Sorption Studies of Violet Plant (*Securidaca longepedunculata*) Root Powder as Sorbent in Oil Spill Treatment.

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Abstract

The sampled Crude Oil (CO) showed density of 0.9066 g/cm3, specific gravity 0.9077 g/cm3, API gravity 24.38 and viscosity of 6.43 N S m-2 at 30 oC. The sorption capacities shown for the crude oil by the VTRP sorbent gain increased weight at 17.80% g/g compared to unmodified VTRP with 14.5% g/g. The modified VTRP also showed sorbent recyclability up to five (5) times and of high buoyancy proven by low water uptake. There were observed variations in water uptake and enhanced sorption capacity, which were recorded as modification benefits from the modified samples. The water uptake at 4.61 g/g which decreased to 1.62 g/g was an indication of successful and effective acetylation. The success and effective oil sorption and recovery by modified VTRP have shown oil sorption ability and therefore can be an environmental acceptable product.

Keywords: **Crude Oil, Sorption, Sorbent, Violet Tree Root Powder, Securidaca longepedunculata.**

1 INTRODUCTION

Human effort in other to provide befitting resources for living have resulted to unwanted phenomenon that renders the environment unfit, and threaten the survival of man along other living organism, perhaps total pollution of the ecosystem. Oil is one of the most important energy raw material sources for the synthesis of synthetic polymers and chemical worldwide (Gregorio, 2006). Crude oil makes a major contribution to the world economy today. The provision of heat, light, and transportation depends on oil and there has not been yet a single energy source to replace crude oil that is widely integrated. Moreover, the economy currently depends on the ability to acquire the energy required and it is indisputable that oil is the main contributor to this demand. Currently, there is no an energy source available that could compete with oil, making the world, and mainly high energy consumers to rely on countries with large reserves (EIA, 2003)

The term “oil” describes a broad range of hydrocarbon based substances. Hydrocarbons are chemical compounds composed of the elements hydrogen and carbon. This includes substances that are commonly thought of as oils, such as crude oil and refined petroleum products, but it also includes animal fats, vegetable oils and other non-petroleum oils (EPA, 2002a). Oil spill is the release or leakage of petroleum from oil tanker or other vessel (Encarta, 2008). Also numerous human activities have resulted to this form of pollution. Though, the term is often referred to marine oil spill, where oil is released into ocean or coastal waters. It include the spill of crude oil from tankers, offshore platform, drilling rigs and wells as well as spilled of refined petroleum products, such as gasoline, diesel and their byproducts. Also heavier fuels used by larger ships as bunker fuel. The ability to clean up spilled oil may take months or even years to be successful (Encarta, 2008) oil spillage has been a great danger associated with the discovery of oil, its processing and transportation to the consumption point of interest (Annunciado *et al.,* 2005). Thus, the growing demand for this natural depleting material must go with the quest to control its accidental or intentional discharge as the case may be leading to environmental degradation.

The increasing demand for petroleum and allied products during the last ten decades has made petroleum spills inevitable consequences of oil production and refining, especially in oil producing countries like Nigeria and specifically in the Niger Delta area of the country (Adebusoye *et al.*, 2008). Both petroleum and non-petroleum oil can affect the environment surrounding an oil spill. All types of oil share chemical and physical properties that produce similar effect on the environment, in some cases, harmful effects than petroleum oil spills. Thus, oil spills could be harmful in several ways by direct physical contact, toxic contamination, destruction of food sources and habitats and reproductive problems (EPA, 2002a). It has been reported that since the discovery of oil in Nigeria in the 1950s, the country has been suffering the negative consequences of oil development. The growth of the country's oil industry, combined with a population explosion and a lack of enforcement of environmental regulations has led to substantial damage to Nigeria's environment especially in the Niger Delta region (Nwilo & Badejo, 2005).

2 MATERIALS AND METHODS

VTRP samples, Petroleum ether, Acetone, Crude oil, Ethanol, Water. All chemical and reagents used were of analytical grade obtained from BDH without further purification,

The following physical properties were used to characterize the crude oil sample, Crude Oil (CO).

