BIOMASSES AS OIL SORBENT

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ABSTRACT: *Cleaning oil spill is done by three main procedures, namely burning, isolating and skimming and collection. The sorbents used to collect oil in case of oil-spills are mostly synthetic, which limits the possibilities of their disposal. Using biomasses for sorption of these contaminations is economical way to remove various types of oil. The present research work investigate the efficiency of five biomasses wastes as oil sorbents, namely wheat straw, rice husk, corn cob, peanut shells and cotton stalks. Oil sorption capacities these five biomasses were investigated for six mineral oils such as kerosene oil, diesel oil, furnace oil, heating oil, unused lube oil and used lube oil. Tests were conducted at three different temperatures, i.e. room temperature, 40^{0}C and 60 ^{0}C. At all temperatures, results showed that the wheat straw experienced the highest oil sorption capacity where as the furnace oil sorption in all biomasses was highest.*

Key Words: Biomasses, Sorption, Oils, SEM, Wheat husk.

1. INTRODUCTION

Mineral oils are the major source of energy, synthetic polymers and various chemicals worldwide. Whenever oil is transported and stored or its derivatives are used there is risk of spillage which may damage the environment significantly depending upon the type of oil and its quantity [1,2].

Where there is a oil there is possibility of "Oil spill". During oil drilling, production, transportation, loading, unloading, processing oil can be spilled in minor or in large quantities. Major spills are observed in oceans that impact the ecosystem so badly [3]. A marine spill specially disturb the sea life like fish, turtles, seagulls and other birds and ultimately badly destroys the tourism and leisure activities [4]. Economy is also miserably disturbed due to less sea food, tourism and fuel availability due to spillage.

Some Oil products, which are degraded by sun and mico-organism are highly soluble and badly effect the environment in first few hours [5].

There are three methods to cleanup oil spills such as physical, chemical and biological. Physical methods include sorbents, skimmers; booms etc. The chemical methods include in-situ burning, dispersion and solidification. Biological method involves the introduction of oil degrading bacteria and nutrients to contaminated shore lines to enhance the process of natural degradation [6].

The major advantage of booms and skimmers is their environment friendly in nature. Where as in case of in situ burning oil dispersants, a lot of smoke generation is observed that badly affects the environment [7]. Oil dispersants are the chemicals that are used to break the oil in small droplets that are finally decomposed by the action of bacteria and sunlight. These dispersant are toxic and also affect the environment [8].

Characteristics of an ideal Oil sorbent material to clean oil spill include Oleophilicity, Hydrophobicity, high uptake capacity, biodegradability, reusability, high rate uptake of oil, buoyancy, and retention over time, recovery of oil. All of above characteristics are difficult to achieve by single material, however these must be considered before selecting sorbent material [9].

In present study biomasses have been investigated as oil sorbent materials. Agricultural wastes are mostly used as fuel for furnaces as bio fuel. When oil spill occurs bio fuels can be used as sorption material instead of destroying by burning. After sorption the oil rich sorbent material can be shipped back to power plants and can be used as source of energy. This oily bio fuel would be rich in calorific value and enhance the energy level. Sorption behavior of biomasses could be different depending upon the surface area, moisture and its type [10].

To this end biomasses wastes such as rice husk, wheat straw, peanut shells, corn cobs, cotton stalks were investigated as sorption materials and their sorption capacities in six different oils i.e. kerosene oil, diesel oil, heating oil, furnace oil, used lube oil, fresh lube oil were studied

2. MATERIAL AND METHODS

Different biomasses waste was used as oil sorbent material namely rice husk, wheat straw, peanut shells, corn cobs, and cotton stalks. Rice husk, wheat straw and cotton stalks were obtained from agriculture processing units whereas corn cobs and peanut shells were obtained from food processing units. All biomasses wastes were chopped and dried for 20 days in open atmosphere. After 20 days of drying the materials were dried in oven at 90 ^{0}C for 12 hours. After drying the materials were ground and stored in air tight plastic containers. Kerosene oil, diesel oil, heating oil and furnace oil were taken from the local oil company (Shell Pakistan Limited). Whereas 4 strokes used engine oil and fresh lube oil was of Zic A+. The used oil was of 10,000 Km run in four cylinders passenger car. All materials were retained at room temperature for two days before experimentation.

Table: 2.1 Specifications of Agricultural wastes

Specification	Units	Peanut shells	Cotton stalks	Corn Cobs	Wheat Straw	Rice Husk
Moisture content	%	7.99	26.7	17.56	16	27.2
Bulk Density	kg/ m^3	228	450	132	108	144
Silica	%	2.52	4.92	2	5.2	18-20
Heating value	MJ/kg	17.85	17.2	14	18.9	16.4

The oven dried biomasses were separately ground for 15 minutes in a grinding mill. The grinded materials were screened by ASTM sieve of 20 mesh. The passed through 20 sieve materials were collected for experimentation. All samples were weighed to 10 gram with the help of electronic balance and are shown in Fig.1. Oil samples were put into the beakers such that each beaker having 50 ml of oil. 30 beakers were prepared for experimentation. Five grounded bio masses were mixed each type of oil. Each sample was mixed thoroughly in oil and left for 48 hours for sorption. After 48 hours the materials were filtered by ordinary filter paper for 48 hours.

