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Chicken Wastewater Treatment Using Carbon Filtration

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Abstract: Water is one of a main source for human and ecosystem. Water pollution nearby chicken slaughter house are in great concern towards housing area. This is very worrying especially during this uneven climate change in Malaysia. The after effect from raining and sudden bright sun can be resulting a pungent smell occurs from the drainage system. This odor from the chicken wastewater may resulting toward environmental damage. This is because of the Fat, Oil and Grease (FOG) released from the chicken wastewater. The purpose of this study is to filtrate and improve the quality of the wastewater that disposed directly by the chicken slaughtering houses. The main material for this filtration system will be carbon powder. The filtration system also consists of nature resources such as soil, sand and coconut fiber in which it can save costs and easy to obtain. Total Dissolves Solid (TDS) and pH value will be the main benchmark for this study. Total dissolve solid will define on the safeness to be consume by human body while pH value will indicate the acidity and alkaline of the water. The range of pH that safe to be consume by human are from 6.5 to 8.5. The methodology used was using filtration system by combining soil, sand and coconut fiber as media filter of this filtration system. This method will reduce the TDS number and maintaining the pH value while decrease water pollution towards the environment. This method and material can improve the parameter such as reducing the TDS number and improving the pH value towards the chicken wastewater.

Keywords: Chicken Wastewater, Carbon Power Other Keywords

1. Introduction

In 2019, the rate of river pollution in Malaysia increased approximately 34%. Therefore, it can be considered as polluted. In statistics, about 7% of rivers in this country were polluted [1]. Chicken slaughter wastewater disposal is also a threat to the environment which produces large amounts of organic and inorganic waste towards the surrounding. From studies conducted and average results from tested selected water quality nearby a chicken slaughterhouse [2], it is shown to be in very high pollutant

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level. In other words, these wastewaters cannot be discharged directly into the water stream without being treated

Charcoal filters are already being used in domestic and commercial applications that are reliable in defining taste and odor that can lead to growth of bacteria [3]. Charcoal has shown that it is reliable and effective in order to handle biological waste. Studies also show that charcoal has higher porosity and better surface area coverage that can amplify the filtration process [4]. By choosing charcoal as the main component in this filtration system, it leads to a clear low-cost element and is environmentally friendly. It is also proven that it can detect contamination and is able to remove bacterial count that can harm for everyday usage.

Charcoal in household water filters are used to remove chlorine and filter out unpleasant odor from the main tank. It is also essential to ensure that filtered water is free from bacteria and viruses. This is because the existing charcoal filter is mainly used for filtered drinking water thus it is important that it is disinfected thoroughly. Other than that, charcoal also became a practice that was implemented for poison control in the early 1800s.

2. Materials and Methods

This chapter will explain the process through methodology, experimental analysis and the model implementation within this research. The equipment and material used were listed with the data from the material analysis, design performances, volume flowrate, Total Dissolved Slid eliminated and Efficiency rate of TDS number reduce. As an effort to gain the objective of this research, discussion carried forward from the material preparation to the end of the methodology process.

2.1 Materials

These are the equipment is being used in the wastewater treatment process. pH meter is necessary in this test as we need to determine the capability of the treatment for daily usage. Table below shows the equipment used in this process.

Table 1: Equipment and Component

No.	Equipment/Component	Remarks
1.	Water bottle	Size of 1.2 litre
2.	Filter cloth	Tie with rubber band
3.	Sand	-
4.	Black Soil	-
5.	Coconut Fiber	-
6.	Charcoal	Grind with mortar
7.	pH meter	-
8.	TDS Meter	-
9.	700ml of bottle	-

2.1.1 Charcoal

Number of studies and products have shown that charcoal can serve in water filtration systems. Charcoal based filters have been commercialized and covered both household and industries utilization. Remote off-grid households commonly use charcoal filtration systems. Gravity-fed filters are easy to install and obtain without breaking the bank. The porosity of charcoal makes it a better element for filtering water [8]. Wood based charcoal contains meso-pores and micropores internally which can create a low-density element. Absorbing impurities in the water which lead to removing the unwanted element such as chemicals, colors, flavor and does from the source.

