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Optimization of Sugarcane Bagasse in Removing Contaminants from Kitchen Wastewater

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ABSTRACT

Nowadays, most of rivers in Malaysia have been polluted by uncontrolled discharge of wastewater into the river. One of the sources is from kitchen house and restaurants. Kitchen wastewater contains contaminants such as bacteria, organic matter, suspended solid, fat, oil, grease, soap and detergent residue. These contaminants will eventually flow into the river and cause the extinction of aquatic life, continuously degrading quality of river water. Thus, wastewater to be discharged into the river should undergo filtration process. Utilizing bagasse as filter medium is a smart and sustainable idea. Apart from purify water to be cleaned; it is also reducing the production of agricultural waste at landfill. In this study, the effectiveness of raw sugarcane bagasse in removing contaminants from kitchen wastewater will be studied. At the end of this study, bagasse has proven its capability in removing turbidity, suspended solid, colour, pH and chemical oxygen demand (COD) from raw kitchen wastewater at certain allocated time. At the end of this study, sugarcane bagasse is proven to remove contaminants from kitchen wastewater at optimum retention time of 30 minutes with removal percentage of turbidity, suspended solid, colour and COD is 90.86%, 88.41%, 85.00% and 85.50% respectively. Whereas, the best DO and pH reading is 6.50 mg/l and 6.30 at optimum time of 30 minutes.

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INTRODUCTION

In recent times, contamination of river due to human activities has drawn the attention of health expertise worldwide, as water is essential component for sustaining life. However, improper management of wastewater removal has become a greater challenge for us today. Wastewater from kitchens contain contaminants such as bacteria, high concentration of organic matter, suspended solid, fat, oil, grease, soap and detergent residue (WHO, 2006)]. These contaminants encourage the growth of bacteria thus reducing the concentration of dissolve oxygen in the river. Disposal of waste water from the kitchen directly to the drain without going through any treatment process is seen as a trigger to more serious problems in the future. Bagasse pitch is a waste product from sugar refining industry. It is the name given to the residual cane pulp remaining after sugar has been extracted. Bagasse is composed largely of cellulose, pentose and lignin (Siti Khadijah CO et al., 2012). Cellulose in bagasse is one of the best wastewater adsorbent. Several researchers have proven bagasse effeciencies in removing contaminants from wastewater such as Pb (II), Cd (II) (Nasim AK, 2004), Cu (II) (Nelson CF et al., 1996), Cr (II) (Saifudin and Kumaran, 2005), sulphate ion (Daniela RM et al., 2008), and other heavy metal from wastewater. Hence, this study is carried out to investigate the effectiveness of raw sugarcane bagasse in removing contaminant from kitchen wastewater.

2. Materials and methodology:

A. Material preparation:

For this study, raw sugarcane bagasse is taken from sugarcane juice vendor near Sekolah Kebangsaan Pintas Puding, Parit Raja Johor. Sugarcane bagasse is then washed under tap water to remove contaminants, before being dried in dry oven at temperature 105° Celsius for 24 hours. Next, the bagasse is grinded and graded to 1.18 mm to 2.00 mm by sieve analysis test, referring to ASTM C136-06 Standard Test Method for Sieve Analysis of Fine and Course Aggregates.

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B. Water filter system:

The water filter system is conducted in lab scale size with peristaltic pump to convey water from water sample tank to the filter system. Figure 1 shows operation of water filter system.

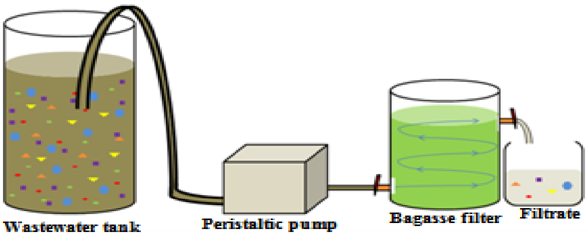

Fig. 1: Water Filter System.

C. Material characterization:

For this technique, two analysis has been conducted: Scanning Electron Microscope analysis (SEM) and X-ray Fluorescent analysis (XRF). From SEM analysis, the pore image of each sample can be seen, while the concentration of element in each sample can be obtained by running XRF analysis.

D. Water quality test:

All water samples undergo several laboratory tests before and after filtration process. Those tests were conducted to determine the quality of the water sample under specified parameters. The parameters that have been used for this study are pH, colour, turbidity, dissolved oxygen, chemical oxygen demand and total suspended solid. The value obtained from each sample is then compared to Parameter Limit of Effluent of Standard A and Standard B from Environment Quality Act.