Fig. 1: Grounded biomasses

Percent absorptivity was calculated by following formula:

Sorptivity

$$\text{Sorptivity} = \frac{\text{Weight of sorbent holding oil}}{\text{Original weight of sorbent}} \times 100$$

This equation can be expressed as a ratio between the weight of oil absorbed and the weight of sorbent.

Sorption Capacity = $(S_t - S_0)/S_0$

Where;

1. St is Weight of sorbent holding absorbed oil
2. S_0 is Original weight of sorbent

The same experiment was repeated for each oil and biomass at two more temperatures (40 ^{0}C and 60 ^{0}C). Oils with biomasses were heated in oven at specified temperature for 4 hours. The materials were removed and the collected material were then put on an ordinary filter paper and drained for 48 hrs. The separated sample then weighed again.

After taking all results it was observed that wheat straw showed the highest sorption capacity in all oils. Therefore we collected some wheat straws, marked some points and dipped them in bottles filled with selected oils to check which oil can climb highest in the wheat straw.

3. RESULTS AND DISCUSSION

The sorption behavior was studied for biomasses wastes at three different temperatures. Each biomass showed its own sorption capacity in each type of oil depending on the nature of oil, physical properties, oil film thickness, and the temperature. Similarly, sorption of particular oil on sorbent material (biomass waste) depends on the surface area of the biomass, pore size, shape and strength of fibers constituting the biomass.

At all temperatures results show that the wheat straw experienced the highest oil sorption capacity. SEM (Scanning electron microscope) of wheat straw clarifies the reason. Fig. 2 depicts that the wheat straw consists of very small pores. These pores are very effective in oil sorption because it determines the rate at which the fluid flows in to the capillary network. The table 2.1 also illustrates the lowest density of wheat straw among five selected biomass wastes. Fluffy nature of wheat straw is also good for oil sorption.

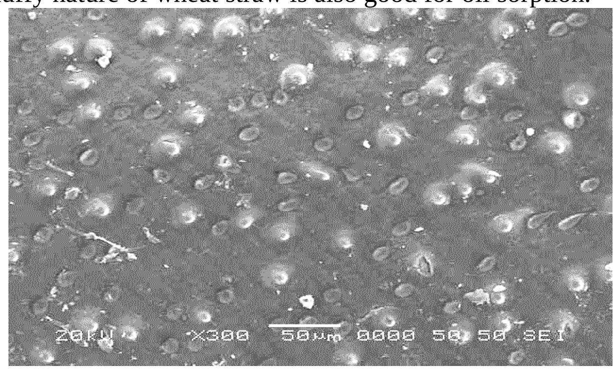

Fig. 2: SEM of wheat husk

Among six different oils the wheat straw sorption of furnace oil was highest. The reason behind is the highest viscosity of furnace oil. Higher sorption may be due to the fibers have greater ability to hold the oil of higher viscosities. Since the oil is more viscous as well as heavy so it moves into the fibrous assembly and stays there. Heavy viscous oil does not easily drain out during the drainage period and exhibit high oil retention. Rice husk SEM shows the protuberances with some pores as shown in Fig.3. It clarifies the least sorption experienced by rice husk. Another reason of least sorption of rice husk is the presence of silica. Rice husk contains 18% to 20% silica which is unable to hold large quantities of any kind of oil.

Similar case is with peanut shells and cotton stalk. The behavior of corn cob was different.

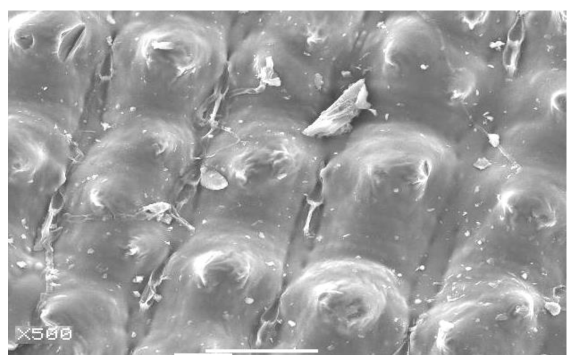

Fig. 3: .SEM of rice husk

In case of corn cob the fibrous assembly consists of big pores therefore oil enters relatively fast and then drain out during filtration. In case of kerosene oil because of its relative low viscosity has low sorption behavior compared to other oil under experiment. Furnace oil has relatively high viscosity therefore its sorption behavior was high in all biomasses. The pore structure of biomasses plays an important role in sorption for all types of oil. Oil holding capacity of agriculture wastes at various temperatures are shown in Figs 4,5 and 6.

4. CONCLUSIONS

Five different types of biomasses were studied for six different types of oils for sorption behaviors. The sorption behavior was highest for furnace oil in all biomasses at room temperature. This was due to its high viscosity among all oils. All biomasses took least amount of kerosene oil because of its low viscosity.

