The use of natural resources for wastewater treatment

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***Abstract*— Wastewater contains of different types of contaminants will bring impacts to the environment and the aquatic life. Therefore wastewater is needed to be treated before it is discharged into river. Activated carbon produce from coconut shell is one of natural resources that is believed can treat the wastewater by removing those contaminated substances. This study identified the potential of these natural resources in the filter system to improve the wastewater quality. Wastewater from KK3 cafe at Universiti Malaysia Pahang was used to be test with this carbon filter system. Four parameters include turbidity, Total Suspended Solid (TSS), Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were check to identify the wastewater quality after using this carbon filter. The water quality of wastewater at KK3 café was improved after using carbon filter. The percentage of wastewater parameter removal in range of 60.63% to 97.48%. This carbon filter was recommended to be set up at KK3 cafe at Universiti Malaysia Pahang as to pre-treat the wastewater before it is discharged into river.**

Keywords*— Wastewater; natural resources, carbon filter; wastewater treatment

I. INTRODUCTION

Wastewater can be defined as the combination of water or liquid that earned waste which is removed from institutions, residences, commercial and industrial [1]. Nowadays, the effluent of domestic wastewater is mostly untreated. It contains different types of contaminants such as suspended solids, biodegradable organics, pathogens and others heavy metals. Those untreated wastewater will flow into river and polluted the river.

Water treatment is the process to treat water and it as able to improve the quality of water especially wastewater. The wastewater is polluting the river when it is discharged directly from household. Therefore wastewater is needed to be treated before it is discharged into river.

Natural resources filter using coconut shell as activated carbon is believed will able to treat the wastewater by removing those contaminated substances. Activated carbon is often be used in the water treatment system. Activated carbon has the potential in improving the water quality especially drinking water by removing tastes, odour, dirt, rust and sand [2]. According to Desilva [3], carbon filtration undergoes two principal mechanisms to remove the contaminants which are adsorption and catalytic reduction. Y.Adul-Ahad [4] also mentioned that activated carbon adsorption is effective and reliable in removing organic impurities that found in portable water supplies. This statement was then supported by Pohan [5] who revealed that activated carbon is highly porous adsorbent and suitable to be used for water filtration. This study aimed to identify the potential of using carbon in the filter system, respective design criteria of carbon filter and effect of carbon to the wastewater quality.

Laboratory testing on wastewater quality include Total Suspended Solid (TSS), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD) and turbidity before and after using a carbon filter. By doing this study, the contaminated water is able to be treated before it is discharged into river.

II. METHODOLOGY

A. Study Area

The study area covered at Universiti Malaysia Pahang Campus Gambang which located at Gambang, Pahang Darul Makmur. The water sample was collected at KK3 student caféteria. The carbon filter was acted as pre-treatment filter system and functioned to pre-treat the wastewater from KK3 café.

B. Water Sampling

The wastewater sample was collected at the main drain for the effluent from cafeteria. Water Sampling had done during peak time 12.30 pm - 1.30 pm and non-peak time 11.30 am. Different time of water sampling was done to compare the water quality during different period. There are two sample, Sample 1 and Sample 2 taken at different day druing peak time and non-peak time.

C. Filter Design

The filter was designed as vertical-flow filter which operated as down flow filter. There were three different filters design which varied from layer and size. The main components for filter were sponge, sand, charcoal, activated

carbon and gravel. The schematic diagrams of detailed design of filters were shown in Figure 1, 2 and 3.

