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PREPARATION AND CHARACTERIZATION OF SAWDUST (CELLULOSE) AS AN ADSORBENT FOR OIL POLLUTION REMEDIATION

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ABSTRACT

Oil pollution is peculiar to oil producing nations of the world. Various researches have been carried out to cub its menace. However, most of the materials are non-biodegradable and require expensive treatment to become an adsorbent. In this study, adsorptive capacities of cost effective raw hard and softwood sawdust were investigated and compared. Soft wood sawdust was found to have better adsorptive capacities. The adsorptive capacities are related to the mesh size of the sawdust, the concentration of the oil, the quantity of the sawdust and the time of contact of the oil and the sawdust. Maximum uptake of the oil by both adsorbents occurred at 120 and 150 minutes for all the results. This study recommends that further research be done on the use of modified softwood sawdust so as to increase its potential as a low cost adsorbent in oil remediation.

Keywords: Oil pollution, Sawdust, Remediation, Adsorption, Hardwood, Softwood.

Contribution/ Originality

This study is one of very few studies which have investigated the use of low cost materials in oil pollution remediation. The use of untreated, raw and mixed variety of hardwood and softwood sawdust in oil pollution remediation was investigated. These materials are readily available in almost every locality. These materials can be used by even a non-professional to save the environment especially in emergency cases.

1. INTRODUCTION

Sawdust is a by-product of wood resulting from cutting, grinding, drilling, sanding and slicing wood with a saw or other tools. In many parts of the world, these by-products are either dumped or burnt. Cellulose is a long chain of linked sugar molecules that gives wood its strength. Cellulose is the major component of wood Environmental effects of oil spillages are global [1]. Oil spillages result from storage tanks, offshore platforms, drilling rigs and wells as well as spills from refined products and their bye products. As far as oils are explored, transported and stored, there exist risks of oil spillage. There has been renewed interest on how to cub this menace recently, including the use of barley straw [2], activated carbon [3], Hydrophobic nan cellulose aerogels [4], bioremediation [5] , wool-based nonwoven materials [6] and so on. Most of these materials have good hydrophobic and lyophilic properties but are disadvantaged because they are no biodegradable [7] and require expensive treatment. Other materials that have been investigated include organic natural materials [8], inorganic mineral materials [9] and synthetic organic polymers [10]. Up to now, sorption technology has attracted academic and industrial interests as one of the most efficient techniques not only for the possibility of complete clean-up of oil pollutants but for other interests. Some of these adsorbents have been used to remove heavy metals from contaminated water bodies [11] dyes [12] and gas mixtures [13]. However, the modified adsorbents may perform better in some cases [14]. Among these adsorbents, Sawdust adsorbent has attracted more attention because it is cheap, versatile and abundant. In some cases, the surface of modified sawdust has better sorption capacity for oil removal [15]. Sawdust has been reported to play important role in waste water management [16]. Throughout history adsorbents have played important roles in pollution remediation. The present study seeks to compare the adsorptive capacities of the raw hardwood sawdust and softwood sawdust. The process is intended to be kept simple and cheap.

2. MATERIALS AND METHODS

2.1. Sawdust

The sawdust from hard wood (mahogany) and soft wood (spruce) used for this work were collected from saw-mill (timber) industry at katako in Jos, Nigeria. The sawdust was primarily washed with water to remove dust, fungus and other foreign materials and sun dried for a full day. The sawdust was oven dried at 78°C to completely remove any water still present for two hours. The dried sawdustis then pounded using mortar and pestle and sieved to different sizes (0.25mm, 0.5mm and size > 0.63mm)

2.2. Crude Oil

The crude oil was collected from Kaduna refining petrochemical company limited.

2.3. Methods

Five sets of constant weight of 10gm each of hard and soft wood sawdust (for mesh size 0.25mm, 0.5mm and >0.63mm) were submerged into oil-water (10ml: 400ml) in plastic containers. The adsorbents were removed after 30, 60, 90, 120 and 150 minutes respectively by decantation. The adsorbents were then oven dried at 105°C and the percentage of the weight of oil adsorbed tabulated (Table 1).