RESULTS AND DISCUSSIONS

X-Ray Fluorescent Analysis (XRF):

Table 1 shows XRF result for raw sugarcane bagasse. There are several elements found in raw sugarcane bagasse; Al, Ca, Cl, CH2, Cr, Cu, Fe, K, Mn, P, S, Ti, Si, and Zn. CH2 is the main component found in raw sugarcane bagasse.

Table 1: Result for XRF.

Formula	Concentration (%)	Formula	Concentration (%)
Al	0.0443	Mn	0.0016
Ca	0.0446	Mo	0
Cl	0.0833	Ni	0
CH2	99.3	P	0.0711
Cr	0.0016	Ti	0.002
Cu	0.0029	S	0.0379
Fe	0.0205	Si	0.146
K	0.28	Zn	0.0017
Mg	0		

Scanning Electron Microscope (SEM):

SEM analysis is conducted to study the morphological view of raw sugarcane bagasse. Figure 2 shows the result of SEM analysis for raw sugarcane bagasse:

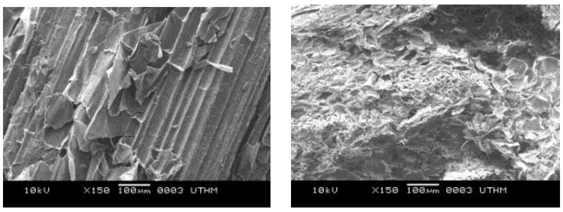

Fig. 2: Morphological View of Raw Sugarcane Bagasse.

Water quality test:

Laboratory test is performed to determine the water quality of wastewater before and after filtration process. Four sample of kitchen wastewater with different initial value of water quality is tested according to several specified parameters namely dissolved oxygen concentration, pH value, turbidity, total suspended solid, colour and chemical oxygen demand (COD). Figure 3 shows kitchen wastewater before and after filtration process.

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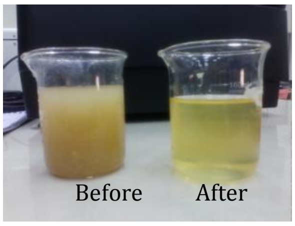

Fig. 3: Kitchen Wastewater Before and After Filtration Process.

Dissolved oxygen (DO):

Figure 4 shows dissolved oxygen concentration for sample 1, 2, 3 and 4. Sample 1 shows the best result out of four samples where dissolve oxygen concentration is the highest at t=30 minutes. All the sample shows the same pattern where the dissolved oxygen removal at first increase to one point and then start to decrease over time at another point. At time t = 0 min is where the raw kitchen wastewater have not undergo any filtration process yet, thus the value of DO is low and not favorable to be discharged into the river. The value of DO start to increase after the wastewater is going through filtration process. This shows that the filtration process had removed contaminants and subsequently increases the DO concentration in water. However, the prcentage of DO removal start to decrease after 30 minutes of filter operation. In here, it can be assumed that the removal of DO decrease after the optimum retention time take place.

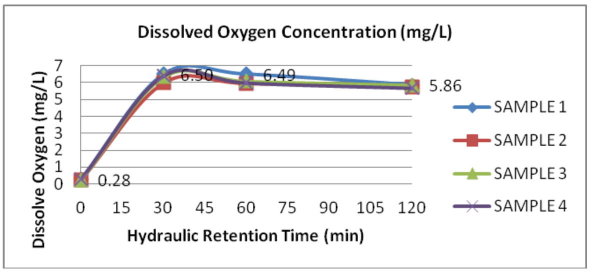

Fig. 4: Dissolved oxygen concentration.

pH:

Figure 5 shows the pH value of kitchen wastewater before and after filtration process. At t = 0 min, value indicates that the wastewater is acidic and has very poor quality. The pH starts to become more neutral after going through filtration process. pH starts to decrease again after optimum retention time at t = 30 minutes. At t = 30 minutes, pH value for sample 1 is 6.30. According to a standard from Department of Environment, the pH limit of effluent for standard B is 5.5 – 9.0. In comparison to this standard, only sample 1 and sample 3 is safe to be discharged into the river.

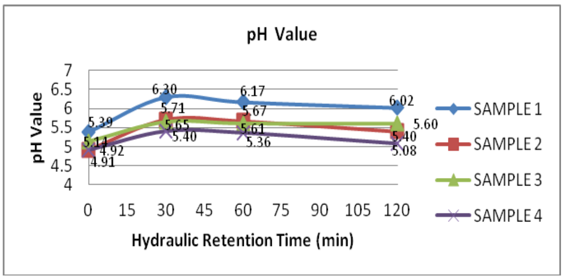

Fig. 5: pH value.

Turbidity:

Figure 6 shows the graph on turbidity removal percentage. The end removal percentage of sample 1, 2, 3, and 4 are 86.66%, 85.06%, 80.96% and 74.95% respectively. The removal percentage is dramatically decrease when HRT increase. This indicates that the filter has efficiently remove turbidity until optimum retention time is reached. This might be happen because of the bagasse has had enough adsorb contaminants from the wastewater. When the efficiency has drop to a point where the water is not favorable to the river anymore, the bagasse need to be change.