2.1 Density

The density of CO sample was done as adopted by Nwankwere (2010) using a specific gravity bottle. The bottle was filled with oil and weighed at room temperature (30 ^{0}C) and the density calculated from:

$$\text{Density} = (M_S - M_b)/V_b$$

where M_S = mass of oil plus bottle

M_b = mass of bottle

V_b = volume of bottle

The method was repeated in triplicate to obtain a mean value.

2.2 Viscosity

The viscosity for crude oil sample was determined using improvised micro syringe 100 ml and a sample of crude oil was carefully drawn into the micro syringe to the level marked and allowed to flow at 20 ml interval, noting the flow rate using a stopwatch. This was done in triplicate and the average flow rate taken.

2.3 Specific Gravity

This was done according to the method employed by Nwankwere (2010). The specific gravity of crude oil was determined from the results obtained for density. The specific gravity, being a more standard measurement was obtained by multiplying the density calculated with density of water 0.998 g/cm^3.

2.4 American Petroleum Institute (API) Gravity

This was determined as carried out by Nwankwere (2010). The API gravity was calculated using the formula: API = (141/s.g) – 131.5

where s.g = specific gravity of crude oil calculated.

2.5 Determination of the amount of water sorption

The sample was determined and recovered. The water content of the sorbent was determined in the laboratory using the method of centrifuge technique described in ASTM D4007 – 81(1998) as done by Hussein *et al.*,(2008). The sorbent VTRP was subjected to pressing to desorb the crude oil. During the pressing stage, 10 ml petroleum ether was added to help extract the oil in the sorbent; the extracted liquid was collected in a centrifuge tube. The centrifuge tube was put in a water bath to break emulsion present and then, centrifuge at 20 minutes. The amount of water sorbed was weighed and recorded.

2.6 Determination of the oil sorption capacity

The sorption capacity of the VTRP on crude oil CO sample was done as employed by Nwankwere (2010). 20 ml of crude oil sample suspended in 150 ml of water using 250ml beaker. Then different weights of dried modified and unmodified VTRP sorbent were spread over the surface of the mixture. After 20 minutes, the VTRP sorbent were collected with an improvised net of known weight and was suspended by retort stand and clamped above a beaker to drain for 15 minutes. This was repeated at different conditions to test the effect for sorbent weight, reusability and time of acetylation. The oil sorption capacity was calculated from the formula:

Sorption capacity = New weight gain/original weight × 100

3 RESULTS AND DISCUSSION

3.1 Characterization of Crude oil

The properties of crude oil (CO) characterized were the density, specific gravity, API gravity and the viscosity. The results obtained are as shown in Table 1.Proximate analysis of crude oil sample (PHCO)

Table 1.**Proximate analysis of crude oil sample (PHCO)**

Parameters	**Values – Mean & S.D.**
Density (g/cm^3)	0.9066 ± 0.01
Specific gravity (g/cm^3)	0.9077± 0.01
API gravity (30 °C)	24.38 ± 0.02
Viscosity, 30℃ (N s m^{-2})	6.43 ± 0.02

The characterization of Port Harcourt crude oil CO revealed its lightness in the recorded density and specific gravity value obtained, making it a promising sorbent with density less than one (1). It was found that, the viscosity at 30℃ *is* 6.43. These properties are important to the sampled oil CO expected absorption by the VTRP upon weathering.

3.2 Water uptake by UMVTRP and MVTRP

The water sorption ability of the VTRP was examined in order to understand the water sorption capacity of the sorbent. The result of UMVTRP showed higher volume of water uptake (4.72 ml) by the sorbent at about 20 minutes compared to water uptake by the MVTRP with equilibrium water uptake of 1.64 ml is water repellant.

Thus, as shown in Fig. 1 the VTRP samples both have shown good sorption ability within the shortest time possible for oil/water mixture. However modification achieved by acetylation resulted in less water uptake by negligible water sorption in MVTRP.

