ISSN: 4247-5218
Volume 9, Number 2, 2024
International Journal of Advancement in Science and Technology

TREATMENT OF EFFLUENT USING ACTIVATED GROUNDNUT HUSK

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ABSTRACT

This research work was done to evaluate the effectiveness of activated groundnut husk in removing contaminants and heavy metals from water. The activated carbon was prepared from groundnut husk in two ways; by carbonizing before activating and by activating before carbonizing. The effectiveness of both carbons in removing contaminants from water were compared by running some parameters which are; pH. Temperature, Conductivity, Total Dissolved Solids, Total Suspended Solids. The presence of four heavy metals; Lead (Pb), Cadmium (Cd), Copper(Cu) and Iron(Fe) was checked for in the effluent and the effectiveness of these carbons in removing heavy metals from the water compared. The results showed that both carbons were effective in removing contaminants from water and also treating heavy metals present in the water, but carbon 1 prepared by Carbonizing before activating the groundnut husk has a higher efficiency of treating the water compared to carbon 2. It is recommended that further work should be done on this project so as to arrive at a more sufficient and efficient means of producing and using activated groundnut husk in wastewater treatment.

Keyword: Groundnut husk activated carbon, Furnace, Effluent Treatment, Removing Heavy Metals from Water

INTRODUCTION

Effluent can be defined as "wastewater or other liquids waste, often containing pollutants, that is discharged into a body of water or the environment. Effluent is a term used to describe a treated or untreated wastewater that is discharged from a source, such as a sewage treatment plant, factory or agricultural area into a receiving environment. It can include a range of pollutants, including organic and inorganic matter, nutrients, metals and pathogens. The emerging contaminants present in wastewater are synthetic or naturally occurring chemicals detected in water and adversely affect human and ecological health (Wang et al., 2019). Activated carbon is a solid, porous, black carbonaceous material that is tasteless. Activated carbon can be defines as a porous carbon material, usually chars, which have been subjected to reaction with gases during or after carbonization in order to increase porosity (Marsh, 1989). Groundnut husk activated carbon presents a promising material for water treatment due to its cost effectiveness, and high adsorption capacity. Its application can enhance the efficiency and sustainability of water treatment processes, making it a valuable addition to modern water treatment plants (Rao et al., 2019; Kumar et al., 2020).

METHODOLOGY

Preparation of activated carbon from groundnut Husk

The washed husk will be allowed to dry in an oven and ground into small particles using a grinder. The ground husks will then be carbonized by heating in a furnace at a temperature of around 400-500^{0}C for some minutes. After carbonization, the resulting material will be washed with water to remove any impurities. The washed material will then be activated using potassium hydroxide (KOH) and then heated again at a temperature of 500-600^{0}C to produce activated carbon before being cooled and ground into powder. Effluent Characterization The collected effluent will be taken to the laboratory for characterization to determine certain parameters in the effluent and the extent to which they are present. The parameters are: Ph value, Temperature (^{0}C), Total dissolved solid

(Mg/l), Total suspended solid (Mg/l), Chemical oxygen demand (Mg/l), Atomic absorption spectrometry for the determination of heavy metals (Pb, Fe, Cu, Cd).
The Ph meter was calibrated using buffer solutions of pH values 4, 7 and 10 respectively. After calibration, a small quantity of the effluent was collected in a beaker. The pH probe was immersed in the effluent in the beaker and then turned on and the corresponding values displayed on the pH screen recorded. The Total Suspended Solid was determined by filtering a well mixed aliquot (1ooml) of the sample through a dried and pre-weighed Millipore filter paper using vacuum filtration apparatus. The filter paper was then dried at $105^{o}C$ to constant weight and weighed again. The difference in weight of the filter paper represents the total suspended solid. The sample was transferred into the heavy metal can and the standard prepared to create a calibration curve.

The Atomic Absorption
Spectrophotometer (AAS) was set up and the correct heavy metals was selected. Introduce the sample to the instrument via the nebulizer. The absorption was measured and the reults compared with the calibration curve

RESULTS
Initial wastewater characterization
Table 1 shows the result of the characterization of Effluents prior to treatment with activated carbon
Table 1. Characterization of effluent prior to activated carbon treatment

S/N	Parameters	Values
1	pH	6.93
2	Temperature	28.7°C
3	Total Dissolved Solids (TDS)	250.2mg/l
4	Total Suspended Solids (TSS)	147.2mg/l
5	Conductivity	373.4иS/cm
6	Lead	<0.01mg/l
7	Cadmium	0.004mg/l
8	Copper	<0.01mg/l
9	Iron	2.257mg/l

Post treatment characterization of effluents
Table 2a. Characterization of the treated effluent using carbon1

