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Potential Application Of Bamboo Particles In Adsorption Of Crude Oil

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Abstract: ***Bamboo constitutes a great percentage of building construction waste and grows abundantly in the Southeast and southsouth regions of Nigeria.The potential of using bamboo as an adsorbent in crude oil cleaning was investigated. Bamboo particles of various sizes from 0.425mm to 2mm were used to adsorb crude oil at room temperature (30^oC). 2mm particle size showed a sharp increase in adsorption between 5minutes and 10 minutes, then a slower increase within the rest of the time. 1mm particle size showed an increase in adsorption between 10 minutes and 20minutes, then a gradual increase between 20 minutes and 30minutes and a sharp drop subsequently, between 30 minutes and 40 minutes. 0.425mm particle size showed a slow increase in adsorption between 15minutes and 20minutes, sharp increase between 20minutes and 30minutes and then slower increase between 30minutes and 40 minutes. The extent of adsorption was highest for the particle size of 0.425mm. The profile of adsorption of crude oil was due to concentration difference which acts as the driving force.***

I. INTRODUCTION

Oil exploration, oil drilling, oil production, oil transportation, oil processing and oil storage cause environmental disasters like oil spillage and air pollution. Oil spillage through tanker accidents, well blow out, sabotage and accidental rupture of pipelines result in release of crude and refined oil into terrestrial and aquatic environments (Atlas, 1981; Colwell and Walker, 1977). The contamination of water and soil by petroleum substances negatively affects plant production and puts health of people and animals at risk as most of the substances are toxic for living organisms (Kolwzan et al., 2001). Oil spillage statistics in Nigeria from 1976 to 1988 has been analyzed by Ifeadi and Nwankwo (1980), Awobajo (1981).

Mangrove swamps zones and near off shores areas of the Niger Delta were found to have the highest incidence of oil spills. Various methods have been adopted to address the problems of crude oil spillage and these include spraying an aqueous slurry of expanded graphite and chalk, burning the oil with wicking agents, disposing of oil with detergent, applying floating barriers or booms, using of polymeric foams and other absorbents and enhanced biodegradation (Lewicke, 1973; Imevbore and Ekundayo, 1987, Lessard et al., 1995). The various methods have proved promising with one disadvantage or the other. However, the use of absorbent material provided it is environmentally friendly, easily recoverable, of low cost and effectively absorbent has proved the fastest way of combating oil spillage (Labelle et al., 1984). Bamboo is a fibre crop that grows in wild forest region in Nigeria and very abundant in the Niger Delta region where oil and gas prospecting are at the peak. It is mainly used in Nigeria for support of decking during construction of building after which bulk percentage are discarded as construction wastes (Awoyale et al., 2013). Being cheap, abundant, environmentally friendly and easily recoverable, bamboo can be used to adsorb and remove oil in the process of sorption and desorption (Udo, 1983; Awoyale et al., 2013).

II. MATERIALS AND METHOD

A. STUDY AREA

Eleme coordinates are 4.7994^oN, 7.1198^o E. It is located at east of Port Harcourt and covers an area of $138km^2$. At 2006

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census, it had a population of 190,884. Precipitation in Port Harcourt averages 2708mm and the average annual temperature is 26.4°C. The average annual relative humidity is 71.0% (https//weather and climate.com). Awka is found in the south eastern part of Nigeria. It is the capital of Anambra State and is located on Latitude 6°09′N and Longitude 7°12′E. The climate is tropical with an annual rainfall of about 11,450mm, average temperature of 28°C and relative humidity of 91% at dawn (Nwangwu, 2015).

B. MATERIALS COLLECTION

Bamboo was collected from a bush in Awka. It was cut into small chunks for easy transportation to the laboratory. Crude oil was obtained from Eleme, Port Harcourt River State.

C. BAMBOO PARTICLE PREPARATION

The chunks of bamboo wood were washed and dried to make them clean. The clean chunks of bamboo wood were cut into sections with a hack saw and later into very small pieces (4.75mm) with the aid of sharp hacksaw and knives. These wood chips were then transferred into a clean and dried electric grinding machine. This was used to reduce the wood to wood particles and fibre mixtures. The mixture was then mechanically sieved into wood particles of 2mm, 1mm and 0.425mm. The fibres were thus separated and removed. The different sizes of wood particles were collected and kept in separate plastic containers.

D. DETERMINATION OF SPECIFIC GRAVITY OF CRUDE OIL AND THE DENSITY

Specific gravity was determined according to the method described by Jacobs (1999) and density calculated using the formula for density.

E. MEASUREMENT OF TIME AND RATE OF ADSORPTION OF CRUDE OIL

Thirteen one-litre beakers were used for the adsorption test. The beakers contained 100cm^3 of crude oil each. 10g of a given particle size of bamboo were weighed into each of the beakers using an electronic balance. After 5minutes, the contents of the first beaker were filtered until no further drops of oil were observed. Then the new weight of bamboo particles was determined. For the remaining beakers the same procedure was repeated at successive 10minutes interval until there was no further change in weight. The difference between the weight and the initial weight of each sample in each beaker was regarded as the weight of crude oil adsorbed at the particular time. Crude oil adsorption was expressed in terms of the ratio of the mass of crude oil retained to that of bamboo particles.

Adsorption yield or crude oil adsorption (oil/g bamboo particle) =

$$\frac{\text{Mass of crude oil retained by bamboo particles}}{\text{Mass of bamboo particles}}$$

The results of adsorption of crude oil with bamboo particles of different sizes with time were recorded. Their graphs of adsorption time were plotted. The rate of adsorption was taken as the slope of the linear portion of the adsorption-time curve (Aisen et al., 2003, Awoyale et al., 2013 and Roselear, 1975).

