter spherical and river water sample in the evening

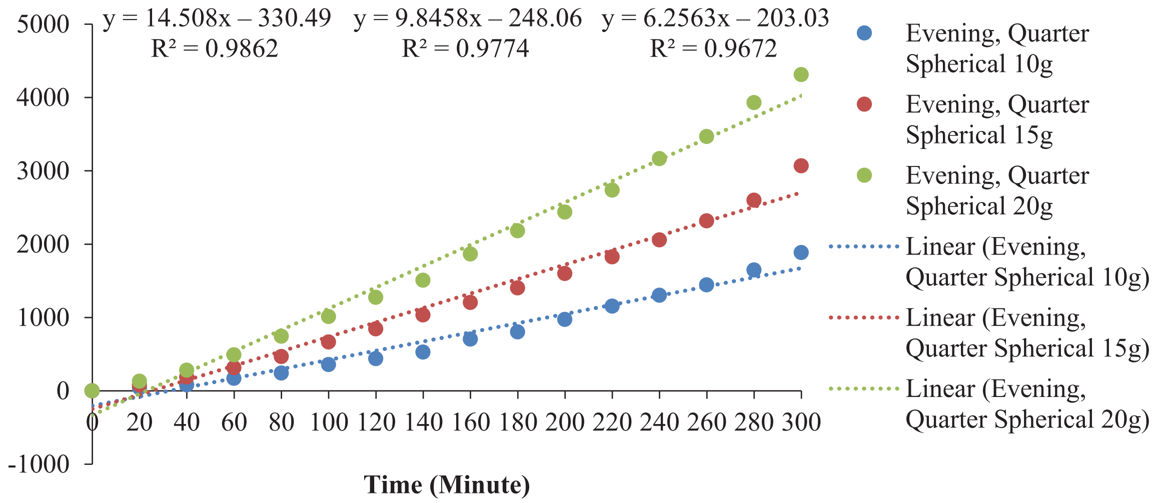
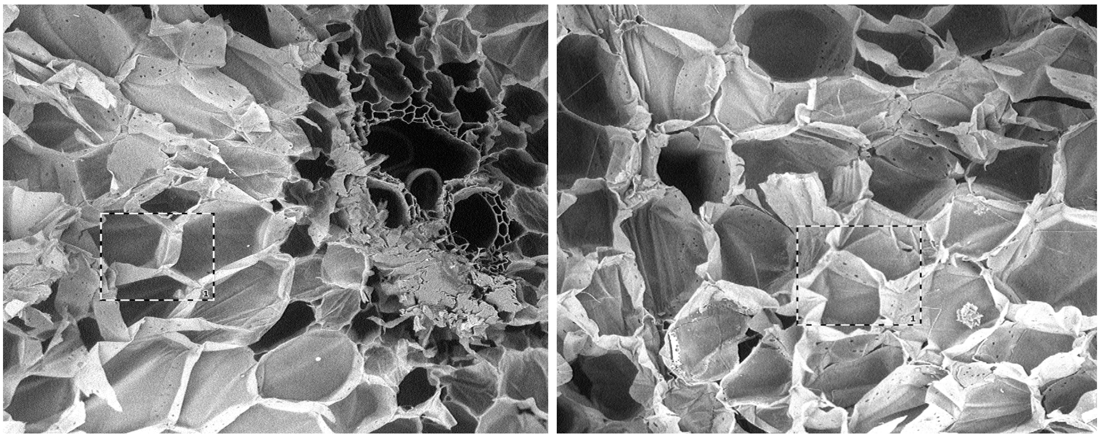


Fig. 15. The modelling of second order pseudo in the variation of adsorbent's mass quarter spherical and river water sample in the evening

3. 5. The Result of scanning electron microscope (SEM) and energy dispersive x-ray (EDX)

Surface morphology and elements content in corn stalks adsorbent to knowing before and after adsorption process in this experiment use SEM *(Scanning Electron Microscope)* and EDX *(Energy Dispersion X-Ray)* shown in **Fig. 16**.