S/N	Parameters	Values
1	pH	7.10
2	Temperature	28.7°C
3	Total Dissolved Solids (TDS)	212.7mg/l

4	Total Suspended Solids (TSS)	101.6mg/l
5	Conductivity	280иS/cm
6	Lead	<0.01
7	Cadmium	0.002
8	Copper	Nil
9	Iron	2.255

Table 2b. Characterization of the treated effluent using carbon 2

S/N	Parameters	Values
1	pH	7.69
2	Temperature	28.7°C
3	Total Dissolved Solids (TDS)	227mg/l
4	Total Suspended Solids (TSS)	108.9mg/l
5	Conductivity	293.9иS/cm
6	Lead	<0.01mg/l
7	Cadmium	0.025mg/l
8	Copper	<0.01mg/l
9	Iron	2.257mg/l

The pH value of the treated effluent using carbon 1 was 7.10 and that of carbon 2 was 7.69. Carbon 1 can be said to be more effective than carbon 2 since the pH value was neutral compared to carbon 2. Carbon 2 has a higher pH because the base activation process introduced alkaline functional groups on to the carbon surface, leading in increased basicity making the pH higher. The temperature of the water remained unchanged before and after treatment with both activated carbons. This implies that the treatment process did not generate heat or alter the thermal characteristics of the water. Carbon 1 had a TSS removal rate of 30.98% while carbon 2 had a removal rate of 26%. Both carbons were effective in decreasing TSS, both activated carbons 1 showed superior performance, achieving a higher percentage reduction compared to activated carbon 2. The observed reduction in the conductivity of the water showed the effectiveness of the activated carbon in adsorbing ions from the water this lowering the overall ion concentration of the water. Carbon 1 showed a 25% decrease in conductivity and this indicates a good adsorption capacity and efficiency in ion removal. Carbon 2 had a decrease of 21.3% in conductivity and suggests that while this activated carbon is effective at reducing dissolved ions, it is less efficient than Carbon

DISCUSSION

The pH value of the treated effluent using carbon 1 was 7.10 and that of carbon 2 was 7.69. Saltos et al (2024) reported a Ph of 5.0 and 5.4 before and after treatment of waste water using activated carbon derived from cocoa shell. These results are slightly more acidic than those reported by Torres and Navarro (2020) who documented a pH close to 6.2 with activated carbon derived from other organic residue. Rodriquez et al (2018), obtained a pH of 5.5 by using higher concentrations of activated carbon in their study, indicating that water acidification could be a common consequence of the use of activated carbon in wastewater treatment. Chiriboga et al (2024) achieved a final pH in a range of 6.8 to 7.1 and explains that there is a difference between the treatments in the removal of pH from the waste water sample. Water has a high specific heat capacity, meaning it requires a relatively large amount of energy to change its temperature and the amount of heat generated or absorbed during the adsorption of solids onto activated carbon is usually insufficient to affect the overall water temperature. This explains why the temperature of the water remain unchanged. Carbon 1 had a TDS removal rate of 14.99% while that of carbon 2 is 9.27%. This falls within the range of previous studies which reported TDS values of 10-16%. A study by saltos et al (2024) reported a TDS removal of 14.64% in waste water treatment using activated cocoa shell. Wilson et al (2018) reported a TDS removal of approximately 20% using polymer membranes reinforced with carbon based nano materials for water purification. Liu and Wang (2019) in their research for the effect of activated carbon source of pollutant removal efficiency observed a TDS removal of 10%. Valbuena (2018), in his study on the use of cocoa husks, reported a 16% TDS removal in waste water treatment. For TSS previous studies conducted by saltos et al (2024) had a 30.8% removal rate from water and this is the close to that obtained by Zhang et al (2018) in a related research where he achieved TSS removal of approximately 35% using UV/Chlorine photodegradation methods in water treatment. Zhang et al (2018) reported a 25% TSS removal using Organo silicon nano sheets with Gemini surfactants for rapid adsorption of ibuprofen in aqueous solutions. Torres and Navarro (2020) in their study on the effectiveness of activated carbons derived from agricultural residues in water treatment, observed a 32% TSS removal. A study by Yun et al (2008) demonstrated that activated carbon could effectively reduce TSS levels in waste water achieving reductions of up to 70% under optimal conditions. Cai et al (2011) found that the use of activated carbon in combination with other filtration methods showed enhanced removal rates of TSS, showing a synergetic effect. The observed reduction in the conductivity of the water showed the effectiveness of the activated carbon in adsorbing ions from the water this lowering the overall ion concentration of the water. Carbon 1 showed a 25% decrease in conductivity and this indicates a good adsorption capacity and efficiency in ion removal. Carbon 2 had a decrease of 21.3% in conductivity and this suggests that while this activated carbon is effective at reducing dissolved ions, it is less efficient than Carbon 1. A previous study by Egbom et al (2013) recorded a 34% reduction rate in conductivity in the treatment of saloon water using activated carbon. Another study by Ahsan et al (2024) recorded a 65% removal in conductivity in activated date pits used in removing pollutants from dye wastewater. The effectiveness of the activated carbon in the water treatment cannot be compared from the above result, but several studies has shown how effective activated carbon is in removing Lead from water. In a previous study by Ahmed et al (2022), a maximum adsorption of 22.8mg/l which removed 99% of Lead ions from a concentration of 100mg/l with an adsorbent dose of 10g/l was recorded. Another study by Ahsan et al (2021) observed a 98.84 % lead removal efficiency in activated carbon nano particle impregnated on light weight expanded clay aggregate from aqueous solution. Ramadevi (2019) bicarbonate treated Acacia Catechu Carbon was able to remove 98% Pb (II) ion from aqueous solution and Commercial activated carbon removed 52%. Carbon 1 had a 50% removal rate of Cadmium from the sample. This demonstrates a higher efficiency in removing Cadmium from water compared to Carbon 2 which has a lower removal rate and is therefore less effective.