The sorption behaviors of biomasses were also studied at 40 ^{0}C and 60 ^{0}C. It was observed that by increasing the temperature sorption capacity decreases. By increasing the temperature the viscosity of oil decreases and therefore retention capacity of biomasses decreases which ultimately affects the sorption of biomasses.

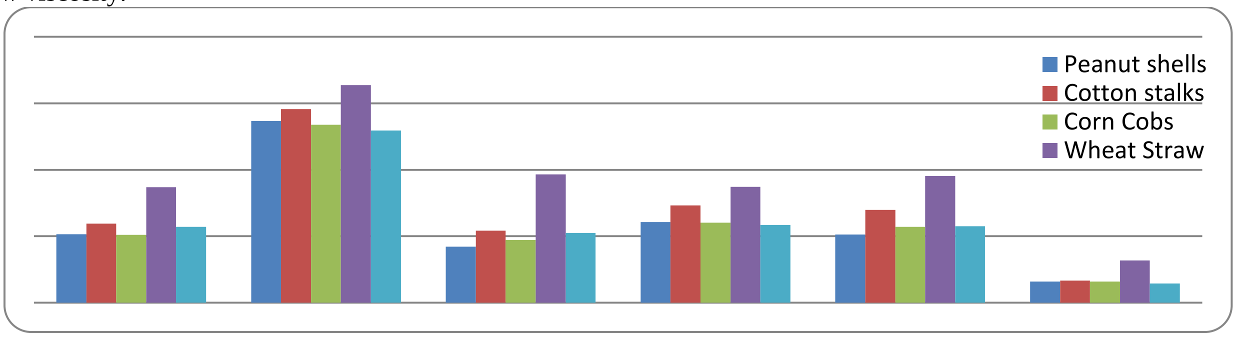

Fig. 4: Sorption capacities at room temperature.

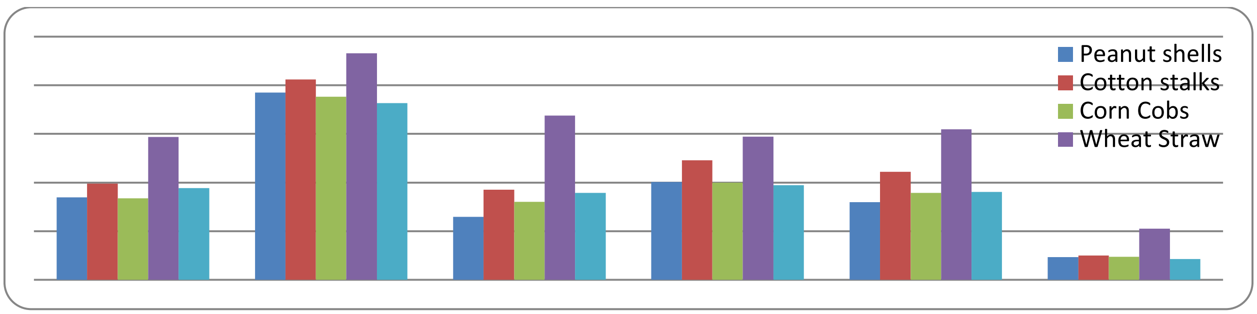

Fig. 5: Sorption capacities at 40 ^{0}C temperature.

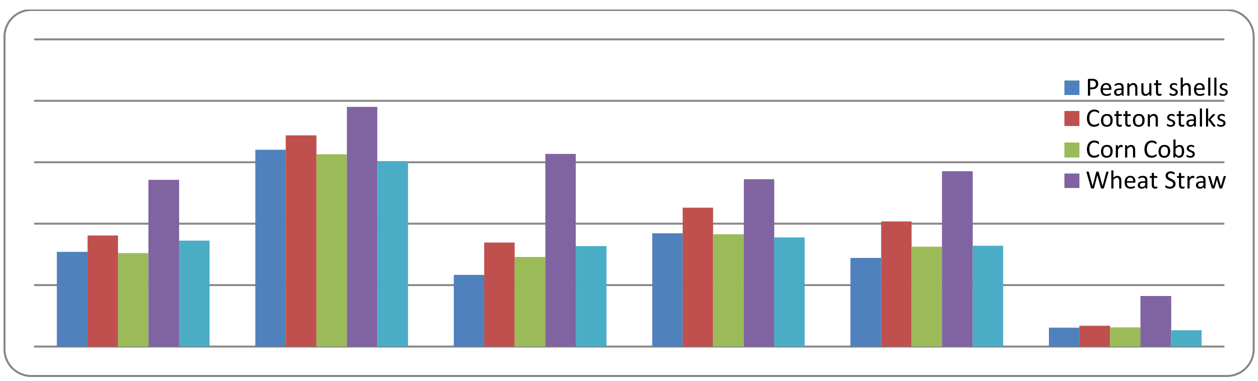

Fig. 6: Sorption capacities at 60 ^{0}C temperature.

5 ACKNOWLEDGEMENTS

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