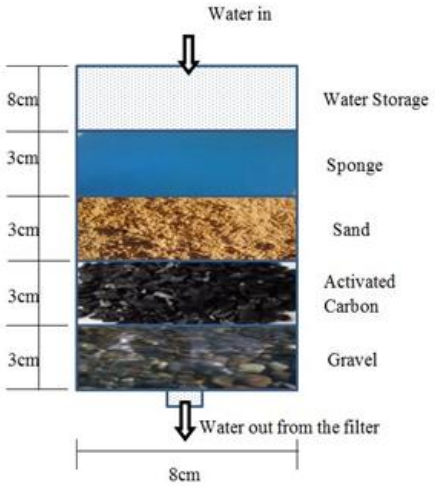

Fig. 1. Schematic diagram of filter A

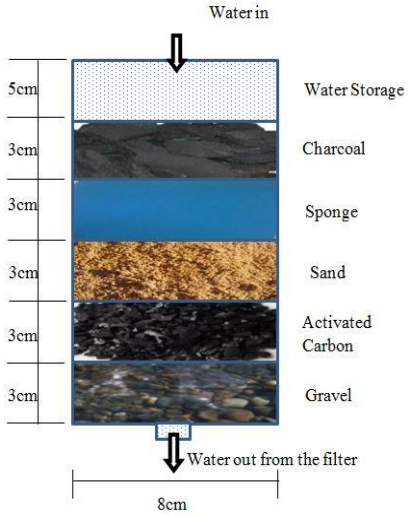

Fig. 2. Schematic diagram of filter B

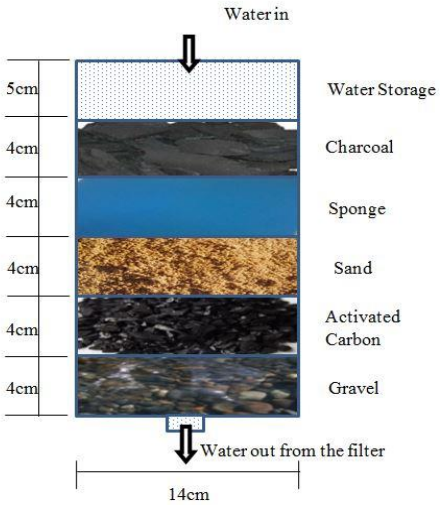

Fig. 3. Schematic diagram of filter C

Filter A consists of four layers: sponge layer, sand layer, activated carbon layer and gravel layer. Each layer is 3 cm high with 8 cm diameter. Filter B is the modification of filter A which consists of 5 layers: sponge layer, charcoal layer, sand layer, activated carbon layer and gravel layer. Each layer is 3 cm high with 8 cm diameter. Filter C is the modification of filter B which has the bigger size compared to filter B and filter A. Filter C has the diameter of 14 cm and each layer of material is 4 cm high.

D. Laboratory Testing

Laboratory Testing was done for wastewater before using carbon filter and after using carbon filter. The laboratory testing which had done include turbidity testing, TSS, 5-day BOD and COD.

III. RESULTS AND DISCUSSIONS

The analysis was covered the wastewater characteristic before using filter and after using filter during peak time 12.30 pm – 1.30 pm and non-peak time 11.30 am . The wastewater characteristic included TSS, turbidity, BOD and COD. There are two sample taken from different day.

As shown in Figure 4, for filtration using Filter A, the TSS value reduced from 19 mg/L to 11 mg/L for Sample 1 while for Sample 2, the TSS value was reduced from 18 mg/L to 7.5 mg/L. For filtration using Filter B, the TSS value was reduced from 10 mg/L to 5.5 mg/L for Sample 1 while for Sample 2, the TSS value was reduced from 12.5 mg/L to 6.5 mg/L. Then filtration using Filter C, the TSS value was reduced from 10 mg/L to 3.5 mg/L for Sample 1 while for Sample 2, the TSS value was reduced from 12.5 mg/L to 1.5 mg/L.

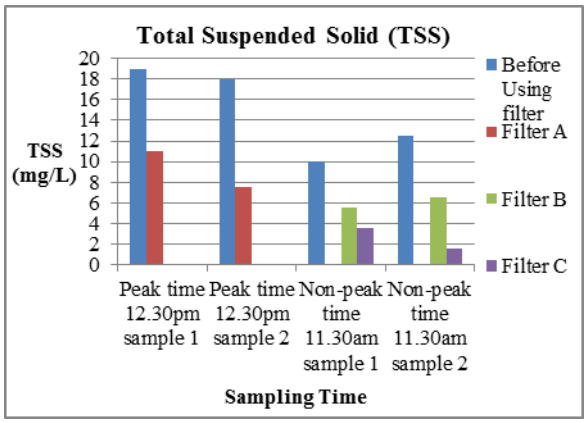

Fig. 4. Comparison of TSS value during different period

For turbidity, after filtration was done, the value of turbidity was reduced as shown in Figure 5. As during peak time 12.30 pm – 1.30 pm , the turbidity before using filter was 11 NTU. After filtration using Filter A, the turbidity obtained was 8.20 NTU while for Sample 2, the turbidity obtained was 8.11 NTU. During non-peak time 11.30 am, the turbidity before using filter was 49.1 NTU. The wastewater was filtered using Filter B and Filter C. For sample that was filtered using Filter B, the turbidity obtained was 1.612 NTU. For sample that was filtered using Filter C, the turbidity obtained was 1.238NTU.

