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Waste Water Reclamation and Reuse in Yenegoa Using Activated Carbon and Zero B

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Abstract

In this study, waste water reclamation and reuse was carried out in Yenegoa Metropolis using activated carbon and Zero B methods. Polluted waste water was obtained from Yenagoa waterside, and characterized and treated using activated carbon by column adsorption and Zero-B method separately to ascertain its potentials for reclamation and reuse. The pH, turbidity, total suspended solid (TSS) and Biochemical Oxygen Demand (BOD) test was carried out on untreated and treated waste water. From the results obtained, the untreated waste water has pH 6.4, turbidity = 38.0mg/6, TSS=66.0mg/L and BOD = 14.2mg/L while the values of lead, zinc, copper and chromium present were 0.03mg/L, 0.04mg/L, 0.04mg/L and 0.03mg/L respectively. Similarly the values of treated waste water using activated carbon were 7.2, 1.9mg/L, 9.01mg/L and 4.6mg/L for pH, turbidity, TSS and BOD. While 6.99mg/L, 1.69mg/L, 8.7mg/L and 4.2mg/L were obtained for pH, turbidity, TSS and BOD using Zero-B. The treated waste water values of lead, zinc, copper and chromium have no significant change with the untreated waste water. It was recommended that the treated waste water is adequate for good water quality even though the TSS were 9.01mg/L and 8.7mg/L in both methods used.

Introduction

Inadequate water supply and water quality deterioration represent serious contemporary concerns for many Municipalities, Industries, and Agriculture in various parts of the world. (Asano, 2002).

Several factors have contributed to these problems, which includes, population growth especially in the Urban areas, surface and groundwater contamination, uneven distribution of water resources and frequent droughts. Presently, a recurring research in environmental and water resources engineering has been that waste water can be treated to high quality which could be put to beneficial use rather than wasted. Therefore by applying this conviction to responsible engineering, coupled with the vexing problems of increasing water shortages and environmental pollution, a realistic framework has emerged for considering multiple uses of water through reclamation and re-use in many parts of the world (Adike, 2008).

Water pollution control efforts in many countries have made treated municipal and industrial waste water suitable for economical augmentation to the existing water supply, when compared to increasingly expensive and environmentally destructive new water resources development.

Water reclamation and re-use however accomplishes two fundamental functions. The functions is that, the treated effluent is used as a water resource for beneficial purposes and the effluent is kept out of the stream, and lakes thus reducing pollution of surface and ground water.

Yenagoa is the capital city of Bayelsa State in Nigeria. The water from this city from the research conducted shows that it contains much iron and other contaminants of petroleum products (Wenibo, 2007). Due to increase in both polulation growth and urbanization expansion, and the demand for more water in the area, there is need to come up with a programme to solve the water problems in this city. Therefore, to avert this problem and make potable water available to the teeming population, there is need to treat the polluted waste waters in the area.

Activated carbon also called activated charcoal or activated coal is a general term which covers carbon material mostly derived from charcoal. It is a material with an exceptionally high surface area, for example, one gram of activated carbon has the surface area of approximately $500m^2$ (Onugwe, 2006).

Typically determined by nitrogen gas absorption and includes a large amount of micro porosity sufficient activation for useful applications may come solely from the high surface area though often further chemical treatment is used to enhance the absorbing properties of the material. Aktas and Cecen (2001) wrote in addition of activated carbon to batch activated sludge reactors in the treatments of landfill leachate and domestic wastewater. In this study, leachate from Municipal landfill was combined with domestic wastewater and was treated in batch activated sludge systems.

Therefore the main objective of this study is to assess the effectiveness of activated carbon and Zero B in the reduction of heavy metals from polluted wastewater in Yenagoa Waterside. Also to analyze the properties of polluted wastewater before and after treatment and make comparison and make recommendations based on the findings.

Materials and Methods

Materials:

Wastewater (polluted water) obtained from Yenegoa waterside; four liters jerry can; activated carbon; 250ml beakers; 200ml beakers, 100ml beakers funnel; fitter papers; plastic bottles; sodium chloride (NaCl) and aluminum sulphate ($Al_2(SO_4)_3$) as a coagulant, and Zero-B apparatus.

Initial Sample Preparation

The wastewater sample was collected in a four liter jerry-can at an interval of 0.5m in six different spots of the river with six jerry-cans. The samples were then transported to the Rivers State University of Science and Technology for analysis. Before the sample was collected, a thermometer was first inserted inside the river, and the temperature of the water on the thermometer was read as 24.8^0C. In chemical engineering laboratory, 1 liter of each of the cans were collected and added together to form the original waste water used for the experiment.

Experimental Apparatus

Wastewater treatment was carried out using a simple apparatus consisting of a water reservoir connected to a glass column of 25cm long 6cm diameter; and a water received. The column was fitted with activated carbon packed with sand.