Ayedun (2021) discussed the use of activated palm kernel shell in the removal of Cadmium ions from water and explained that this can be achieving optimally at lower pH, room temperature and high Cadmium concentration. A study by Ahmad et al (2023) explained the relationship between the percentage removal rate of Cadmium and pH after treatment of effluent and explained that the removal of Cadmium increases with decrease in pH and decreases with an increase in pH. This implies that a neutral pH condition generally favors the adsorption of Cadmium in water. The result showed the effectiveness of activated carbon 1 in removing all Copper ions present in the water while carbon2was able to treat Copper in water but not totally eliminating the Copper ions present in the water. Previous studies has shown that activated carbon has the capacity of treating Copper ions in water at a removal Percentage range of 90-100%. One of such studies was conducted by Zhang et al (2023) in the research "Adsorption removal of Copper (II) and Chromium (VI) from wastewater by Fe3O4 loaded granular activated carbon. Zhang et al (2023) recorded a removal percentage of 99.98% of the Cu ions in water.

Kumar et al (2014) investigated the removal of Copper ions from synthetic wastewater using activated carbon derived from agro-wastes. The result indicated that the activated carbon was effective in adsorbing Copper ions, with maximum removal efficiency achieved at optimal pH and contact time.

Idris et al (2011) in his study "Evaluation of kinetic models of Copper and Lead up take from dye wastewater by activated pride of Barbados shell "had a 93.94% removal of Cu ions from the dye wastewater. Another study that investigated the effectiveness of activated carbon in heavy metal adsorption from wastewater was conducted by Ekong et al (2023) and they recorded a 90% removal of Copper from water. From the results determined, Carbon 1 decreased the Iron present in the sample by 0.002mg/l which is a 0.09% removal after treatment. This implies that Carbon 1 had a very minimal effect on removing Iron from the untreated water sample. The Iron content for Carbon 2 remained unchanged after treatment, this indicates that the second activated carbon had no effect in removing Iron from the untreated effluent. A study by Ekong et al (2023) recorded a 94% in the removal of Iron from wastewater yet another study conducted by Zhang et al (2023) recorded a 99.98% in the removal of Iron and Cadmium from wastewater using Fe3O4 loaded granular activated carbon. The in significant reduction shown in this study in the removal of Iron from water could be as a result of the type of activated carbon used.