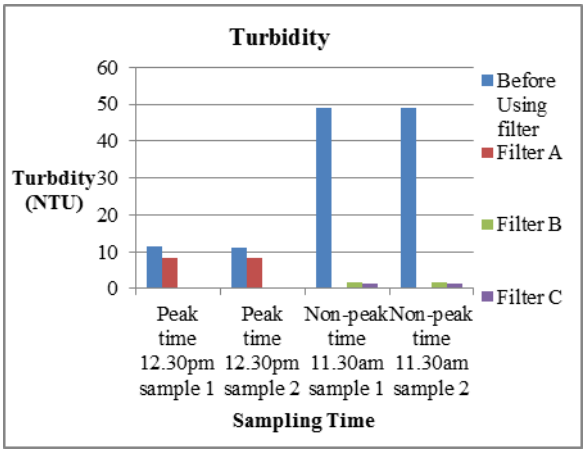

Fig. 5. Comparison of Turbidity value during different period

Figure 6 showed the comparison of BOD value during different period. For filtration using Filter A, the BOD value can be reduced from 40.27 mg/L to 37.25 mg/L for Sample 1 while for Sample 2, the BOD value was reduced from 39.5 mg/L to 39.05 mg/L. For filtration using Filter B, the BOD value was reduced from 30.1 mg/L to 13.70 mg/L for Sample 1 while for Sample 2, the BOD value was reduced from 32.35 mg/L to 14.15 mg/L. Then filtration using Filter C, the BOD value was reduced from 30.1 mg/L to 11.85 mg/L for Sample 1 while for Sample 2, the BOD value was reduced from 32.35 mg/L to 10 mg/L.

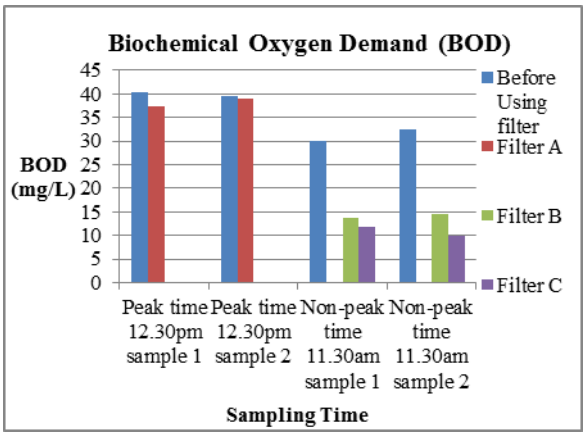

Fig. 6. Comparison of BOD value during different period

As shown in Figure 7, the COD value was reduced from 350.67 mg/L to 251.33 mg/L using Filter A. For filtration using Filter B, the COD value was reduced from 109.33 mg/L to 47 mg/L. For filtration using Filter C, it resulted in the highest degree of reducing which the COD value was reduced from 109.33 mg/L to 42 mg/L.

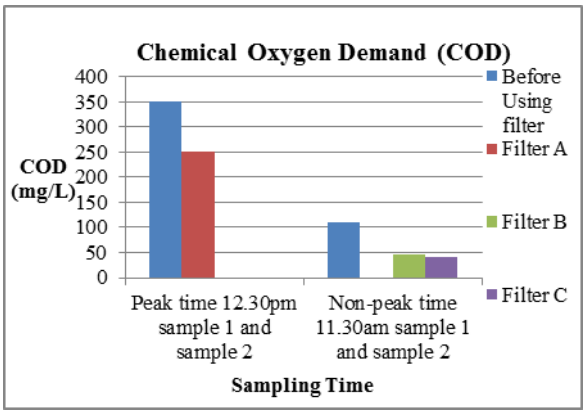

Fig. 7. Comparison of COD value during different period

Based on the analysis, all the wastewater parameter were able to reduced using the entire three filters. The efficiency of three filters was showed in Table 1, 2 and 3.

