

Removal of Oil Spills Using Mango peels as Natural Adsorbent

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Abstract— Oil spills is one of the major type of pollution that is disturbing the ecosystem. Majorly oil spills occurs in the ocean due to the negligence of the human activities because generally the crude oil is transported with the help of ships where water is the main means of transportation which results in the damage of the aquatic life. In this study sorbents are used to remove the oil spills that occurred on the surface of the ocean water. Naturally available sorbent is used in this removal process namely Mango peels powder. As it is difficult to collect the oil spills sample from surface of the ocean here in this study we prepared synthetic oil solution by mixing the 5liters of crude oil into 25liters of distilled water. After the synthetic oil sample is prepared we vary the sorbent heights as 5cm, 10cm, 15cm, 20cm, 25cm, 30cm and plot the graph between the %removal efficiency and the bed height by maintain the constant contact time as 20min and flow rate as 0.3mg/lit and as the column studies are going on the studies that are done in this project is Bed Depth Service Time (BDST) where the graph is plot between bed height and service time i.e. the 350ml of sample is collected and the time is measured for that 350ml which is the maximum sorption capacity of the adsorbent for different heights of different adsorbent dosage height i.e. bed depths. The efficiency for the removal of oil spills observed by using Mango peels is 94.22% and percentage removal of the oil varies from 80.92% - 94.22% at constant contact time of 20 min and flow rate of 21.6 mL/min for varying bed heights i.e. from 5cm to 30cm respectively.

Keywords— Adsorbent, Bed depth service time (BDST), Adsorption, Mango peels powder, Oil spills, Ecosystem

I. INTRODUCTION

Oil spills is one of the burning issue in the latest pollution of the waters that can disturb both aquatic life as well as the human life. Majorly oil spills occurs in the ocean due to the negligence of the human activities because generally the crude oil is transported with the help of ships where water is the main means of transportation which results in the damage of the aquatic life and also it can be responsible for the fire accidents because generally the oil floats on water. The oil spills that spilled in the water are known as Marine oil spills and spills can also occur on lands when they are getting carried out by the tankers. The reason that oil spills are very dangerous because the removal of the oil spill is not an easy thing because there are lot of things that needs to be taken into consideration before removing it such as the type of the oil that got spilled, temperature and the shore conditions. There are statistics that shows that more than 37% of the oil spills had occurred during when the oil is getting carried away by the ships or cargos. So the oil spills must be removed no matter what the situation is as it can be responsible for effecting the society Economically, Environmentally and Socially. There are different mechanical equipment required to remove the oil spills when the accident occurred and different procedures to remove the oil spills are there out of which one method is usage of sorbents to remove the oil spills that occurred on the surface of the ocean water. There are two types of sorbents Natural sorbents and Synthetic sorbents where Natural sorbents are used in this present thesis for removal of spills.

II. NATURAL SORBENTS

A. Sorbents

Oil spills are the one of the major criteria for the polluting which can be treated by different method such as mechanical methods as well as the natural methods but if we use only mechanical methods it is very costly procedure and cannot applied individually and for suppose if we go for natural methods we can be able to adsorb the or absorb the oil spills but that cannot be used to retain the oil sample further so the combination will be worked out in general but the Oil sorbents are majorly divided in to two types synthetic adsorbents and natural adsorbents where majorly for the removal of the high viscous oil synthetic oil sorbents are used and for low viscous oils the naturally available sorbents can be used for the removal of these oil spills and another major reason to avoid the synthetic oil sorbents is it produces certain amount of wastes which results in increase of the cost of the removal of these oil spills so based on the circumstances we go for either natural sorbents or synthetic sorbents and the major drawback of using natural sorbents is it can only be able to remove the oils which are low viscous in nature

B. How Sorbent Works?

The major function of sorbent is to adsorb the oil that got spilled over the water. This can be done in two ways either absorption or adsorption whereas most of the sorbents works on the principle of adsorption which can be defined as the surface phenomenon where the oils pills get adsorbent on to the adsorbent surface which we added

C. Adsorbents

To minimize confusion, the widely used generic term sorbent is adopted in this paper as its primary focus is the use of adsorbents in oil spill response. The various mechanisms that allow a material to adsorb oil are described below:

1) Wetting properties

In order to act as an adsorbent one of the most important aspect is that the adsorbent must have the capacity to wet the water sample such that it can adsorb the oil spill that got on the top of the surface of water. In general the surface tension for the oil must be around 20 mN/m.