2.1.2 Black Soil

Black soil is rich with nutrient and able to improves water and nutrient retention. The black soil contain mix of compose, clay and gravel. Within this black soil, clay is the least permeable compared to the other material. The clay leaves minor spaces for water to get through. Gravel will play a main part as they are the most permeable material in this black soil. The characteristic for gravel is that it is lightweight, porous and gravel has gap that can offer a good surface area bacterium to stick on. The gap produced can also trap other large elements such as bugs, sediments and other larger particles that can be found in the water. Gravel can be defined as inexpensive material with high usage within the filtration industry. Organic and inorganic compound can be filtered and stop by clay mineral in the soil. Roughing filtration is an effective way and reliable to removing suspended solid, turbidity and coliform bacteria [5]. amended basalt horizontal roughing filters and found only marginally improved River rock and limestone efficiency (7%) for calcite amended basalt filters over unaltered filters [6]. Improved removal efficiencies are generally correlated to smaller media sizes.

2.1.3 Sand

Studies also shown that sand filtration able to remove COD and TTS efficiently. [7] [2]. Sand filtration is effective in filtering septic waste. Examples of septic waste are indigested organic matter. sand filtration is one of the earliest tertiary treatments and it has been used for meat and poultry processing wastewater [7]. Therefore, sand filtration extracts large amounts of organic materials and even suspended solids from domestic waste which in this case is the chicken wastewater.

2.2 Methods

In this study, there were 3 layers of material used to make a functional filtration system that can filter out chicken wastewater to desired pH level with suitable TDS number. Each component was prepared specifically and suitable way to be used into the filtering system and each component will be stacked to complete the filtering system.

2.3.1 Volumetric Flowrate

Volume flow rate was measured by the total amount of volume that goes through an area per time. The volume of the units can be defined also with the number of cubic meters of fluid flow per second. Equation for volume flow rate can be shown as;

$$\mathrm{Q} = \frac{V}{\tau} \qquad Eq.1$$

Q = Flow rate

V = Volume

τ = Time

2.3.2 Total Dissolve Particles (TDS)

Total Dissolve Particles (TDS) is the indication to describe the performance quality and concentration of substance within large mixture. Therefore, within this study we can calculate efficiency rate of the elimination of TDS number before and after the filtration process. Equation for efficiency can be shown as;

$$\frac{Final\ TDS - Initial\ \ TDS}{Initial\ TDS} \times 100 \quad Eq.2$$

3. Results and Discussion

3.1 Carbon Powder

A pretreatment process was conducted. Due to oiliness and contain small sediment during the wastewater collection, the wastewater will be filter using filter paper in advance before the pretreatment. Carbon powder had the ability to purify and absorbs the oiliness and neutralize the smell released by the wastewater.

Table 2: pH Value and TDS Number After Pretreatment

Mass of Carbon Powder (g/200ml)	pH Value	TDS Number	Observation
5	5.51	970	Slightly red + no smell
10	5.30	1012	Clear + no smell
15	5.27	1020	Clear + no smell
20	5.21	1050	Clear + no smell
25	5.16	1064	Clear + no smell

Within the data, 10g of carbon powder per 100ml of water is enough to eliminate the color of chicken wastewater and the odor released by them. A higher amount of carbon powder used will affected the overall pH and TDS number into a more unsafe level.

3.2 Clay Powder

Clay powder or bleaching earth is the second component tested during the pretreatment. Clay powder have the abilities to be absorbent, remove impurities. It is also can eliminate unwanted matter such as coloring, oil and fats. However, a slight amount of the powder will plummet the pH number of the pretreated solution. Table 3 show the number of pH value and the amount of clay powder used. Due to depleted in pH value, clay powder will be discarded from this experiment. This is because of the result shown in between the carbon powder pretreatment and the clay powder resulting the same observation. Since the pH value leaning toward low acidic value and not safe to be use.

Table 3: pH Value and TDS Number After Pretreatment for Clay Powder

Mass of Clay Powder (g)	pH Value	Observation
1	5.10	Clear + no smell
2	4.54	Clear + no smell
3	4..36	Cloudy + no smell

4	4.25	Cloudy + no smell
5	4.06	Cloudy + no smell

As a result, carbon powder will be main pretreatment material throughout this experiment.

