BIO-TREATMENT OF PRODUCED WATER USING ELECTRODE PRODUCED FROM SELECTED BIOMASS IN MICROBIAL FUEL CELL

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ABSTRACT

The aim of this research is to investigate the electrodes potential of groundnut shell charcoal (GSC), used toner charcoal (UTC) and wood ash charcoal (WAC) used as electrodes in microbial fuel cell for wastewater treatment. AAS and laboratory water sample analysis methods were used to check for the properties of the wastewater after subjecting to MFC treatment. The analysis confirmed that MFC is a good option for wastewater treatment. The physiochemical properties analyzed were COD, PH, TSS, TDS, Turbidity, Salinity and conductivity, the electrode effectiveness were as follows WAC > UTC > GSC., thus wood ash charcoal electrode has the highest potential in MFC for treating the above stated properties. For heavy metals tested (Zn, Pb, Cu, Cr and Cd), the efficiency of the electrode were GSC > UTC > WAC. It is pertinent to mentioned here that the choice of the electrodes in MFC for wastewater treatment should depend on the type of contaminant(s) present in the water.

Keywords: Biomass, biotreatment, electrode, Microbial fuel cell, produced water

1.0 INTRODUCTION

The present of contaminants in water are cause by daily human activities in process industries, manufacturing industries and during exploration of natural resources (Argonne National laboratory, 2009), it is also generated from domestic activities. Wastewater containing diverse organic substances (e.g. fatty acid, carbohydrate, protein) and heavy metals (e.g. chromium, copper, and cadmium etc.) has caused severe environmental pollution. (EPA, 2008)

. Some of this wastewater when allowed into the ecosystem endangers the life of living things. Good percentage of this chemical are mutagenic while some are carcinogenic.

Many regulations have been put down by regulating agents to curtail the level of contaminants been sent along side with the wastewater but yet most of these standard are violated. In the other way around the cost of treating this wastewater is very expensive thus becoming difficult to meet up with the standard.

Over the year many methods such as adsorption, biodegradation, ion exchange, precipitations, coagulation etc have been developed for the treatment of wastewater, some of these methods are based on the type of substance contaminating the water and most at time choice are made based on the cost of treatment. The most striking consideration is the fact that most of the methods introduce new substance(s) into the water, this called for the search of less expensive and ecologically friendly approach to wastewater treatment and one of such method is the Microbial fuel cell (MFC). (Yokoyama et al., 2006: Karmakar et ak., 2010: Kiely et al., 2011).

MFCs employ bio-electrochemical reactions by bacteria in oxidizing various organic or inorganic compounds in the anode chamber and produced electron and proton that is been transported to the cathode chamber in-order to reduced oxygen to water (Logan and Regan, 2006: Hameler et al, 2006). It has the advantage of generating electricity during the process (Oji et al., 2013). Electrons flow from the anode to the cathode across a load thereby generating electric current (Kim et al., 2008: Oji et al., 2013).

Treatment of wastewater for example produce water using this method is very efficient because of zero demand of external source of energy and does not pose threat to the ecosystem (Longan 2005: Kim et al., 2006: Logan and Rebacy 2012).

In this research, investigation is carryout on wood ash, groundnut shell and use toners charcoal to ascertain the best material for the production of electrodes used for MFC, with the level of treatment of the contaminants in the water as performance indicator.

3.0 MATERIALS AND METHOD

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The analysis of the waste water was done using standard ASTM procedure listed in table 3.1

Table 3.1: Methos of analysis of waste water parameter

S/N	Parameter	Unit	Measurement Method (ASTM)
1	Conductivity	µs	D1125-14
2	pH		D1293-12
3	Turbidity	NTU	D1889
4	TSS	mg/l	D5907-18
5	TDS	mg/l	D5907-18
6	Salinity	%	D1125-19
7	BOD	mg/l	D6238-98
8	COD	mg/l	D6238-98

4.1 MFC Physiochemical Analysis Result

This experimental work was observed for 20days. It was operated in a semi-batch process where samples are taking for each of the cells every 5days via the valves and the heavy metals were determined.