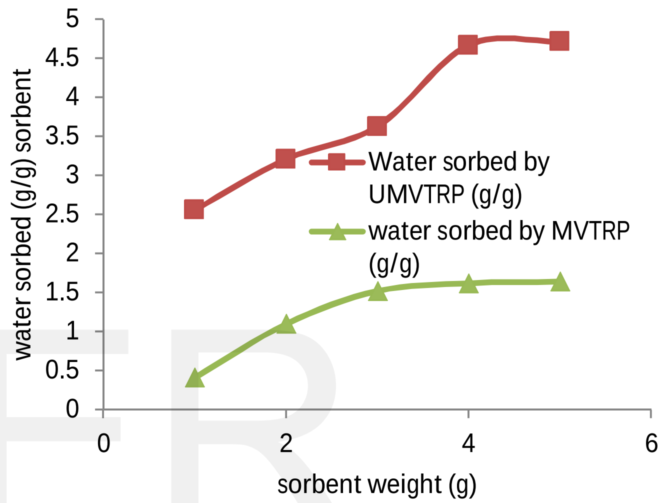

Fig.1 Water sorbed by UMVTRP and MVTRP

3.3 Oil uptake by UMVTRP and MVTRP

The oil sorption capacity recorded by UMVTRP showed oil sorption at 14.4 g/g compared to the MVTRP 18.3 g/g sorption. The higher oil sorption capacity exhibited by the MVTRP is a proof of successful replacement of the water attracting hydroxyl group of acetic anhydride. Obviously, chemical modification has improved hydrophobic state of the fibre due to acetylation. This is in tandem with studies on fibre modifications.

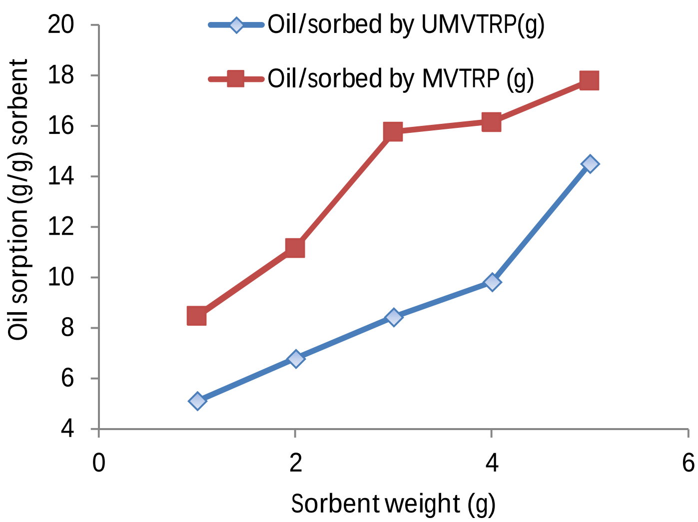

Fig.2 Oil sorbed by UMVTRP and MVTRP

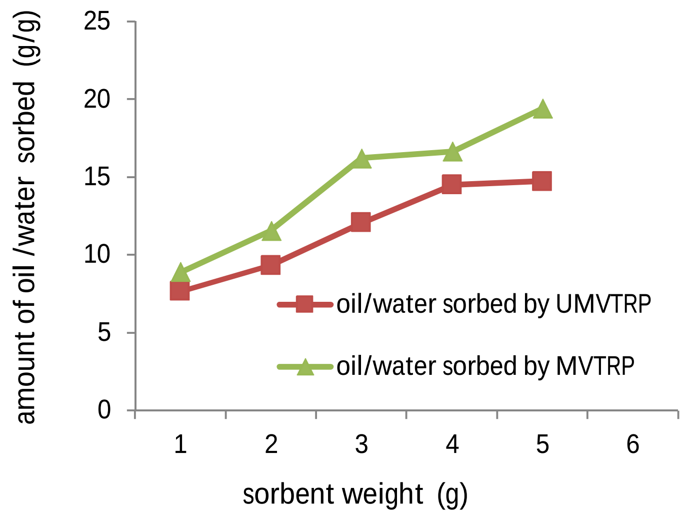

Fig. 3 Oil/Water sorbed by UMVTRP and MVTRP

3.3 Oil/Water sorption by UMVTRP/MVTRP

Fig. 3 showed increase in sorption capacity for PHCO with increased in sorbent weight for VTRP ranging from 1-5 g of VTRP weight. Although, there were difference in values obtained by UMVTRP and MVTRP, the modified VTRP showed higher sorption than the unmodified VTRP. The water/oil sorption by MVTRP ranges from (8.89 -19.42) g/g of sorbent on PHCO, While that of UMVTRP ranges from (6.67 – 14.73) g/g showed reduction in water sorbed along with oil due to hydrophilic tendency of the unmodified sorbent. In other words, the higher sorbed oil and water by MVTRP is a proof of hydrophobic character with low water pick up as reported similarly by Hussein *et al.*, (2008), there was very low water sorption by the modified VTRP sample compared to unmodified VTRP sample.

