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STUDY AND SELECTION OF ADSORBENT FOR THE REMOVAL OF PETROLEUM PRODUCT SPILLS IN MARINE ENVIRONMENT

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ABSTRACT: Crude oil is the most important non-renewable energy resource currently on earth. It has become really difficult to complete a day without depending on petroleum products. However, production and transportation of oil has paved way to one of the major environmental threats in the form of oil spills. These spillages damage the coastal environment and marine ecosystem. Thus, it is mandatory to clean up this mess as soon as possible. Though there have been many technologies none of it has been efficient. In this work removal and recovery of crude oil by selecting a suitable sorbent among Bananastem, Coconut hair, Polyurethane and Polysulfide polymer under various parameters. From the results obtained in this study, the polyurethane performed well for removal and recovery of crude oil.

Keywords: *Marine Environment, Crude oil spills, Petroleum Product spills, Polyurethane.*

1 Introduction

Crude oil accounts a large percent of world's energy consumption. It is vital to many industries and is of importance to maintenance of industrialized civilizations itself. Oil is often produced in remote locations away from where it will be consumed. Therefore, transportation networks have been built to transport the crude oil to refineries where it is processed and to ship the refined products to where they will be consumed. But transporting petroleum has led to a major environmental threat in the form of oil spills. Most oil is spilled during loading and unloading and has resulted in fouled coastlines, polluted fisheries.Despite varying levels of toxicity, all petroleum products have adverse impacts on our ecosystem and health. Many components found in oil are carcinogenic. Studies have proved that exposure to benzene in parts per billion (ppb) can cause leukemia, Hodgkin's lymphoma and other immune system diseases within 5-15 years of exposure. So it becomes mandatory to remove the spilled crude oil as soon as possible from the accident zone. Though there have been many efficient methodologies in exploiting oil from reserves, there is no such way in cleaning the spills. So far skimmers, sorbents, dispersants, oil booms are the most commonly employed methods.

Choi and cloud (1992) reported that the milkweed and cotton fibers adsorbed 74-85% of crude oil from the surface of an artificial sea water bath containing crude oil. Moller et al.(1997) Explored approaches for managing activity bans in fisheries and aquaculture sectors following oil spills. Ghaly et al. (1999) reported a maximum adsorption of 6.7g-1 peat moss. Natural organic adsorbents are less expensive, readily available and their adsorbing capacities are 3-15 times their weight. Martin et al.(1999) Examined costs associated with low technology shoreline clean-up methods that were used in response to the Sea Empress incident. At the same time the paper categorized incidents according to their causes, type of ship, oil spilt and location. Alther (2002) reported that modified clays with quaternary ammonium cations have better performance in adsorption of 50 types of oil than activated carbon. Anderson et al.(2002) sketched the characteristics of black oils that normally do not break down readily after spill and remain long enough in the environment to necessitate response. Hussein et al.(2004) Studied about the utilization of natural sorbents in removing the oil spills and for the removal of oil sheens. He mainly focused on the cotton fibers for the removal of the spill and sheens. Rodriguez-Trigo (2010) et al. studied the Nakhodka oil spill and suggested improvements with respect to shippers' perspective when defining the role of industry in dealing with oil spill pollution. Campagna et al.(2011) Stated that oil spills contaminate both agricultural facilities and livestock, which can be prevented by innumerable self-help response options such as relocation of cages, transfer of stock and early harvest, the paper elucidated the need for cooperation between ship owners, government, and private bodies involved in addressing problems due to oil spillage. Allan et al.(2012) dealt with shorelines inundated with thick black oil pollutants. Results of the study focus on

society to accept responsibility for repair of damage to environment through human intervention and carefully targeted clean-up activities.

But none has been efficient. Every method mentioned above is applicable only for batch mode and the oil removed from the crude oil cannot be reused.So the objective of the project is to develop a Novel method to recover petroleum based oil and study the reusability of various sorbents. o study the sorbent characteristics of Natural Waste Sorbents (Banana stem, Coconut fiber) and Synthetic Sorbents (Polyurethane, Polysulfide polymer) for efficient removal of oil from oil spills.