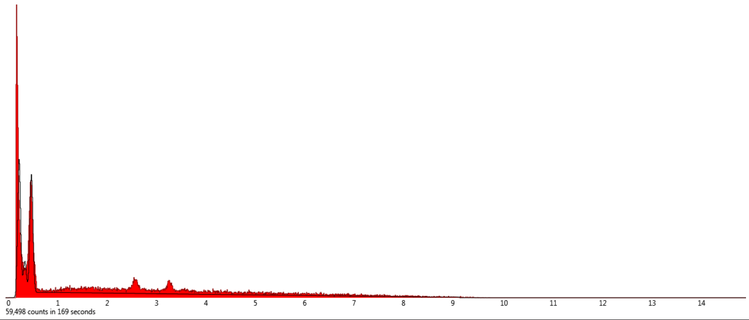


a *b*

Fig. 16. SEM testing enlargement 500x in:
a – adsorbent before adsorption; *b* – adsorbent after adsorption

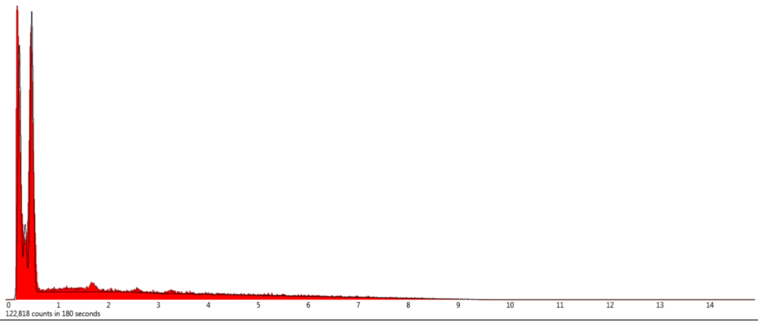
It can be seen in **Fig. 16, *a*, *b*** from the result of SEM testing that the shape of the adsorbent's surface before and after treatment are not showing any significant difference. This thing happens because there are no activation or base washing to an adsorbent that want to be treated with treatment. An adsorbent with base washing has a more porous surface and is rough [25]. Adsorbents after treatment have a bigger size and volume compared to those before treatment [26]. The porous material is a material that has an adsorption ability [27].

As for the analysis result of EDX from corn stalk adsorbent before treatment in **Fig. 17, *a*** shows that there are chemical elements which are O for 79.6 %, C for 9.7 %, and N for 10.7 %. EDX analysis of corn stalks adsorbent after treatment in **Fig. 17, *b*** shows that there are chemical elements, which are O for 81.6 %, C for 8.4 %, and N for 10.0 %. EDX result of analysis in **Fig. 17, *a, b*** shows that the adsorbent before and after have the same elements, which are C, O, and N. The content has a different weight of element percentage. Adsorbent after treatment has a higher weight of Oxygen element.



Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
6	C	Carbon	100.0	9.7	1.3
8	O	Oxygen	100.0	79.6	1.3
7	N	Nitrogen	Manual	10.7	2.9

a



Element Number	Element Symbol	Element Name	Confidence	Concentration	Error
8	O	Oxygen	100.0	81.6	0.7
6	C	Carbon	100.0	8.4	0.8
7	N	Nitrogen	100.0	10.0	1.6

b

Fig. 17. EDX testing on the surface of adsorbent:
a – adsorbent without treatment; *b* – adsorbent after treatment

3. 6. Limitations of the research and directions of its development

This research is about to study on the adsorption capacity of corn stalks in reducing the turbidity of Babura river's water with batch operation. The main concern of this research for the turbidity experienced in the Babura river's water. **Fig. 18** shows the map of the study area.

Water pollution is a major problem that hinders Sustainable Development Goal (SDG) 6: Clean water and sanitation. The limitation that can occur during the adsorption process using batch experiments conducted in a laboratory at ambient temperature and standard pressure. The results obtained under these specific conditions may not be directly applicable to real world scenarios, such as factors like water flow rates may vary significantly. **Fig. 19** shows the condition of the Babura river's water.

