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Short Communication

Utilization of coconut fibre carbon in the removal of soluble petroleum fraction polluted water

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Activated carbon powder was obtained by treating coconut fibre with ammonium chloride and carbonized at 400°C. The powdered activated carbon was sieved. The portion that passed through a 212 um and retained on a 90 um mesh size was used for this study. The treatment was done to increase the surface area and the adsorption site of the carbon. The activated carbon was characterized in terms of pH, surface area, loss on ignition, moisture content and bulk density. The adsorption pattern of soluble petroleum fraction (kerosene and diesel) on coconut fibre carbons as a function of time was studied. The removal of diesel and kerosene from aqueous solutions measured by changes in the chemical oxygen demand shows that removal efficiency was less than 45% corresponding to about 6.8 mg/l/g decreases in chemical oxygen demand (COD). The removal of diesel and kerosene from aqueous solution followed a psuedo first order rate law.

Key words: Activated carbon, adsorption, chemical oxygen demand, characterisation, carbonisation.

INTRODUCTION

An inevitable consequence of economic development and civilization in an advance and technical age such as ours is the environmental impact of oil exploration. Yearly, both the government and various multi-national private oil companies contend with the hazards of crude oil spillage and its eventual contamination of both the aquatic and terrestrial ecosystem (Henry and Heike, 1989).

Each year, an average of 14 million gallons of oil from more than 10,000 accidental spills, are discharged into fresh water and salt water environments. These spills occur as a result of under water well blowouts, tanker accidents, storage tank failures, production platform blowouts, intensified petroleum exploration on the continental shelf, transfer operations between ships and shores, economic sabotage and youth restiveness like the Niger Delta militias in my country Nigeria. Many species of fish, birds and marine animals were adversely affected and an estimated 2 billion dollars have been spent on cleaning up the spill. Presently, Shell Petroleum Company is to pay the sum of 1.5 billion US dollars to the people of Niger –Delta for environmental degradation since the inception of the company in the region. The case was decided at the Supreme Court in Nigeria.

Immediate response in the cleaning up of the immiscible oil does much good in reducing the environmental hazards, the use of booms to contain the oil, as well as other methods have proved very useful, nevertheless, there is the problem of dissolved fractions of the oil in the water bodies, these, infact cause more harm than the bulk of the oil that floats on the top of the water since it interferes with the ecosystem of the water bodies.

The dissolved fraction of the oil are made up of hazardous organic substances such as benzene, xylene, toluene, that ate capable of causing diseases such as carcinogenesis and mutagenesis, they can also lead to death of aquatic lives (Radojevi and Bashkin, 1999).

Organic contaminants, however, are not the only problem; heavy metals also find their ways into surface and groundwater. These heavy metals are especially introduced into the environment through industrial active-ties such as agro-based pharmaceutical, oil, and steel based industries. These heavy metals progressively accumulate in the ecosystem until an intolerable level is reached. The presence of these harmful metals could lead to several

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diseases (Wartelle and Marshall, 2001).

For these looming dangers, the need to treat industrial and other related waste water to bring about a reduction in the concentrations of the pollutants to tolerable levels as approved by national and international guidelines and standards for polluted waters before their final discharge into the environment can not be overemphasized, but sad to say, many industries indiscriminately discharge their waste water containing these hazardous pollutants directly into the environment. Through the mechanism of bio-accumulation and biotransformation, mental cons present in the contaminated water accumulate in the aquatic lives.

Methods have been devised to solve problem of contaminated effluent, but they have been found to be expensive, though effective, such method include precipitation and ion exchange resins. Due to this problem of high cost of treatment, while trying to maximize profit, a number of companies shy away from the umbrella of pro-per waste management and prefer to give certain percentage of the amount for treatment to those undertaking the supervision. This action only goes to harm the environment and the human living around it (Okieimen and Onyekpa, 1989).

In many countries, nonetheless, government has set up agencies concerned with protecting the environment from degradation; these agencies not only enact laws but also see that the laws are implemented. In Nigeria, for instance, the Federal Environmental Protection Agency (FEPA) ensures that wastes from industries are treated of hazardous chemicals before they are discharged in the environments.

Although, agricultural by- products have been widely reported to be effective removal of metal ions from aqueous solution, there are few reports on their capacity to remove dissolved organic compounds from aqueous solution partly because the know binding sites in agricultural by – products are considered to be ineffective in the removal of many polluted molecules. In addition, the agricultural by – products have low resistance to mechanical abrasion (with attrition levels reaching 30%) making them suitable only for once –for-all application. In order to overcome these problems, much emphasis have been given to the treatment of waste water through adsorption technology using activated carbons (Aggarwal and Dollimore, 1997).

The overall purpose of this project is the development of value-added, industrially useful products from low-value agricultural residues. This paper reports on the use of activated carbon produced from coconut fibres in the removal of dissolved organic compounds from aqueous solution.

MATERIALS AND METHODS

Activated carbon was prepared from coconut fibre obtained from Ihievbe in Owan East Local Government Area of Edo State, using the method described by (Kadirvelu et al., 2001). The coconut fibre was steeped in saturated solution of ammonium chloride for 8 h, air-dried and then carbonized at 400°C for 1.5 h. The activated carbon was powdered and sieved. The portion of the powdered activated carbon, which passed through 212 um mesh size and retained on a 90 um mesh size was used for the study.