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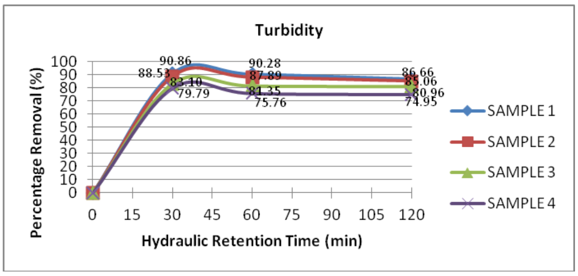

Fig. 6: Removal Percentage of Turbidity.

Suspended solid:

Graph in Figure 7 shows the removal percentage of suspended solid for sample 1, 2, 3 and 4. All samples exhibit the same behavior. The end removal percentage of sample 1, 2, 3, and 4 are 74.10%, 85.88%, 62.80% and 61.64% respectively. The highest removal shows by sample 2 at t = 30 minutes with percentage of 88.41%. The efficiency of bagasse filter in removing suspended solid is decreasing after t= 30 minutes, at optimum HRT.

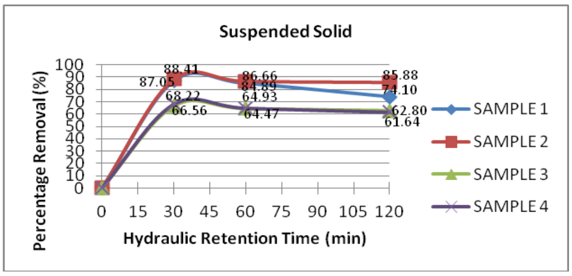

Fig. 7: Removal Percentage of Suspended Solid.

Colour:

Graph in Figure 8 shows the removal percentage of colour for sample 1, sample 2, sample 3 and sample 4.The graph shows that all the lines exhibit the same behavior. The removal percentage of sample 1, sample 2, sample 3, and sample 4 at t = 30 min where HRT is optimum are 85.00%, 79.55%, 60.71% and 56.67% respectively. It can be concluded that sugarcane bagasse has effectively remove colour before it reduced at 60 minutes HRT.

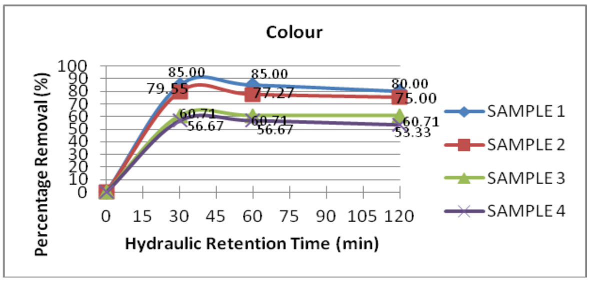

Fig. 8: Removal Percentage of Colour.

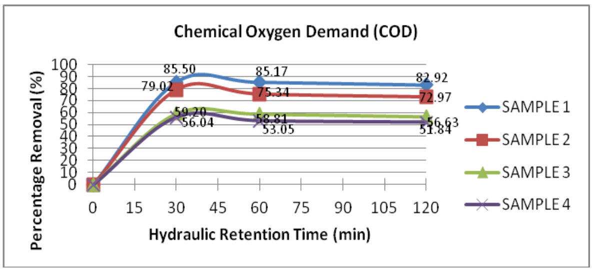

Fig. 9: Removal Percentage of COD.

Chemical Oxygen Demand (COD):

The removal percentage of colour for sample 1, sample 2, sample 3 and sample 4 is shown in Figure 9.The graph shows that all the lines exhibit the same behavior where the percentage is high at first but slowly decrease as time passes. The removal percentage of sample 1, sample 2, sample 3, and sample 4 at t = 30 min are 85.50%, 79.07%, 59.20% and 56.04% respectively. The highest COD removal recorded by sample 1 at t = 30 minutes with 85.50%. The removal dropped gradually after HRT optimum.

3. *Conclusion and recommendation:*

At the end of this study, it can be concluded that raw sugarcane bagasse has the ability to remove contaminants in kitchen wastewater. Hydraulic retention time optimum at t = 30 minutes. At this time, the quality of wastewater was at the best condition due to the efficicencies of removal was at the highest rate. Thus, raw sugarcane bagasse can be proposed to be used as pretreatment of kitchen wastewater. Several recommendations are suggested for this study:

- Sugarcane bagasse should be treated or activated to increase the porosity of raw material.
- Fats, oils and greases (FOG) should be trapped first for the system to be functional more efficiently.

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