Fig. 19 shows the condition of the Babura river's water. It can be seen in **Fig. 19, *a*,** the Babura river's water has its own flow. **Fig. 19, *b*,** shows that the turbidity of the Babura river's water is impaired and the location is near the residential area. The flow may change due to flooding in the rainy season or increased organic/particle content in the river's water. Therefore, the applicability of the results to practical situations should be carefully considered. The study focuses on corn stalks as an adsorbent material. Corn stalks were chosen because of the need to utilize local potential sources that are available and can add value. It's important to note that the effectiveness of adsorption can depend on various factors such as surface area, porosity and chemical composition of the adsorbent. Based on this research, the surface area is taken into account using adsorbent surface area. The specific characteristics of the corn stalks used in this study may not be representative of all corn stalks, and results may vary with different sources. The research focuses primarily on turbidity reduction as an evaluation parameter of adsorption efficiency. While turbidity is an important aspect of water quality, it is not the only factor to consider. Other parameters such as pH, dissolved solids, and organic contaminants may also play a critical role in the adsorption of river's water. To further develop this research, the following directions could be considered in the future, such as optimizing adsorbent properties by creating a fundamental model, kinetic modeling, and mechanism studies. Expanding the analysis to include water quality using High Performance Liquid Chromatography (HPLC). This would provide a more complete understanding of the performance of the river's water. Finally, validate the results of the laboratory-scale study by conducting pilot-scale experiments. This would involve testing the adsorbent under more realistic conditions, taking into account factors such as varying flow rates and longer operating times. Therefore, the effectiveness of corn stalks as an adsorbent could be investigated.

a *b* *c*

Fig. 18. Map of the study area:
a – map of Indonesia; *b* – map of Medan city; *c* – map of Babura river's water

a *b*

Fig. 19. The condition of Babura river's water:
a – Babura river's water flow; *b* – Babura river's water location near residential area

4. Conclusions

After executing this research, then it can be concluded that adsorbent with quarter spherical has bigger adsorption power compared to the spherical adsorbent and half-spherical because quarter spherical adsorbent has a bigger surfa area, so it maximizes the adsorption process, the optimum mass of corn stalks adsorbent in decreasing Babura River's water turbidity (sample) in 300 minutes and the variation of shape from spherical, half spherical, and quarter spherical is 20 g. The suitable adsorption kinetics modeling based on correlation coefficient is second order equation, which in adsorption mechanism that involves interaction chemically (chemisorption) between adsorbate and adsorbent after rough treatment compared to adsorbent before treatment and EDX result in adsorbent shows that there is increasing phenomena in weight of Oxygen element.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Data will be made available on reasonable request.

References

[1] Peraturan Pemerintah (PP) Nomor 82 Tahun 2001 tentang Pengelolaan Kualitas Air Dan Pengendalian Pencemaran Air. Available at: https://peraturan.bpk.go.id/Home/Details/53103/pp-no-82-tahun-2001

[2] Syauqiah, I., Wiyono, N., Faturrahman, A. (2018). Sistem pengolahan air minum sederhana (portable water treatment). Konversi, 6 (1), 27. doi: https://doi.org/10.31213/k.v6i1.16

[3] Baljyan, P., Sarukhanyan, A., Avanesyan, E. (2023). Study of sediment deposition processes and assessment of the change in the W-H characteristics of the madaghis reservoir. EUREKA: Physics and Engineering, 1, 3–12. doi: https://doi.org/10.21303/2461-4262.2023.002757

[4] Quddus, R. (2014). Teknik Pengolahan Air Bersih Dengan Sistem Saringan Pasir Lambat (Downflow) Yang Bersumber Dari Sungai Musi. Jurnal Teknik Sipil dan Lingkungan, 2 (4), 669–675. Available at: https://ejournal.unsri.ac.id/index.php/jtsl/article/download/1878/pdf