The processes were repeated for the two adsorbents by increasing their concentration progressively from 10 mg to 50 mg at intervals of 10mg (10mg, 20mg, 30mg, 40mg and 50gm) for mesh size 0.25mm, 0.5mm and >0.63mm respectively and the results tabulated in table 2. The experiments were carried out at varied time intervals of 30 minutes starting with 30 minutes and ending at 150 minutes and at Ambient Temperature

3. RESULTS AND DISCUSSION

3.1. Effects of Particle Size

The adsorbents used in this research work were screened into different mesh sizes: 0.25mm, 0.5mm and >0.63mm. Adsorbents with larger surface areas (0.25mm) were found to have adsorbed more crude oil than those with smaller surface areas (0.63mm). Again, the softwood sawdust was found to have greater adsorptive capacities than the corresponding hardwood sawdust of the same size (table 2).

3.2. Effects of Sorption Time or Contact Time

Table 1 and 2 shows the various time intervals by which the adsorbents were remove from the solution between 30 to 150 minutes. The result shows that the maximum uptake occurred at 150 minutes for both adsorbent types.

3.3. Effects of Concentration

Increase in concentration of the adsorbents also lead to increase the adsorption of the oil as time also increases. Further analysis of the results indicates that the rate of oil adsorbed is a function of time. From table 1 and 2 the maximum adsorption of oil from the water occurred at 120 and 150 minutes respectively.

Table1 above is showing the relative percentage of the crude oil adsorbed by the hardwood sawdust with different mesh sizes. Maximum adsorption occurred at 150 minutes for mesh size 0.25mm. When the concentration of the crude oil was increased from 8.38gm to 16.60gm for adsorbent of mesh size >0.63mm, there was no significant increase in the percentage of crude oil adsorbed by the adsorbent.

As the contact time between the adsorbent and the crude oil increases, adsorption also increases.

Maximum adsorption occurred at 150minutes when constant weight of hardwood sawdust was used. The same observation also occurred when the concentration of the weight was increased gradually at 10mg interval.

As the contact time of the adsorbent with the oil increases, with increasing quantity of the sawdust, adsorption of the oil also increases. Here, the higher the surface area, the higher the rate of adsorption.

4. CONCLUSION

This research work concludes that sawdust of softwood is more effective in oil-water clean-up than the corresponding sawdust of hardwood. This is attributed to its low density and high porosity. Maximum uptake of the oil by both adsorbents occurred at 120 and 150 minutes for all the results. This study recommends that further research be done on the use of modified softwood sawdust to increase its potential as an adsorbent in oil remediation.

Table-1. Percentage of crude oil Adsorbed by hardwood sawdust at constant weight of 10mg and varied weight of between 10mg interval.

		Constant weight of adsorbent			**Varied weight of adsorbent**			
Time of Adsorption (mins.)	Weight of oil used (gm)	Weight of sawdust (gm)	% of oil adsorbed for 0.25mm	% of oil adsorbed for 0.5mm	Weight of sawdust (gm)	% of oil adsorbed for 0.25mm	% of oil adsorbed for 0.5mm	% of oil adsorbed for > 0.63mm
30.00	8.38	10	38.80	38.60	10	41.00	40.00	44.05
60.00	8.38	10	2.00	40.00	20	51.00	50.00	52.60
80.00	8.38	10	9.00	48.80	30	60.00	59.00	52.65
120.00	8.38	10	51.00	50.00	40	65.00	65.00	53.00
150.00	8.38	10	61.50	60.00	50	71.00	70.00	54.10