Table 4: Data Table of the Filtration System

Sample	Sand (g)	Black Soil (g)	C.Fiber (cm)	pH	TDS (mg/l)	Δt	Q (x10^-3) ml/s	Observation
1	100	-	-	5.51	1100	20	10	Very light cloudy
2	200	-	-	5.57	975	26	7.692	Very light cloudy
3	300	-	-	5.65	964	34	5.882	Very light cloudy
4	400	-	-	5.72	884	42	4.762	Very light cloudy
5	500	-	-	5.83	863	51	3.922	Very light cloudy
1	-	100	-	6.11	843	46	4.379	Slight cloudy
2	-	200	-	6.2	862	64	3.425	Slight cloudy
3	-	300	-	6.4	880	73	2..739	Cloudy
4	-	400	-	6.43	954	96	2.083	Cloudy
5	-	500	-	6.53	1012	136	1.471	Cloudy
1	-	-	15	5.41	986	23	8.696	Clear
2	-	-	30	5.36	942	24	8.333	Clear
3	-	-	45	5.52	902	22	9.091	Clear
4	-	-	60	5.42	884	25	8.000	Clear
5	-	-	75	5.58	862	24	8.333	Clear

3.3 Analysis on the pH value After the Filtration Process

Based on the result shown in table 3.1, we can see that black soil has the highest pH affect changed toward the chicken wastewater at 6.5 compared to sand and coconut fiber. The initial pH for the pretreatment wastewater was 5.2. This pH was in acidic state before being filtered through the black soil. Therefore, black soil has the properties that can increase the pH value of the pretreatment wastewater. Black soil contains clay stones and others organic matter. The black soils are full with lime, iron, aluminum, magnesium and potassium which also be the factor towards increase of pH value. Coconut fiber and sand both has comparable amount of pH changes. For sand the highest pH at 5.83 while for coconut fiber at 5.58 pH value.

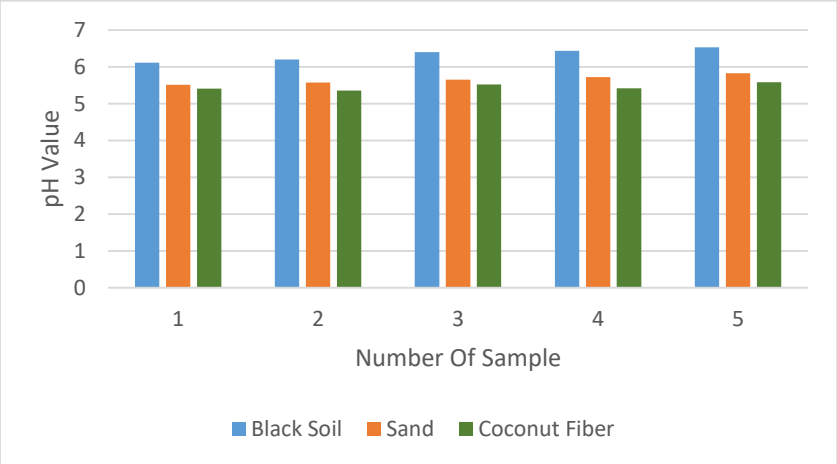

Figure 1: Analysis on pH Value towards Number of Samples

3.4 Analysis on the efficiency value After the Filtration Process

The tabulated data from table 3.2 shown that sample 1 of sand contained the highest TDS compared to sample 5 at 1100mg/l and 863mg/l respectively. It is also indicated that the treated wastewater is safe to be used. The higher the weight of sand used, the better the rate of efficiency rate. However, for black soil, the graph shown decrease in number of efficiency rate as the number of weight increase. This is because black soil consists of high amount of sediment that will be affecting the pretreatment water that go through the medium. Therefore, sample 5 of black soil has the lowest efficiency rate with 0% and high amount of black soil will also result a cloudy water due to soil content of the black soil. The data can be expressed in term of efficiency before and after the filtration process. Higher efficiency rate resulted a better water filtration system. As for TDS number, the lower the number of TDS, the better the filtration process