Table 4.1: Physiochemical Results

		Groundnut shell cell	Wood ash cell	Tonner cell
	START	END	END	END
COD(ppm)	1187	649	434	584
PH	8.54	7.86	7.43	7.69
Conductivity	3.56	11.04	9.47	10.21
Turbidity (NTU)	183	19	9.44	12.0
TSS(ppm)	181	53	12	39
TDS(ppm)	6080	5610	2410	5200

Salinity (ppm)	6.3	5.7	2.5	5.3

4.1.1 COD Results

The microbial fuel cells started with the COD value of 1187ppm, and in the groundnut shell cell there was a decrease to 649ppm with percentage reduction of 45% and in the wood ash cell, it decrease to 434ppm with percentage reduction of 63.43%,, and also the tonner cell also reduced it to 584 ppm with percentage reduction of 50.8%

4.1.2 PH Results

The microbial fuel cells started with the PH value of 8.54 and in the groundnut shell cell there was a decrease to 7.86 with percentage reduction of 7.96%, and in the wood ash cell, it decrease to 7.43with percentage reduction of 12.99%, and also the tonner cell also reduced it to 7.69 with percentage reduction of 9.95%

4.1.3 Conductivity Results

The microbial fuel cells started with the conductivity value of 3.56 and in the groundnut shell cell there was an increased to 11.04, and in the wood ash cell, it increased to 9.47, and also the tonner cell also reduced it to 10.21.

4.1.4 Turbidity Results

The microbial fuel cells started with the Turbidity value of 183(NTU) and in the groundnut shell cell there was a decreased to 19(NTU) with percentage reduction of 89.61%, and in the wood ash cell, it decreased to 9.44(NTU) with percentage reduction of 94.84%, and also the tonner cell also reduced it to 12(NTU) with percentage reduction of 94.47%.

4.1.5 TSS Results

The microbial fuel cells started with the TSS value of 181(ppm) and in the groundnut shell cell there was a decreased to 53(ppm) with percentage reduction of 70.71%, and in the wood ash cell, it decreased to 12(ppm) with percentage reduction of 93.37%, and also the tonner cell also reduced it to 39(ppm) with percentage reduction of 78.45%.

4.1.6 TDS Results

The microbial fuel cells started with the TDS value 6080ppm and in the groundnut shell cell there was an increased to 5610ppm with percentage reduction of 7.73%, and in the wood ash cell, it increased to 2410ppm with percentage reduction of 63.37%, and also the tonner cell also reduced it to 5200ppm with percentage reduction of 14.47%.

4.1.7 Salinity Results

The microbial fuel cells started with the Salinity value of 6.3ppm and in the groundnut shell cell there was an increased to 5.7ppm with percentage reduction of 9.52%, and in the wood ash cell, it increased to 2.5ppm with percentage reduction of 60.31%, and also the tonner cell also reduced it to 5.3ppm with percentage reduction of 15.87%.

4.2 Heavy metal removal Result

Table 4.2: Groundnut shell electrode cell for heavy metal removal in an MFC

	GROUNDNUT SHELL CELL				
Days	Zn(ppm)	Pb(ppm)	Cu(ppm)	Cr(ppm)	Cd(ppm)
0	0.194	0.095	0.087	0.097	6E-04
5TH DAY	0.068	0.092	0.035	0.029	5E-04
10TH DAY	0.042	0.038	0.014	0.021	5E-04
15TH DAY	0.036	0.019	0.013	0.019	4E-04
20TH DAY	0.023	0.004	0.008	0.002	2E-04