2) Capillary action

Another major factor that occurs in the adsorption is capillary action where the adsorption occurs via capillarity. The major component in this capillarity is viscous nature of the oil where the studies showed that the rate of reaction will be even greater for the low viscous oils when compared to the high viscous oils.

3) Cohesion/Adhesion

Cohesion can be defined as the attraction between same kind of molecules whereas the adhesion is the attraction between the one kind of molecule with another kind of molecules simply it is the attraction of two different kinds of molecules and in the most of the oil spills the major criteria that occurs is cohesion because most of the oil spills that spilled in to the water are of the low viscous in nature.

4) Surface Area

The major criteria for the adsorption rate to be successful is to consider the size of the particle because the surface area must be high when compared to its volume ratio which results in the increase of the adsorption rate. Along with the above criteria such as capillarity action, cohesion and wetting properties the surface area of the adsorbent will play a key role in the adsorption of the oil spills successfully.

III. OBJECTIVES

1. Removal of the oil spill using Mango powder as adsorbent
2. Effect of Adsorbent by Bed Depth Service Time
3. Study of variations in contact time.
4. Study of variations in Bed Height.

IV. MATERIALS AND METHODOLOGY

A. Banana peels :

The bio-peel wastes of Banana Peels are collected from the fruit juice seller shop near bus stand of Kakinada. The raw peels were cut into small pieces, washed with distilled water to remove adhering substances and dust followed by drying in the oven at 100°C. The dried peels were ground with a mortar grinder, and the pulverized peels were sieved through mesh to achieve 850 μm particle size.



Fig. 1 Mango peels



Fig. 2 Mango peels powder

V. SYNTHESIS OF OIL POLLUTED WATER

A. Experimental procedure

- In this experimental procedure a glass tube is fixed to the card board where the scale or ruler is fixed beside it such that the bottom of the ruler is in line with the glass tube that is attached to the card board
- At the top of a plastic bucket is placed with the tube placed in to the beaker such that the synthetic oil which we prepared flows in to the glass beaker at constant flow rate
- Now we fill the glass tube with adsorbent powder i.e. the mango powder up to the 5cm and allow the oil sample which we prepared in to the beaker such that it gets in to contact with the adsorbent

- At bottom of the glass tube we place a collecting beaker to collect the treated water sample where the flow rate must be measured for every varying height.
- In the similar way the experiment must be conducted for different adsorbent heights varying from 5cm to 30cm.

B. Sample Analysis

350ml of We use Spectrophotometer to measure the amount of oil that got adsorbed or removed when the adsorbent is added to it but before going for the testing we need to collect the 350 ml of the sample which got treated with the adsorbent in the column and we add 35ml of 1, 1, 1-trichloroethane. After the addition we shake the water sample and allow it to settle for 10 min such that it can form two layers out of which the top layer is removed and the bottom layer is sent for testing with spectrophotometer.

VI. ANALYSIS AND RESULTS

A. Bed depth service time

Hutchins gave an important relation between the service time (t) and the bed height (Z) whereas the column study which we have done the important thing is how much time that the added adsorbent takes to adsorb the synthetic oil solution is given as

$$T = (N_o/C_o u) - 1/k_a C_o \ln [(C_o/C_b) - 1] \dots \text{Eq. (1)}$$

where C_o is the initial oil concentration (mg/L), C_b is the breakthrough oil concentration (mg/L), u is the linear velocity (cm/min), N_o is the sorption capacity of bed (mg/L), k_a is the rate constant in BDST model (L/mg/min), t is the time (min) and Z is the bed height (cm) of the column. Eq. (1) can be rewritten in the form of a straight line as presented in Eq. 2.

$$t = aZ - b \dots \dots \dots \text{Eq. (2)}$$

$$a = \text{slope} = (N_o/C_o u)$$

$$b = \text{intercept} = 1/k_a C_o \ln [(C_o/C_b) - 1]$$

The critical bed depth (Z_o) is the theoretical depth of the sorbent sufficient to ensure that the outlet solute concentration does not exceed the breakthrough concentration, C_b , value (4.53mg/L in the present study) at time $t=0$. Z_o can be calculated by setting $t = 0$ and solving Eq. (2) for Z yields Eq. 3.

$$Z_o = u/k_a C_o \ln [(C_o/C_b) - 1] \dots \dots \text{Eq. (3)}$$

TABLE 1
VARIATION OF HEIGHT VS SERVICE TIME

Bed height (cm)	Service time (min)
5	17.8
10	29.6
15	39.2
20	50.6
25	61.3
30	82.7