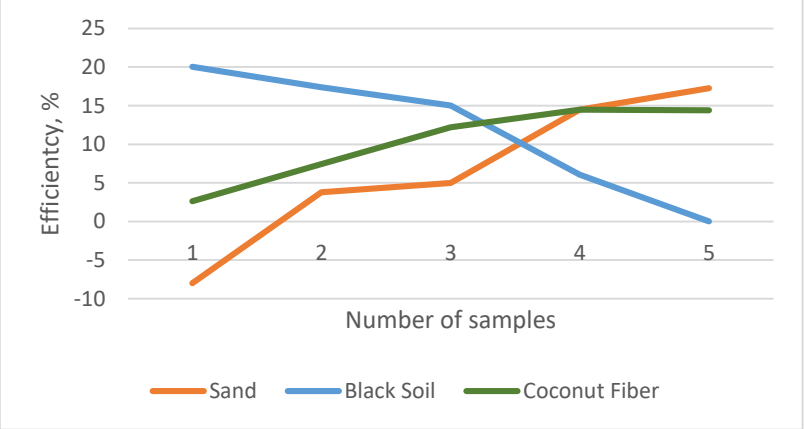

Figure 1: Analysis on Efficiency towards Number of Samples

The table 3.3 shown the overall flowrate for each media filter used for chicken wastewater filtration. We can see that coconut fiber has the highest flowrate compared to black soil and sand. However, coconut fiber has inconsistent flowrate for each increment of weight used for each test. This is because the coconut fiber has random shape of space between the material. The pretreated water can easily go through the water. As for black soil, it has the lowest flowrate 1.471(x10^-3) ml/s. This is because black soil contains high amount of sediment and clay stones. Clay has lower porosity than sand. The slit between clay was packed which resulted a dense media filter and low space between the clay particle. These sediments will produce clog at the end of the filtration system. The sand media filter has high porosity and loose packing between grains, each sample does not clog in and has low possibility to leak even with high volume of wastewater in the direction of the system.

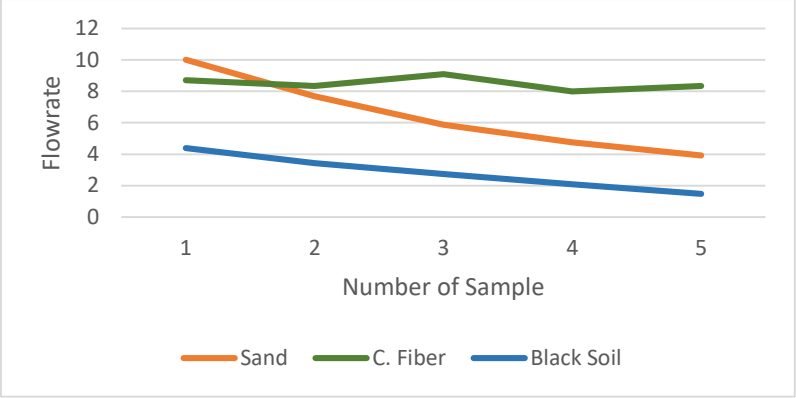

Figure 2: Analysis on Flowrate towards Number of Samples

3.2 Water Filtration System

After selecting sample for each material, a full filtration system was constructed. The selected sample for each material were Sample 5 for grain of sand, Sample 2 for Black soil and Sample 5 for coconut fiber. This selected sample were selected through the Pugh Matrix Method which contain parameter such as flowrate, TDS number and pH number. As a complete filtration system, the total time taken for 500ml of pretreated wastewater was 305s. Therefore, the flowrate of the system will be 0.61ml/s. The full filtration system also changes the TDS number from 1012mg/l into 654mg/l. It is also having 35.38% of efficiency of TDS elimination.

4. Conclusion

Based on this study, the objective of was achieved whereby to assemble a water filtration system for chicken wastewater. The filtration system built was able to filter the physical properties of the chicken wastewater. The filtration system also able to handle 0.61ml/s flowrate of water. The system was focused on reducing the total dissolve solids (TDS) and pH value of the chicken wastewater. Throughout this study, carbon powder was a main material used to filter the chicken wastewater. By including carbon powder in the wastewater, pH value of the solution will drop in acidic state. Nevertheless, the carbon will absorb the impurities of the wastewater including color and smell. As the results shown, the pH value for the chicken wastewater react differently on each media filter used. Therefore, others materials were needed in the filtration system to neutralize the pH value.

The study also needs to determine the Total Dissolved Solids (TDS) after the filtration process. After pretreating the chicken wastewater with carbon powder, the TDS number increases into non-save level that released by the National Water Quality and by Ministry of Health. The treated water however can be used as daily usage because the treated water does not exceed 1000mg/l.

As a result, this carbon filtration was able to filter organic waste from chicken wastewater. However, the treated water from the filtration system cannot be consume as the current TDS number was 645mg/l and the safe value needed was under 100mg/l. Therefore, the treated water can be used for other daily usage

For future studies, there are few other steps that can help in improving the results of the carbon filtration system;

I. The concentration of raw chicken wastewater before treatment is reduced by adding distilled water to reduce the amount of carbon powder use and resulting a less acidic state after the pretreatment.

II. More sampling can be taken from different chicken slaughter house to understand the characteristic and understanding on concentration of chicken wastewater.

III. Adding chemical solution into the raw chicken wastewater. The solution can help in increase the alkalinity after the pretreated water of carbon powder. For example. calcium oxide, sodium hydroxide or sodium carbonate.

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