Experimental Procedures

1000ml of wastewater sample was measured into the bottle. A digital weighing balance was used to weigh 20g of $Al_2(SO_4)_3$ which was then added into the bottle and shaked properly for about five minutes. 3.0g of Nacl salt (Sodium Salt) was added and shaked very well. The bottle was tightly corked and kept in chemical engineering laboratory for five days to equilibrate. The addition of Al2(SO4)3 and Nacl serves as a coagulant to aid in the removal of fine carbon particles. The fine carbon particles hinder the adsorption efficiency of the activated carbon by clogging its pores spaces.

Filter Papers

Filter papers were used for filtering and decanting the treated water sample into another plastic bottle in the chemical engineering laboratory. After a period of 7 days, a specimen sample of 250ml was then used for analysis to determine the effect of the activated carbon on the treated waste water.

Zero-B Equipment for Waste Water Treatment

The procedure for Zero-B water treatment equipment is shown in figure 3.1. The lid on the body of Zero-B was unscrewed, and the inner protective seal was then removed and replaced with the filter pad provided separately. The blue adaptor was also fit onto the body of Zero-B and the lid then screwed back. The lower seal on the Zero-B was peeled off and the Zero-B was then screwed to the tap attached to the rubber bucket until it was securely attached. Wastewater was then poured inside the bucket and allowed to pass through the Zero-B equipment via the tap for about 10 minutes so that the Zero-B resin inside gets wet properly. This is important as the medium work best when wet. To carryout this work effectively, the tap was adjusted so that it took 6 seconds to fill a 200ml beaker. The water that passed through the Zero-B was then carried for analysis.

Laboratory Analysis

The Physic-Chemical Parameters of the wastewater sample. Such as PH value, Turbidity, Total Suspended Solid (TSS), Lead, Zinc, Copper and Chromium Concentrations were done using the methods by the American Public Health Association (APHA). The procedure and method of test was also used to test the treated sample water

Results and Discussion

The results of the experiments on the physic-chemical parameters of the waste water, treated wastewater and the recommended specification for quality water standard by World Health Organization (WHO) are presented in Table 4.1

Table1: Summary of data obtained for Untreated waste water, Treated waste water with

Activated Carbon and Zero B, and WHO Standard.

Parameter	Untreated water	Treated waste water using activated carbon	Treated waste water using zero-B	WHO standard for water quality
PH	6.4	2.7	6.99	7-8
Turbidity	38.0	1.9	1.6	1
TSS	66.0	9.01	8.7	5
Lead	0.03	0.03	0.03	0.05
Zinc	0.04	0.03	0.03	5
Copper	0.04	0.03	0.02	5
Chromium	0.03	0.03	0.03	0.05
BODS	14.2	4.6	4.2	4

Table 1, column 2 shows the initial physio-chemical parameters of the untreated waste water. The result indicates that the turbidity, total suspended solid and Biochemical Oxygen demand were quite higher than the world health organization water quality standards. The pH value is almost acidic in nature, while the heavy metals were less than the required specification for quality water meaning that they need no further treatment.

Comparing the PH of the untreated wastewater with that treated with activated carbon; zero-B and WHO standard: untreated wastewater is 6.4, activated carbon and zero-B treated are 7.2 and 6.99 meaning that the waste water treated with activated carbon fall within the range of world health organization standard, and that treated with zero-B approximately fall within the range of WHO standard of PH of 7 for good water. From the table, we can see that the turbidity of the waste water is 38.0. This value is very high compared with the WHO standard value of 1, while the treated wastewater value using activated carbon and Zero-B are 1.9 and 1.6 respectively. Total suspended solid value for untreated waste water is 66.0 and the corresponding treated waste water are 9.01 and 8.7 for activated carbon and Zero-B, while that of WHO standard is 5.

The table also shows that the heavy metals were all less than the world health organization standard. Lead and chromium have a uniform value of 0.03 for both untreated and treated waste water. This is less than 0.5 value by world health organization for lead and chromium. The untreated waste water for zinc reduced from 0.04 to 0.03 in both treated methods, used in the analysis. Copper shows variation of 0.01 from untreated waste water to activated carbon and Zero-B method used in that order. The table also showed that the biochemical oxygen demand (BOD) exhibit high value of 14.2 for the untreated waste water when compared with the world health organization standard value of 4 for BOD. The use of activated carbon by column adsorption and zero-B method in treating the waste water reduced the BOD from 14.2 to 4.6 and 4.2 for activated carbon and zero-B in that order.