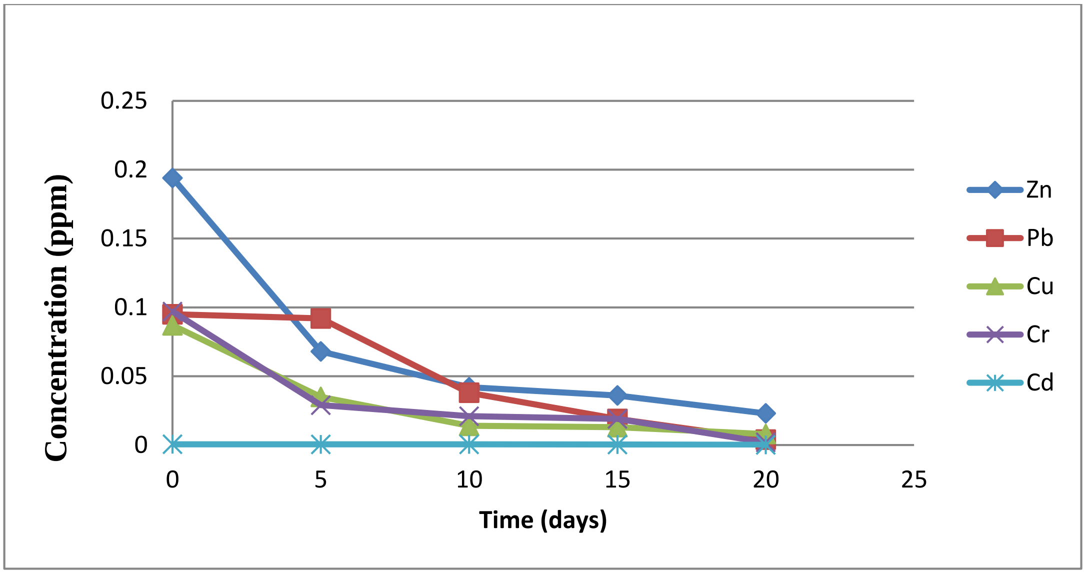

Figure 4.1: Plot of heavy metal concentration against time for the groundnut shell cell

Table 4.3: Wood ash electrode cell for heavy metal removal in an MFC

	WOOD ASH CELL				
Days	Zn(ppm)	Pb(ppm)	Cu(ppm)	Cr(ppm)	Cd(ppm)
0	0.194	0.095	0.087	0.097	6E-04
5TH DAY	0.127	0.095	0.055	0.021	5E-04
10TH DAY	0.107	0.092	0.05	0.019	4E-04
15TH DAY	0.093	0.038	0.031	0.002	3E-04
20TH DAY	0.075	0.004	0.01	0.002	2E-04

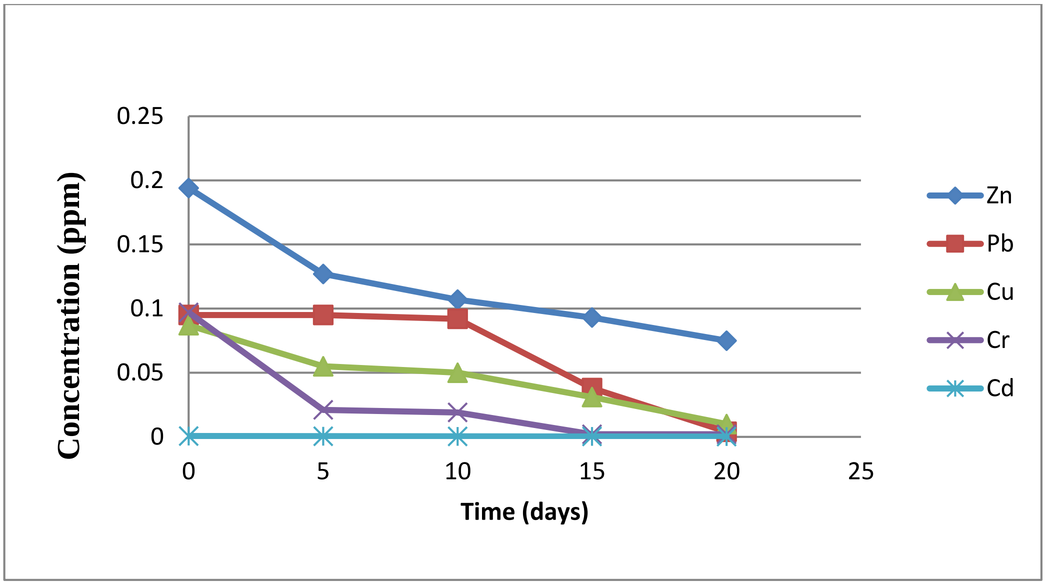

Figure 4.2: Plot of heavy metal concentration against time for the wood ash cell

Table 4.4: Tonner electrode cell for heavy metal removal in an MFC

	TONNER CELL				
Days	Zn(ppm)	Pb(ppm)	Cu(ppm)	Cr(ppm)	Cd(ppm)
0	0.194	0.095	0.087	0.097	6E-04
5TH DAY	0.118	0.092	0.055	0.019	5E-04
10TH DAY	0.064	0.053	0.018	0.014	4E-04
15TH DAY	0.063	0.004	0.008	0.002	0.004
20TH DAY	0.047	0.004	0.008	0.002	2E-04