2 METHODOLOGY

The main principle used in this method is physical adsorption. Physical adsorption is a surface phenomenon where adsorbate is adsorbed on to the active sites present in the adsorbent due to weak Vander Waals forces of attraction. When mechanical stress is applied to the adsorbent, the adsorbed molecule tends to escape from the pores or active sites present on the adsorbent. Based on this principle we have designed a device to remove and recover crude oil from oil spills using a suitable adsorbent. A combination of two natural adsorbents (Banana stem and Natural Fiber) and two synthetic adsorbents (Polysulfide Polymer and Polyurethane) where chosen. Among these four, Polysulfide Polymer was manufactured in the laboratory using Sulfur and Vegetable oil. And then batch studies were conducted to select the best adsorbent among the four adsorbents.

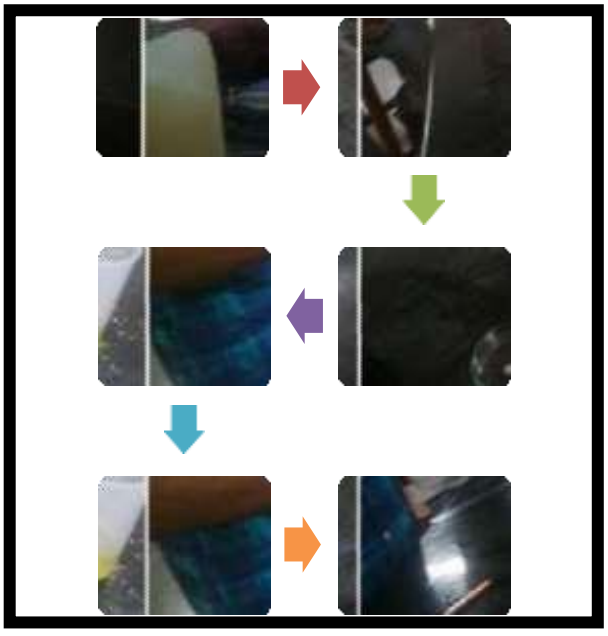


Figure 1. Schematic representation of oil removal

The batch tests conducted were:

Test 1: Selection of best sorbent.
Test 2: Selection of best type Polyurethane.
Test 3: Sorbent characteristics of Polyurethane with Tap water and Saline water.

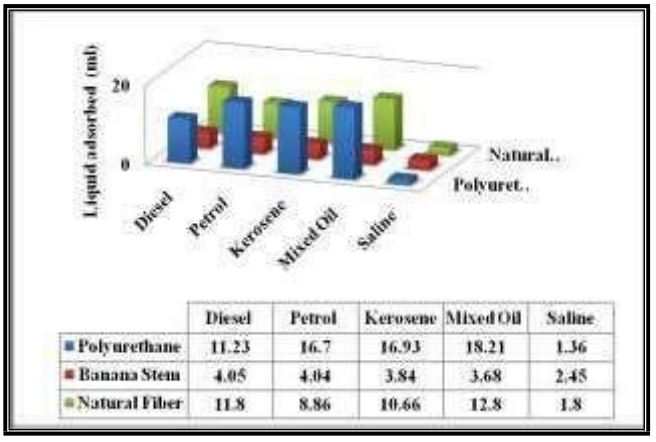
Manufacture of Polysulfide Polymer

Polysulfide Polymer is a polymer manufactured in the laboratory using Sulfur powder, Vegetable oil and Common Salt. 70 weight % of Sulfur powder was taken heated to 180° centigrade till it melts. Once the sulfur powder is melted, 15 weight % of Vegetable Oil and 15 weight % of Common Salt was added slowly for next 10 -20 minutes with constant stirring. The mixture tends to tightens and forms a sponge type substance. This is the required Polysulfide polymer. But the produced polymer was too fragile and foul smelling. So it is rejected for further testing.

3 RESULTS AND DISCUSSION

Selection of Best Sorbent

The test 1 shows the adsorption capacity of Polyurethane, Banana Stem and Fiber of uniform dimensions (3 cm *3 cm * 3 cm) with 300 ml of Diesel, Petrol, Kerosene, Mixed oil and Saline water. The sorbent was immersed into the liquids for 1 minute. After 1 minute, the immersed sorbent was taken out and squeezed for recovery of adsorbed liquids. The weight of the adsorbent and amount of the liquid adsorbed was noted. A graph is plotted for the amount of liquid adsorbed vs. the sorbent.