Figure-1. % of crude oil adsorbed for constant weight of hardwood sawdust

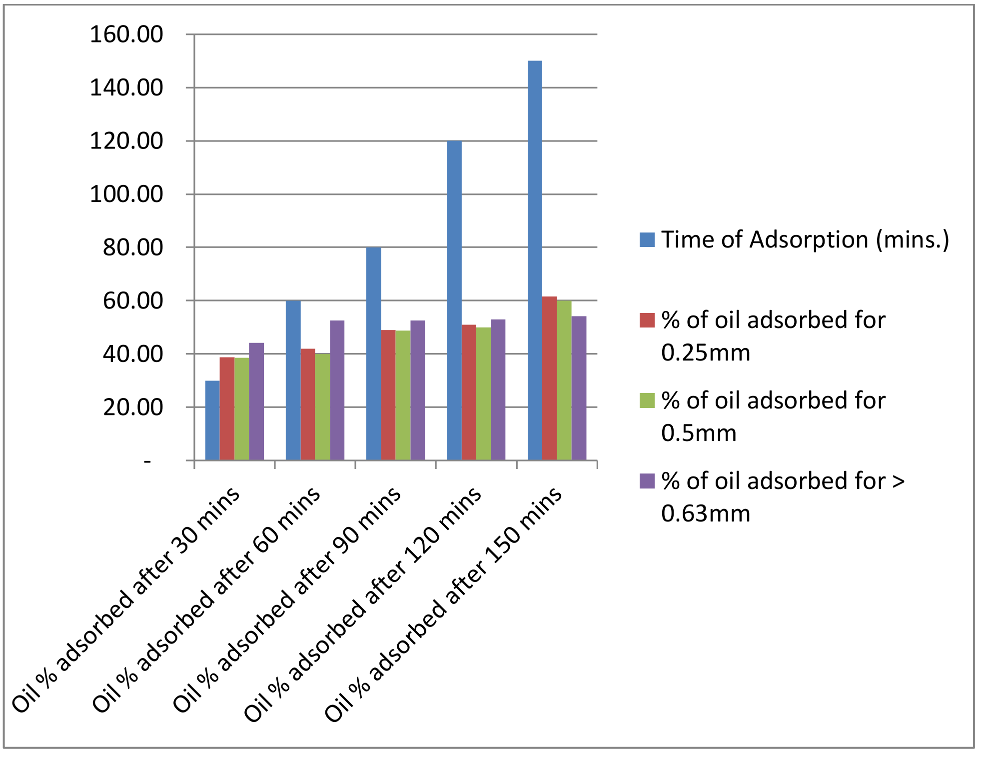

Figure-2. % of crude oil adsorbed by increasing the weight of hard wood sawdust

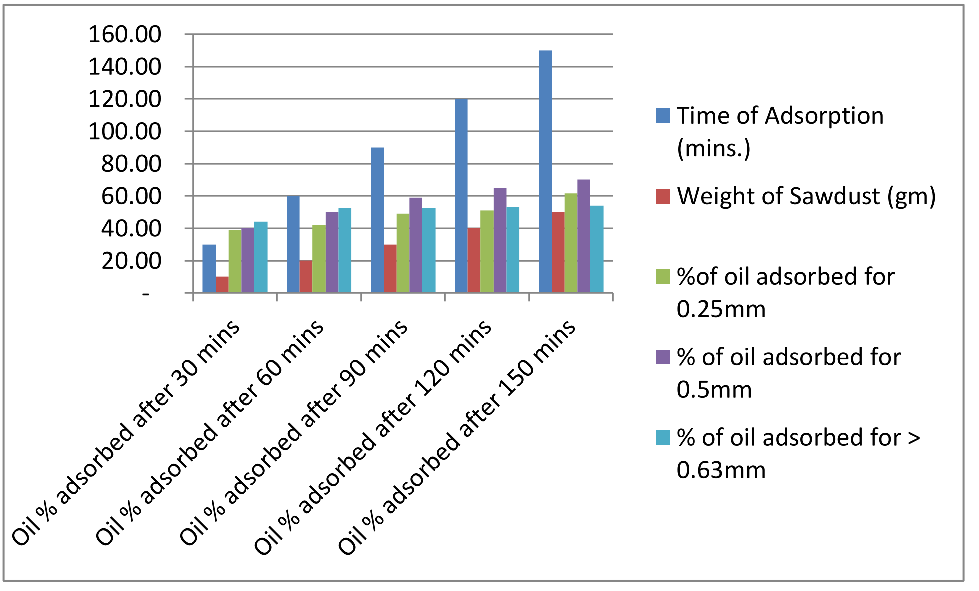

Table-2. Percentage of crude oil adsorbed by Softwood sawdust at constant weight of 10mg and at varied weight of adsorbent between 10mg and 50mg at 10mg interval.

		Constant weight of adsorbent Softwood Sawdust			**Varied weight of adsorbent Softwood Sawdust**			
Time of Adsorption (mins.)	Weight of oil used (gm)	Weight of sawdust (gm)	% of oil adsorbed for 0.25mm	% of oil adsorbed for 0.5mm	Weight of sawdust (gm)	% of oil adsorbed for 0.25mm	% of oil adsorbed for 0.5mm	% of oil adsorbed for > 0.63mm
30.00	8.38	10	48.00	40.00	10	48.00	46.50	43.00
60.00	8.38	10	49.60	46.00	20	56.00	60.00	53.50
80.00	8.38	10	53.00	52.00	30	55.00	59.20	54.65
120.00	8.38	10	61.00	59.00	40	62.00	65.10	51.00
150.00	8.38	10	62.00	61.00	50	71.00	70.00	54.20

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