TABLE 1. PERCENTAGE OF PARAMETER REMOVAL USING FILTER A

Parameter	Percentage of removal (%)	
	Sample 1	***Sample 2***
Turbidity	28.32	26.27
TSS	42.11	58.33
BOD	7.45	1.14
COD	28	28

TABLE 2. PERCENTAGE OF PARAMETER REMOVAL USING FILTER B

Parameter	Percentage of removal (%)	
	Sample 1	***Sample 2***
Turbidity	96.72	96.72
TSS	45	48
BOD	54.49	55.33
COD	57.01	57.01

TABLE 3. PERCENTAGE OF PARAMETER REMOVAL USING FILTER C

Parameter	Percentage of removal (%)	
	Sample 1	***Sample 2***
Turbidity	97.48	97.48
TSS	65	88
BOD	60.63	69.09
COD	61.58	61.58

Based from the results shown, among the three filters, Filter C achieved the highest percentage of removal for all the parameter. The turbidity was able to be removed around 97.48%. For TSS the percentage of parameter removal was 65% and 88%. For BOD, the percentage of parameter removal was 60.63% and 60.09% while for COD, the percentage of parameter removal was 61.58%.

Results showed that carbon filter was able to improve the wastewater quality and the efficiency of filter was increased with the filter dimension and material components.

The results of wastewater after using the filter C also were compared with the Water Quality Index Classification (WQI) refer Table 4.

TABLE 4. DOE WATER QUALITY INDEX CLASSIFICATION

Source: EQR (2012)

PARAMETER	UNIT	CLASS				
		I	II	III	IV	V
Ammoniacal Nitrogen	mg/L	< 0.1	0.1 – 0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
Biochemical Oxygen Demand	mg/L	< 1	1 – 3	3 – 6	6 – 12	> 12
Chemical Oxygen Demand	mg/L	< 10	10 – 25	25 – 50	50 – 100	> 100
Dissolved Oxygen	mg/L	> 7	5 – 7	3 – 5	1 – 3	< 1
pH	-	> 7.0	6.0 – 7.0	5.0 – 6.0	< 5.0	> 5.0
Total Suspended Solid	mg/L	< 25	25 – 50	50 – 150	150 – 300	> 300
Water Quality Index		> 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31

The Water Quality Index (WQI) is the basic guideline which related to the category of pollution load and the classification for water quality as stipulated under Interim National Water Quality Standards for Malaysia. Table 4 show the water quality standards for Malaysia for each parameter.

TABLE 5. WQI CLASSIFICATION FOR SELECTED PARAMETER OF WASTEWATER AFTER USING FILTER C

Parameter	WQI				
	Sample 1		***Sample 2***		***Class***
Non –peak time	***Before***	***After***	***Before***	***After***	
Turbidity (NTU)	49.1	1.23	49.1	1.23	I
TSS (mg/L)	10	3.5	12.5	1.5	I
BOD (mg/L)	30.1	11.85	32.35	10	IV
COD (mg/L)	109.33	42	109.33	42	III
DO (mg/L)	7.43	7.79	7.42	7.74	I

Based from Table 5, the turbidity obtained was 1.238 NTU for both sample and it is belonged to Class I. The value was reduced about 97.48% from 49.1 NTU.

For non-peak time 11.10 am, the TSS obtained before using filter was 10 mg/L and 12.5 mg/L for Sample 1 and Sample 2. After the filtration process the values decrease to 3.5 mg/L for Sample 1 and 1.5 mg/L for Sample 2. It shows that the TSS after the filtration will be in Class I.

The BOD value obtained decrease to 11.85 mg/L from 30.1 mg/L for Sample 1 and from 32.35 mg/L to 10 mg/L for Sample 2 and these values belonged to Class IV.

For the COD value of wastewater after filtration was done USING Filter C, the COD value was 42 mg/L from 109.33 mg/L for both samples. The COD for this wastewater after filtartion is in Class III.

The DO level was increased from 7.43 mg/L to 7.79 mg/L for Sample 1 and from 7.42 mg/L increased to 7.74 mg/L for Sample 2. It shows that DO level after using filter C is in Class I.

IV. CONCLUSIONS

As a conclusion, the three designed filter: Filter A, Filter B and Filter C were able to improve the wastewater parameter. Filter A resulted about 1.14% to 58% of parameter removal; Filter B was able to remove about 45% to 96.72% of parameter removal. While for Filter C, it was able to show the highest percentage of removal which the percentage removal was more than 60% for all the parameter and the highest percentage of parameter removal was 97.48%. The best efficiency in improving the water quality which was Filter C will be recommended to be set up near KK3 café as can be used to pre-treat the wastewater from KK 3 café before it is discharged into river.

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