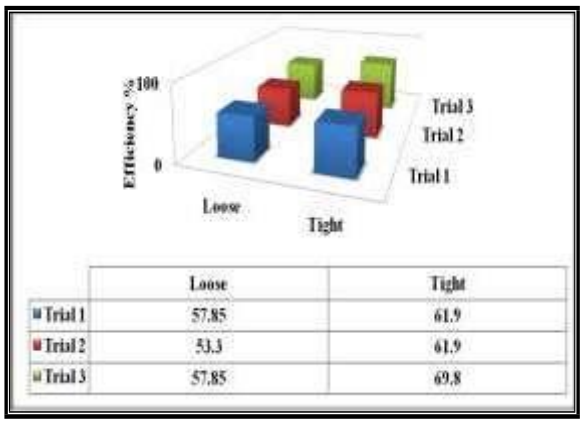


	Diesel	Petrol	Kerosene	Mixed Oil	Saline
Polyurethane	11.23	16.7	16.93	18.21	1.36
Banana Stem	4.05	4.04	3.84	3.68	2.45
Natural Fiber	11.8	8.86	10.66	12.8	1.8

Figure 2. Selection of sorbent for various petroleum products

Selection of Best Type Polyurethane

The test 2 shows the selection of best type of Polyurethane for effective adsorption of oil.Two types of Polyurethane (Loosely packed and tightly packed) was cut into specific dimensions (3 cm*2.9 cm*3 cm) and immersed into 80ml of Diesel for 1 minute. After 1 minute, the immersed sorbent was taken out and squeezed for recovery of Diesel. The efficiency of the adsorbent was calculated. A graph is plotted for the efficiency of the sorbent against the type Polyurethane used.

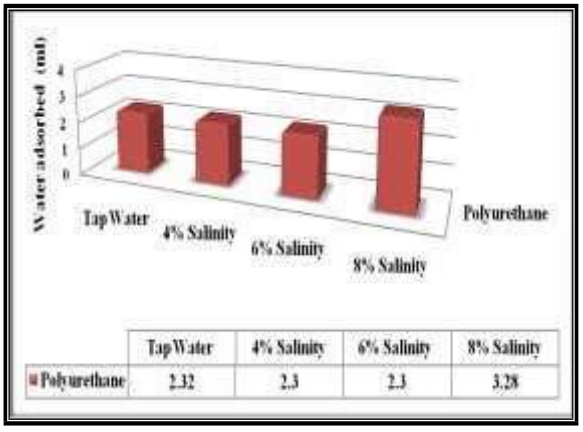


	Loose	Tight
Trial 1	57.85	61.9
Trial 2	53.3	61.9
Trial 3	57.85	69.8

Figure 3. Selection of type of polyurethane

Sorbent Characteristics of Polyurethane with Tap water and Saline water

Fig. 4 shows the adsorption characteristics of Polyurethane with Tap water and Saline water of uniform dimensions (7.7 cm*5.1 cm*3.5 cm) with Tap water and Saline water (4%, 6%, 8% Salinity). 20 grams, 30 grams and 40 grams of salt was added to 500 ml of water in 3 separate beakers respectively. 500ml of Tap water was taken in another separate bowl. The sorbent was immersed into the liquids for 1 minute. After 1 minute, the immersed sorbent was taken out and squeezed for recovery of adsorbed water. The weight of the adsorbent and amount of the liquid adsorbed was noted. A graph is plotted for the amount of liquid adsorbed against the sorbent.



	Tap Water	4% Salinity	6% Salinity	8% Salinity
Polyurethane	2.32	2.3	2.3	3.28

Figure 4. Characteristics of polyurethane with Saline water

4 CONCLUSION

Banana stem, Coconut hair, Polyurethane and Polysulfide polymer were chosen as adsorbent for the removal and recovery of spilled petroleum products. Polyurethane was the best adsorbent among the rest and it is highly hydrophilic in nature. Also it was concluded that tightly packed polyurethane performed well compare to the loosely packed polyurethanes. So it can be used in our design and fabrication. Efficient and hassle-free removal and recovery of crude oil from spillages is made possible using suitable natural or synthetic sorbent material made from day to day wastes, without causing any harm to the marine eco-system is made possible.

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