TABLE 2
CONSTANTS OF BDST MODEL

Slope	$N_o/(C_o u)$	2.4629
Intercept	$(1/K_a C_o) * \ln \{ (C_o/C_b) - 1 \}$	3.7667
N_o	15959359	mg/L
$1/K_a$	217.390	
K_a	0.004600036	(L/mg/min)

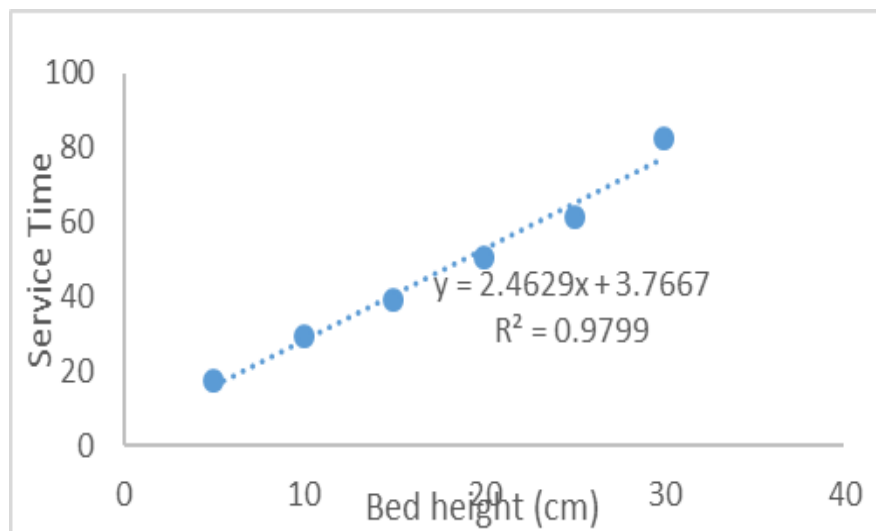


Fig. 3 Bed Height vs Service Time

B. Effect of Bed Height

From the graphs which we plotted at different heights varying from 5cm to 30cm with 5cm interval at a fixed flow rate of 21.6 mL/min and pH of 8.3. By this study it is evident that as the height of the adsorbent increases the percentage removal of the synthetic oil sample got increased. The optimum uptake, which was 139.62 mg/L, was found at bed depth 25 cm. and at 30cm height that is the final height we got the removal efficiency as 94.22% oil removal.

TABLE 3
OIL REMOVAL WITH VARYING BED HEIGHT

S.No	Bed Height(cm)	Concentration , Ppm		% oil removal
		Initial	Final	
1	0	150	150	0
2	5	150	28.62	80.92
3	10	150	21.36	85.76
4	15	150	16.54	88.97
5	20	150	12.36	91.76
6	25	150	10.38	93.08
7	30	150	8.67	94.22

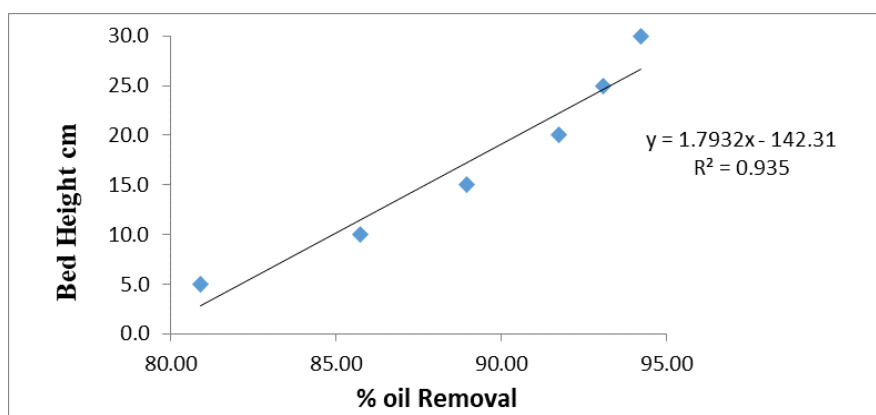


Fig. 4 %Oil removal with Varying Height

VII. CONCLUSIONS

1. The removal of oil spills observed by using Mango peels i.e. 94.22%.
2. Percentage removal of the oil varies from 80.92% - 94.22% at constant contact time of 20 min and flow rate of 21.6 mL/min respectively for Mango peels as adsorbent at varying heights i.e. from 5cm-30cm
3. As correlation factor R^2 is approximately equal to one the study which we have taken is the perfect fit to explain the variation of bed height with the service time.

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