Characterization of coconut fibre carbon

pH determination

The pH of the carbon was determined by immersing 1.0g sample in 100 ml of distilled/dionised water and stirring for 1 h and the pH of slurry taken.

Bulk density determination

The bulk density of the coconut fibre carbon was determined by the tamping procedure described by Ahmedna et al. (1997)

Surface area determination

The surface area of coconut fibre carbon was determined by the iodine adsorption method (Okieimen and Okieimen, 2001). The amount of iodine adsorbed from aqueous solution was estimated by titrating a blank with standard thiosulphate solution and compared with titrating against iodine containing the sample.

$$1 \text{ mg/g} = \frac{B - S.}{B} \quad \frac{VM}{W} \text{ X } 126.91$$

Where B and S are the volumes of thiosulphate solution required for black and sample titrations respectively, W is the mass of activated carbon sample, M is the concentration (Mol/ L) of the iodine solute and 126.91 is atomic mass of iodine.

Determination of COD

Chemical oxygen demand was determined using standard methods (APHA, 1971) of aqueous mixtures of the diesel and kerosene before and after contact for 2 h with coconut fibre carbon. A known amount of the activated carbon was slurried in the aqueous mixture of the diesel and kerosene using 1 part of the activated carbon to 3 parts of the aqueous mixture in a closed vessel and shaken for 2 h. The chemical oxygen demand of aliquots of the supernatant liquid was determined using standard method (APHA, 1971) and compared with values obtained for the mixtures before contact with activated carbon. Changes in the measure chemical oxygen demand are reported as uptake levels of the organic compounds by the activated carbons. The removal of soluble diesel and kerosene from aqueous solution was carried out at 30°C.

RESULTS AND DISCUSSION

Table 1 shows some physical properties of coconut fibre carbon. The pH of the coconut fibre carbon is 6.19. Accordingly, for most application, carbon pH of 6 - 8 is acceptable (Ahmedna et al., 2000).

The surface area of coconut fibre carbon was determined by the iodine adsorption method. Large surface area is generally a requirement for good adsorbent. Sur-

Table 1. Some physical properties of activated carbon prepared from coconut fibre.

Parameters	Coconut fibre carbon
pH	6.19 ± 0.02
Surface area	1.26 ± 0.06
Bulk density (g/ml)	0.846 ± 0.03
Loss on ignition (875^{0}C) (%)	6.02 ± 0.08

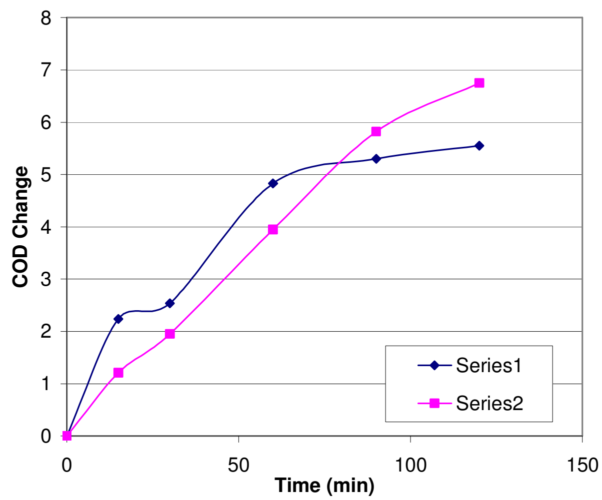

Figure 1. The removal rates of diesel and kerosene from aqueous solution by coconut fibre carbon. Note: Series 1 = Diesel; Series 2 = Kerosene

face area is the single most important characteristics of activated carbons designed for adsorption of com-pounds from liquid media. The surface area of the activa-ted coconut fibre and non activated coconut fibre was found to be 1.26 and 0.06 respectively. This shows that chemical activations increased the surface area of coconut fibre.

The bulk density of coconut fibre carbon was found to be about 0.85 g/L. bulk density determines the amount of carbon that can be contained in a filter of a given solids capacity and the quality of the treated liquid that is retain-ed by the filter cake (Hutchin, 1988). Figure 1 shows the removal rates of diesel and kerosene from aqueous solu-tion by coconut fibre carbon. The removal of diesel and kerosene from aqueous solution was estimated from measurement of changes in the value of chemical oxygen demand provides a measure of the total organic compo-unds present in waste water. It measures the oxygen necessary for conversion of organic material to carbon (IV) oxide ($C0_2$) and water. Measurement of oxygen uptake is an indirect method but has two advantages (Schroeder, 1977). Oxygen uptake is a process operation parameter in aerobic biological processes and it is an important characteristic in determining effluent quality. The uptake of kerosene is higher then for diesel. Up to 42% of the initial amount of the hydrocarbon was removed by coconut fibre carbon. Diesel and kerosene are petroleum fraction containing hydrocarbons of varying molecular weights, with kerosene containing lighter fraction than diesel. The ability of the activated carbon to substantially reduce the levels of water soluble fractions of hydrocarbons is important in many respects particu-larly it demonstrates the usefulness of coconut fibre carbon in environmental remediation and in petroche-mical waste water treatment.

Conclusion

In this study, it shows that coconut fibre carbons are effective remover of diesel and kerosene from aqueous solution. Activation carbons prepared by chemical active-tion are generally considered to be mainly microporous in nature. These results from this study indicate that the coconut fibre carbon produced by ammonium chloride activation may possesses sufficient meso- and micropo-rosity mix required for the treatment of effluent contain-ing pollutants compound with varying molecular size.

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