III. RESULTS AND DISCUSSION

The specific gravity and density of crude oil were found to be 0.8601 and 0.8486g/ml respectively.

Tables 1, 2 and 3 show the results of adsorption of crude oil with bamboo particles of different sizes with time. The trend or pattern followed are expressed by graphs found in figures 4.25-4.27 respectively.

Time (Minute)	Adsorption (g/g)
5	1.92
10	2.642
30	3.13
40	3.52

Table 1: Adsorption of oil by 2mm bamboo particle size

Time (Minute)	Adsorption (g/g)
10	3.44
20	3.47
30	3.34
40	2.11

Table 2: Adsorption of Oil by 1mm bamboo particle size

Time (minute)	Adsorption (g/g)
10	3.15
20	3,18
30	3.61
40	3.68

Table 3: Adsorption of Oil by 0.425mm bamboo particle size

Adsorption-time curves for various particle sizes of bamboo are figures 1, 2 and 3.

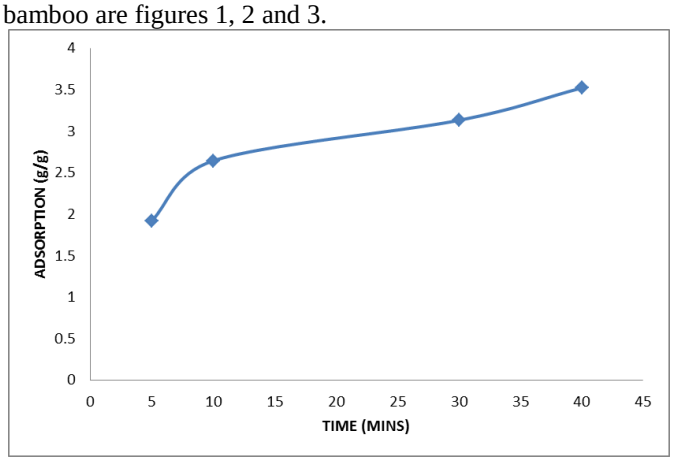

Figure 1: Variation of adsorption with time for bamboo particle size of 2mm

Figure 1 shows a sharp increase in adsorption between 5minutes and 10minutes, then a slower increase within the rest of the time (Roselear, 1975: Awoyale, 2013).

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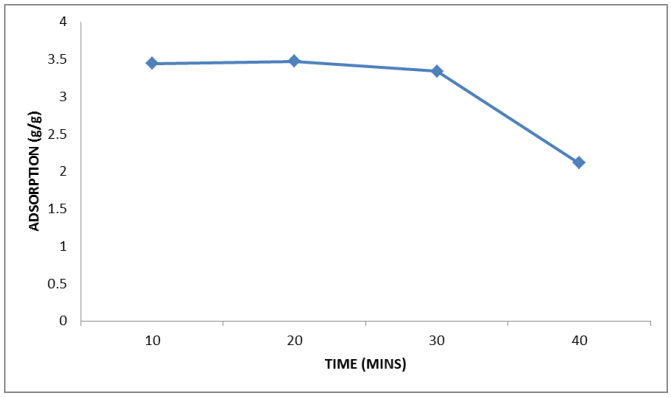

Figure 2: Variation of adsorption with time for bamboo particle size of 1mm

Figure 2 shows an in increase in adsorption between 10minutes and 20minutes, then a gradual increase between 20minutes and 30minutes and a sharp drop subsequently (between 30minutes and 40minutes).

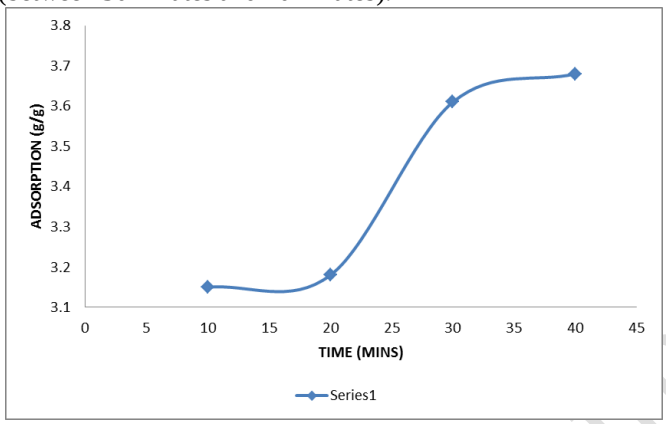

Figure 3: Variation of adsorption with time for bamboo particle size of 0.425mm

Figure 3 shows a slight increase in adsorption between 15minutes and 20minutes, sharp increase between 20minutes and 30minutes and then slower increase between 30minutes and 40minutes (Awoyale, 2013). The profile of adsorption of crude oil is due to concentration difference which acts as the driving force. The difference between the concentration of crude oil in the bamboo particles at the beginning of adsorption and that at equilibrium is high. This subsequently decreases to zero at equilibrium adsorption of oil.

Effect of the particle size of the bamboo on the adsorption of crude oil is shown in the graphs of figures 1, 2 and 3. As the particle size is increased from 0.425mm to 2mm, the equilibrium adsorption of oil decreases from 3.68 to 3.52.This shows an increase in the level of oil adsorption for the 0.425mm particle size bamboo relative to the 2mm particle size bamboo. This confirms the fact that finely divided substances have large surface areas for increased adsorption (Brown, 1976).

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