3.4 Recyclability of the Sorbent

The results of recyclability illustrates that, the sorption capacity increases up to 3 repeated use with maximum sorption of 7.2167 g sorbed oil per gram of sorbent. It was observed that amount of sorbed decreases with recycling effect. Perhaps, the resulting morphological structure due to tearing of the micro fibrils, disruptive pores and traces of oil entrapment might have led to the decreased in amount of oil sorbed. This also support, the findings of El-Maghraby *et al.*, (2009) in availability of barley straw application in oil spill cleanup. The oil recovery which was obtained by simple mechanical compression resulted to later decrease through the fifth application. Elsunni and Collier, (1996) pointed that, the sorbent is considered reusable if a loaded sorbent can easily compress or squeezed to its original size and shape even if there was tendency toward decrease in sorbent efficiency with repeated sorption and desorption. However, it's evident that the MVTRP sorbent could be efficient in recycling as seen practically in its stable floatability even with much cycles carried out.

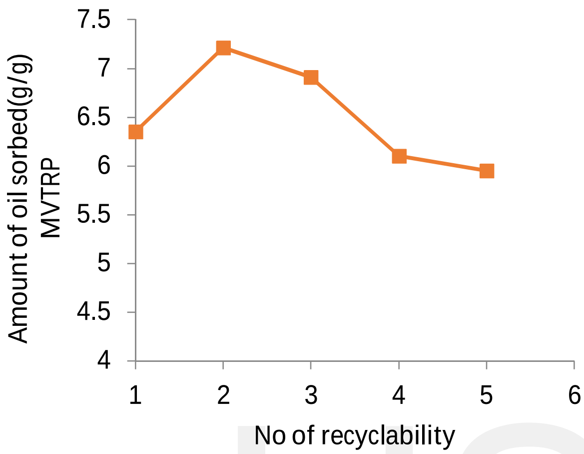

Fig. 4 Sorbent recyclability.

3.5 Effect of Time on PHCO sorption by MVTRP

The results of the effect of time reported, indicates that sorption capacity of MVTRP increases with increasing sorption time to a maximum of 7.51 PHCO g/g oil of MVTRP Sorbent in 60 minutes. Perhaps, this could have resulted from the loosed powder surface area of the VTRP fiber. This findings agrees with the related studies of Hussein *et al.*,(2011) on practical application of low grade raw cotton and Hussein *et al.*,(2008), on sorption qualities of barley strands both of which reveals increasing sorption capacity with increased sorption time.

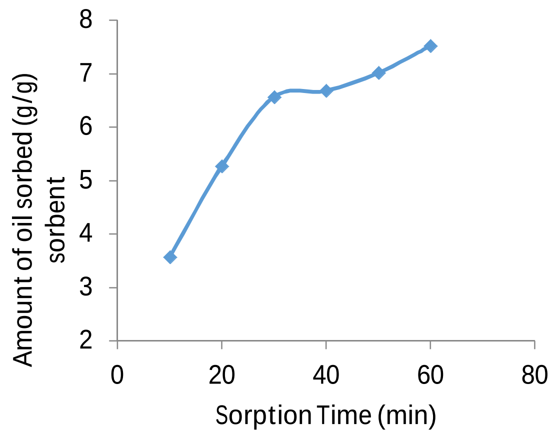

Fig. 5 Sorption time by MVTRP.

4 SUMMARY AND CONCLUSION

The sorption behaviour of the acetylated sample (MVTRP) has surely indicated the hydrophobic status of the modified sample. Thus, the production of MVTRP is a low cost project and environmentally acceptable with mild reaction conditions. The sorbed crude oil was easily recovered by simple pressing operation, in addition the washing of the reaction products with petroleum ether for re-use of the sorbent increased maximum recovery of the crude oil. The recyclability of the sorbent MVTRP was obtained for about five (5) times, with the third cycle being the highest sorption amount at 6.9 g/g. The sorbent MVTRP can be disposed of because it's biodegradable, thus, a better substitute for synthetic commercial sorbent.

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