[5] Munfiah, S., Ariabawani, R. M. P. (2015). Kemampuan Karbon Aktif Tongkol Jagung Dalam Menurunkan Kekeruhan Air. Medsains, 1 (1), 30–34. Available at: http://download.garuda.kemdikbud.go.id/article.php?article=2987590&val=26817&title=KEMAMPUAN%20KARBON%20AKTIF%20TONGKOL%20JAGUNG%20DALAM%20MENURUNKAN%20KEKERUHAN%20AIR

[6] Fatimah Rahmayani, Siswarni MZ. (2013). Pemanfaatan limbah batang jagung sebagai adsorben alternatif pada pengurangan kadar klorin dalam air olahan (treated water). Jurnal Teknik Kimia USU, 2 (2), 1–5. doi: https://doi.org/10.32734/jtk.v2i2.1427

[7] Tangio, J. S. (2013). Adsorpsi logam timbal (Pb) dengan menggunakan biomassa enceng gondok (Eichhorniacrassipes). Jurnal Entropi, 8 (1), 500–506. Available at: https://ejurnal.ung.ac.id/index.php/JE/article/view/1158

[8] Maliandra, S. M. R., Shatriadi, H., Zairinayati (2016). Efektivitas Kulit Pisang Dalam Menurunkan Kekeruhan Dan Kadar Besi (Fe) Pada Air Sumur Gali. Masker Medika, 4 (2), 371–381. http://jmm.ikestmp.ac.id/index.php/maskermedika/article/view/126

[9] Legiso, Juniar, H., Sari, U. M. (2019). Perbandingan Efektivitas Karbon Aktif Sekam Padi Dan Kulit Pisang Kepok Sebagai Adsorben Pada Pengolahan Air Sungai Enim. PROSIDING SEMNASTEK 2019. Available at: https://jurnal.umj.ac.id/index.php/semnastek/article/view/5175

[10] Sulastri, S., Nurhayati, I. (2014). Pengaruh media filtrasi arang aktif terhadap kekeruhan, warna dan tds pada air telaga di desa balongpanggang. WAKTU: Jurnal Teknik UNIPA, 12 (1), 43–47. https://doi.org/10.36456/waktu.v12i1.825

[11] Fadhillah, M., Wahyuni, D. (2016). Efektivitas Penambahan Karbon Aktif Cangkang Kelapa Sawit (Elaeis Guineensis) dalam Proses Filtrasi Air Sumur. Jurnal Kesehatan Komunitas, 3 (2), 93–98. doi: https://doi.org/10.25311/jkk.vol3.iss2.110

[12] Kamaruzaman, K., Yee, L. P., Azhari, N. N., Mat, N. C. (2022). Bio-Adsorption Process Using Carica Seed to Reduce Water Turbidity from Linggi River. International Journal of Infrastructure Research and Management, 10 (2), 50–56. Available at: https://iukl.edu.my/rmc/wp-content/uploads/sites/4/2022/12/5.-IJIRM-Vol.10_2_December-2022_Khairunisah.pdf

[13] Opitz, J., Alte, M., Bauer, M., Peiffer, S. (2020). Quantifying iron removal efficiency of a passive mine water treatment system using turbidity as a proxy for (particulate) iron. Applied Geochemistry, 122, 104731. doi: https://doi.org/10.1016/j.apgeochem.2020.104731

[14] Joniak, T., Jakubowska, N., Szeląg-Wasielewska, E. (2013). Degradation of The Recreational Functions Of Urban Lake: A Preliminary Evaluation Of Water Turbidity And Light Availability (Strzeszyńskie Lake, Western Poland). Polish Journal of Natural Sciences, 28 (1), 43–51.