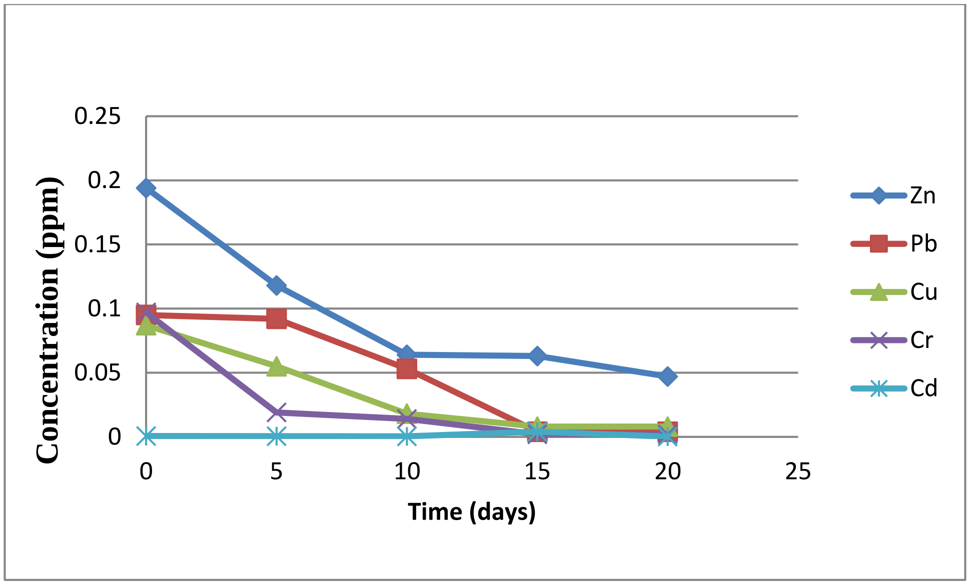

Figure 4.3: Plot of heavy metal concentration against time for the Tonner cell

The plots shows that the electrodes are effective for heavy metal removal in an MFC and therefore.

4.2.1 Zn removal Result

The microbial fuel cells started with the Zn concentration 0.194ppm and in the groundnut shell cell, it decreased to 0.023ppmwith percentage reduction of 88.14% after 20days of treatment using MFC, and in the wood ash cell, it decreases to 0.075ppmwith percentage reduction of 61.34%, and also in the tonner cell also reduced it to 0.047ppmwith percentage reduction of 63.43%.

4.2.2 Pb removal Result

The microbial fuel cells started with the Pb concentration 0.095ppm and in the groundnut shell cell, it decreased to 0.004ppm with percentage reduction of 95.79% after 20days of treatment using MFC, and in the wood ash cell, it decreases to 0.004ppmwith percentage reduction of 95.79%, and also in the tonner cell also reduced it to 0.004ppmwith percentage reduction of 95.79%.

4.2.3 Cu removal Result

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The microbial fuel cells started with the Cu concentration 0.087ppm and in the groundnut shell cell, it decreased to 0.008ppm with percentage reduction of 90.80% after 20days of treatment using MFC, and in the wood ash cell, it decreases to 0.01ppm with percentage reduction of 88.50%, and also in the tonner cell also reduced it to 0.008ppmwith percentage reduction of 90.80%.

4.2.4 Cr Removal Result

The microbial fuel cells started with the Cr concentration 0.097ppm and in the groundnut shell cell, it decreased to 0.002ppmwith percentage reduction of 97.93% after 20days of treatment using MFC, and in the wood ash cell, it decreases to 0.002ppmwith percentage reduction of 97.93%, and also in the tonner cell also reduced it to 0.002ppmwith percentage reduction of 97.93%.

4.2.5 Cd Removal Result

The microbial fuel cells started with the Cd concentration 0.0006ppm and in the groundnut shell cell, it decreased to 0.0002ppmwith percentage reduction of 66.67% after 20days of treatment using MFC, and in the wood ash cell, it decreases to 0.0002ppmwith percentage reduction of 66.67%, and also in the tonner cell also reduced it to 0.0002ppmwith percentage reduction of 66.67%.

5. CONCLUSION

Microbial fuel cells from the results obtained has proven to an efficient method of wastewater treatment. It is easy and ecologically friendly way of handling toxic contaminants in water. It is also observed that MFC can be attractive for produced wastewater treatment or for the modification of current conventional treatment plants. The research outcome proved that the composition/source of the locally prepared electrode (that is, source of charcoal) used in MFC, also contributes greatly to the treatment efficiency. In this case the wood ash, groundnut shell and Tonner charcoals are explored and it's observed from the results tabulated above that the wood ash cell has a higher efficiency in removal of physiochemical contaminants in wastewater when compared to the other charcoals used as electrodes. While groundnut shell is more efficient in remove heavy metal from the water. And MFCs can also serve as an alternative renewable source of energy through bio-energy production.

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