Table 2: Physio Chemical Properties of Untreated Water

S/N	PH	Turbidity	TSS	Lead	Zinc	Copper	Chromium	BODS
1	6.4	38	66.0	0.03	0.04	0.04	0.03	14.2
2	6.2	38	66.0	0.03	0.04	0.04	0.03	14.2
3	6.3	38	66.0	0.03	0.04	0.04	0.03	14.2
4	6.4	38	66.0	0.03	0.04	0.04	0.03	14.2
5	6.3	38	66.0	0.03	0.04	0.04	0.03	14.2
6	6.4	38	66.0	0.03	0.04	0.04	0.03	14.2
7	6.2	38	66.0	0.03	0.04	0.04	0.03	14.2
8	6.4	38	66.0	0.03	0.04	0.04	0.03	14.2

Table 3: Physio Chemical Properties of Treated Waste Water Using Activated Carbon

S/N	PH	Turbidity	TSS	Lead	Zinc	Copper	Chromium	BODS
1	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
2	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
3	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
4	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
5	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
6	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
7	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6
8	7.2	1.9	9.01	0.03	0.03	0.03	0.03	4.6

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Table 4: Physio Chemical Properties of Treated Waste Water using Zero-B

S/N	PH	Turbidity	TSS	Lead	Zinc	Copper	Chromium	BODS
1	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
2	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
3	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
4	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
5	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
6	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
7	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2
8	6.99	1.6	8.7	0.03	0.03	0.02	0.03	4.2

Table 5: Summary of Physio Chemical Properties of Waste Water Treated Wastewater and the recommend WHO Specification

Parameter	Untreated Waster Water	Treated Waste Water using Activated Carbon	Treated Waste Water Using Zero B	WHO Standard for Water Quality
PH	6.4	7.2	6.99	7-8
Turbidity	38.0	1.9	1.6	1
TSS	66.0	9.01	8.7	5
Lead	0.03	0.03	0.03	0.05
Zinc	0.04	0.03	0.03	5
Copper	0.04	0.03	0.02	5
Chromium	0.03	0.03	0.03	0.05
BODS	14.2	4.6	4.2	4

Table 6: Two-Factor Anova Without Replication Comparing Zero B method And WHO Standard.

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
PH	2	14.49	7.245	0.13005
Turbidity	2	2.6	1.3	0.18
TSS	2	13.7	6.85	6.845
Lead	2	0.08	0.04	0.0002
Zinc	2	5.03	2.515	12.35045
Copper	2	5.02	2.51	12.4002
Chromium	2	0.08	0.04	0.0002
BODS	2	8.2	4.1	0.02
Treated waste water using zero-B	8	21.6	2.7	12.3476

WHO standard for water quality	8	27.6	3.45	7.576429

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	109.7921	7	15.68459	3.699681	0.052859	3.787044
Columns	2.25	1	2.25	0.53073	0.489948	5.591448
Error	29.6761	7	4.239443			
Total	141.7182	15				

Table 7: Two-Factor Anova Without Replication Comparing Activated carbon Method And WHO Standard

SUMMARY	*Count*	*Sum*	*Average*	*Variance*
PH	2	14.7	7.35	0.045
Turbidity	2	2.9	1.45	0.405
TSS	2	14.01	7.005	8.04005
Lead	2	0.08	0.04	0.0002
Zinc	2	5.03	2.515	12.35045
Copper	2	5.03	2.515	12.35045
Chromium	2	0.08	0.04	0.0002
BODS	2	8.6	4.3	0.18
Treated Waste Water using Activated Carbon	8	22.83	2.85375	13.23466
WHO Standard for Water Quality	8	27.6	3.45	7.576429

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Rows	113.7283	7	16.2469	3.55965	0.057888	3.787044
Columns	1.422056	1	1.422056	0.311569	0.594114	5.591448
Error	31.94929	7	4.564185			

Total	147.0996	15

Conclusion

The following conclusions were made based on the results of the analysis carried out on the waste water.

The pH, turbidity, total suspended solids and biochemical oxygen demand values obtained for untreated waste water are 6.4, 38.0, 66.0 and 14.2. These values were quite higher than the standard recommended by the world heath organization. Lead, zinc, copper and chromium in the waste water were also tested and found to be 0.03, 0.04, 0.04 and 0.03 respectively.

The wastewater treated with activated carbon and zero-B method in two different experiments was found to be 7.2, 1.9, 9.01, and 4.6; and 6.99, 1.6, 8.7 and 4.2 for pH, turbidity, total suspended solid and biochemical oxygen demand. Lead, zinc, copper and chromium have no significant changes when compared with their wastewater values.

The activated carbon by column adsorption and zero-B methods used in the analysis is adequate for waste water treatment.

Recommendation

The following recommendations were made

Zero-B method should be adopted for treatment of waste water for house hold usage, since it is affordable and economically better than activated carbon based method are good for waste water treatment and should be adopted.

Both Zero-B and activated carbon based method are good for waste water treatment and should adopted.

The treated waste water should be used for agricultural and other irrigation purposes.

Since the Zero-B water purifier apparatus is three thousand naira (N3,000) only and straight forward compared to that of activated carbon based method which requires aluminum sulphate and sodium chloride which is more expensive. Zero-B water purifier should be adopted especially for domestic purposes.

Further studies should be carried out on the lakes and river closer to Yenegoa metropolis.

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