[15] Syauqiah, I., Amalia, M., Kartini, H. A. (2011). Analisis variasi waktu dan kecepatan pengaduk pada proses adsorpsi limbah logam berat dengan arang aktif. Info Teknik, 12 (1), 11–20. Available at: https://ppjp.ulm.ac.id/journal/index.php/infoteknik/article/view/1773/

[16] Ikenyiri, P., & Ukpaka, C. (2016). Overview on the Effect of Particle Size on the Performance of Wood Based Adsorbent. Journal of Chemical Engineering & Process Technology, 07 (05). doi: https://doi.org/10.4172/2157-7048.1000315

[17] Müller, B. R. (2010). Effect of particle size and surface area on the adsorption of albumin-bonded bilirubin on activated carbon. Carbon, 48 (12), 3607–3615. doi: https://doi.org/10.1016/j.carbon.2010.06.011

[18] Ayyappan Vasantha, P., Anil, L. S., Mohamedali, N., Dileep, R., Nair, V. S. (2022). Impacts of Flood on Water Quality of Periyar River and Remediation Using Natural Fibers. Journal of Natural Fibers, 19 (15), 12295–12308. doi: https://doi.org/10.1080/15440478.2022.2057382

[19] Nurlaili, T., Kurniasari, L., Ratnani, R. D. (2017). Pemanfaatan Limbah Cangkang Telur Ayam Sebagai Adsorben Zat Warna Methyl Orange Dalam Larutan. Inovasi Teknik Kimia, 2 (2), 11–14. doi: https://doi.org/10.31942/inteka.v2i2.1938

[20] Midwar, D., Muhammad, S., Faisal, M., Hasmita, I. (2018). Karakterisasi Nano Ziolit Teraktifasi ZnCl 1 dan Aplikasinya pada Limbah Cair Pabrik Minyak Kelapa Sawit. Jurnal Serambi Engineering, 3 (2). doi: https://doi.org/10.32672/jse.v3i2.712

[21] Ateia, M., Helbling, D. E., Dichtel, W. R. (2020). Best Practices for Evaluating New Materials as Adsorbents for Water Treatment. ACS Materials Letters, 2 (11), 1532–1544. doi: https://doi.org/10.1021/acsmaterialslett.0c00414

[22] Yagub, M. T., Sen, T. K., Afroze, S., Ang, H. M. (2014). Dye and its removal from aqueous solution by adsorption: A review. Advances in Colloid and Interface Science, 209, 172–184. doi: https://doi.org/10.1016/j.cis.2014.04.002

[23] Taihuttu, B., Kayadoe, V., Mariwy, A. (2019). Studi kinetika adsorpsi ion Fe (III) menggunakan limbah ampas sagu. Molluca Journal of Chemistry Education (MJoCE), 9 (1), 9–17. doi: https://doi.org/10.30598/mjocevol9iss1pp9-17

[24] Boparai, H. K., Joseph, M., O'Carroll, D. M. (2011). Kinetics and thermodynamics of cadmium ion removal by adsorption onto nano zerovalent iron particles. Journal of Hazardous Materials, 186 (1), 458–465. doi: https://doi.org/10.1016/j.jhazmat.2010.11.029

[25] Setyarini, H. D., Apriani, M., Cahyono, L. (2021). Karakterisasi Adsorben dari Ampas Teh Tanpa Aktivasi dan Teraktivasi. National Conference Proceeding on Waste Treatment Technology, 156–159. Available at: https://www.researchgate.net/profile/Mirna-Apriani/publication/367043698_Karakterisasi_Adsorben_dari_Ampas_Teh_Tanpa_Aktivasi_dan_Teraktivasi/links/63bed630a99551743e5d761c/Karakterisasi-Adsorben-dari-Ampas-Teh-Tanpa-Aktivasi-dan-Teraktivasi.pdf

[26] Desta, M. B. (2013). Batch Sorption Experiments: Langmuir and Freundlich Isotherm Studies for the Adsorption of Textile Metal Ions onto Teff Straw (Eragrostis tef) Agricultural Waste. Journal of Thermodynamics, 2013, 1–6. doi: https://doi.org/10.1155/2013/375830

[27] Zhu, L., Shen, D., Luo, K. H. (2020). A critical review on VOCs adsorption by different porous materials: Species, mechanisms and modification methods. Journal of Hazardous Materials, 389, 122102. doi: https://doi.org/10.1016/j.jhazmat.2020.122102

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