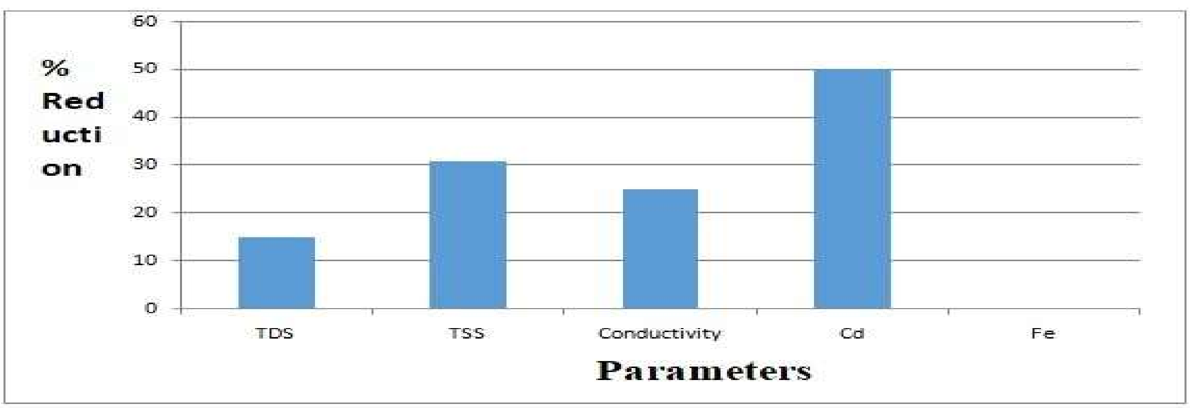

Fig 1:% Reduction of some Chemical Parameter for Carbon1

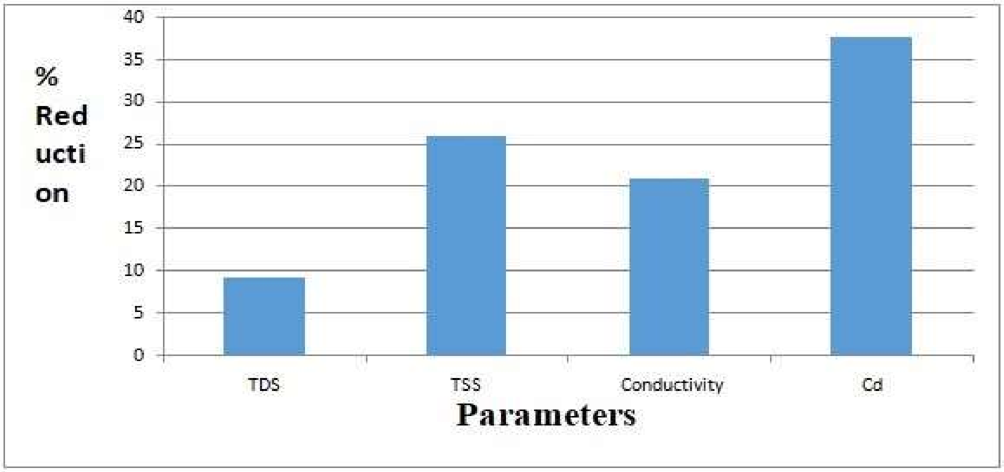

Fig 2:% Reduction of some Chemical Parameter for Carbon 2

CONCLUSION

In this study, activated groundnut husk was used in the treatment of effluent water and the activated groundnut husk was prepared in two ways; By carbonizing before activating (Carbon1) and by activating before carbonizing (Carbon2). The effectiveness of both carbons were compared by running some test parameters on the collected effluent. These parameters are pH, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Conductivity. Also the presence of some heavy metals Lead (Pb), Cadmium (Cd), Copper (Cu) and Iron (Fe). On comparing both Carbons, Carbon 1 was observed to be more effective than Carbon 2 in treating the effluent water as it had a higher removal percentage in treating Total Dissolved Solids (TDS), Total Suspended Solids (TSS), Conductivity and even on treating the heavy metals Pb, Cd, Cu and Fe present in the water Thus the type of activated carbon and the method of preparation can greatly affect its performance.

REFERENCES

1. Ahmad, Ibrahim M., Hayek W., Sarayah K. (2023) journal of ecological engineering 21(2), 131-139
2. Kumar, Geetha M., Mythili R., (2022). Synthesis of Activated Carbon from Groundnut shell via Chemical Activation. Journal of the institute of Engineers, 103, 15-22
3. Marsh H and Reinoso R (2006). Activated carbon production. Elseveir Science,6, 324-327
4. Ramadevi (2019). Removal of lead in water using activated carbon prepared from Acacia catechu.Water SA vol.45
5. Rodríguez, Praveena Y., Sashikesh G., (2018). Comparison of the efficiency of different activated carbons in chlorine removal. Journal of Environmental Chemistry and Engineering, 14(2), 120–130.
6. Saltos, Mosquera C., Riera A., Bravo A. P., (2024). Efficiency of Activated Carbon Derived from Cocoa Shells in Removing Pollutants from Wastewater. Journal of Ecological Engineering 2024, 25(7), 151–162
7. Torres, A., Navarro, M. 2020. Impact of Activated Carbon Derived from Agricultural Residues on the pH of Treated Wastewater. Journal of Environmental Management, 145(2), 234–241.
8. Wang, Akil H., Rashid U., (2010). Preparation of Activated Carbon from Agricultural Waste. Afr.J. Biotechnology, 9 (19), 2762-2767
9. Zhang, Yamashita N., Tamaka H., Kim I., (2018). Photo degradation of pharmaceuticals and personal care products in water treatment by UV/Chlorine: A review. Water research, 133, 182–195.