Study Of Nonwoven Material For An Oil Sorbent By Using Bamboo And Cotton Blend.

[1]N Aswathy, [2] Prof. V Shunmugam.
[1,2]Department Textile Technology, Jaya engineering college ,Thirunindrvur - Chennai, Tamilnadu, India.

Abstract **-** Crude oil is currently the most important raw material and energy source worldwide. Oil sometimes gets accidentally introduced into the environment during production, transportation, and refining process causing adverse effects on aquatic life and human economic activities. Sorbent materials can provide useful resource in a response of spill of oil, allowing oil to recover in situations that are unsuitable for other techniques. However sorbents can be used for minimize the secondary problems such as pollution, contamination of soil and other problems. Major problems, it can generate the fire while it can mixed with environmental activities. It can be developed by using various techniques. Needle punching is the most fabliest method for developing a non-woven pad. Cotton is the most important natural fibre used in the production of apparel products all over the world. Bamboo is one of the superficial natural fibre. Fibres are blended together and fabric manufactured by using miniature carding machine and its needle felted by needle punching machine. Then the fabric is surface modified with acetic anhydride in the presence of 2 to 3 drops of concentrated H_2So_4. The modified nonwoven fabric was characterized by FT-IR and oil sorption capacity analysed for different oils.

Keywords- Cotton and bamboo fibre, needle punching, miniature carding machine, acetic anhydride and surface modification.

I.INTRODUCTION

Oil is the most common pollutant in the oceans. Oil is a complex mixture of thousands of different compounds. Oils have a high carbon and hydrogen content and are usually flammable. Oil is any neutral chemical substance that is a viscous liquid at ambient temperature. Oil is immiscible with water but soluble in alcohol or ethers. Crude oils are composed primarily of five elements[C, H, S, N and O]. These five elements are present in various combinations within the oil. Hydrocarbons are the most abundant compounds found in crude oils. Rapid economic growth has caused a substantial increase in oil consumption in recent decades.

To meet market demand, oil producers have established a worldwide network of sea-going vessels that transport oil through major waterways. As a result a significant amount of oil is spilled into seas from operational discharges of ships as well as from accidental tanker collisions. Oil spills resulting from tanker traffic, offshore drilling. Associated activities are likely to increase in years to come as demand for petroleum and petroleum products continue to rise. An oil spill accident is harmful to the ocean environment and the health of mankind. A major oil spill can cause serious damage to the fisheries and contaminate the shoreline.

More than 3 million metric tons of oil contaminant the sea every year. The majority of oil pollution in the ocean comes from land. Runoff and waste from cities, industries and rivers carriers oil into the ocean. Ships cause about a third of the oil pollution in the oceans when they wash out their tanks. When oil leaks spills into water it floats on the surface of water because the density of oil (0.85 g/cm^3) is less than water (density=1.02 g/cm^3).

The most common effect is the spreading of the oil over the surface of the water. Oil spreads very quickly, with lighter oils, like gasoline, spreading faster than heavy crude oils. Currents, wind and warm temperatures will cause the oil to spread faster. Typically, oil can spread as thin as a coat of paint very rapidly. For this reason, it is important for oil spills to be spreads as quick as possible. Oil can settle to the bottom of the water, while the density of oil ranges from 0.85 grams per cubic centimetre to 1.04 grams per cubic centimetre, most oil densities fall into the 0.90 to 0.98 grams per cubic centimetre range. Ocean water has a density between 1.02 and 1.03 grams per cubic centimetre, depending on the salt concentration. River water, however, has a density of 1.0 gram per cubic centimetre. This means that a heavy oil, with a density of 1.01 grams per cubic centimetre, would float in ocean water, but sink in a river. The oil can be moved with currents, tides and the wind. The currents can carry the oil a great distance from its origin. It can also cause substantial damage in oceans, because the tide can carry the oil to seashores and intertidal zones, which are especially sensitive to oil pollution. Some oil will evaporate, up to 50 percent of the volume of most oil spills can evaporate. Light fuels, such as gasoline, will almost entirely evaporate within one or two days.

Once oil comes in contact with water, it forms emulsion that needs to be treated before it is disposed because of toxic and hazardous properties of its components. The physical and chemical properties of oil change progressively when oil spilled on water or on land. This process is referred as 'weathering'. Major processes of weathering of oil spilled on water include evaporation, dissolution, oxidation, emulsification and microbial degradation.

The commonly used methods to remove oil are booms, dispersants, skimmers, and sorbents. The main disadvantage of these methods are high cost and inefficient trace level absorption. The most commonly used commercial sorbents are polypropylene and polyurethane. They have good hydrophobic and oleophilic properties. The main disadvantage is non-biodegradable character. Our project aims at proposing solutions for the above mentioned problems. The oil sorption capacities of cotton fiber, kenaf bast fiber, kenaf core fiber, and moss fiber were compared after refining, extraction, and reduction in particle sizes. The tests were conducted on diesel oil in a pure form. Cotton fiber showed the highest capacity, followed by kenaf core and bast fibers. Wetting, extraction, and reduction in particle size all contributed to the changes in sorption capacity. The most significant change was due to the reduction in particle sizes of cotton and kenaf , bast fibers; however, the kenaf core was not affected. Usually, lignocellulosic fibers are hydrophilic and the oil sorption capacity is very low. These hydrophilic fibers must be converted to hydrophobic fibers to improve the oil sorption capacity [11].

The adsorption capacity was examined of three different types of materials: a sludge which is mainly composed of calcium aluminum silicate and formed in water clarification and filtration and in dissolved air floatation units in petroleum refineries and thermal power stations, and garlic and onion peel as agricultural wastes. Results showed that the adsorption capacities of the chemically treated sludge with 30 μg/mL dodecyl benzene sulphonic acid, untreated sludge and the thermally treated sludge at 1200EC are 2, 1.388 and 0.8 g/g respectively, while, garlic and onion peels have adsorption capacities of 0.385 and 0.455 g/g respectively. These results were obtained by placing 0.6 g crude oil on a saline solution — 750 mL of 0.5 M NaCl at 30EC with different weights of the adsorbents for 90, 90, 90, 30 and 30 s for each, respectively. Characteristics of the crude oil and sludge were investigated by FTIR, X-ray fluorescence, X-ray diffraction, pour point and centrifuge instruments [18].

Oil spills impose serious damage on the environment. Mechanical recovery by the help of oil sorbents is one of the most important countermeasures in oil spill response. Most sorbents, however, end up in landfills or in incineration after a single use. These options either produce another source of pollution or increase the oil recovery cost. In this study a biosurfactant was used to clean used oil sorbents. This use of biosurfactants is new. Washing parameters tested included sorbent type, washing time, surfactant dosage and temperature. It was found that with biosurfactant washing more than 95% removal of the oil from sorbents was achieved, depending on the washing conditions. Biosurfactants were found to have considerable potential for recycling the used sorbents [58].

II. MATERIALS ANS METHOD

The materials used for the project are cotton, Bamboo Fibres,Oils and oleic acid and sulphuric acid.

A. *Cotton fibres and its physical properties*

Cotton, one of the world's leading agricultural crops, is plentiful and economically produced, making cotton products relatively inexpensive. The fibres can be made into a wide variety of fabrics ranging from lightweight voiles and laces to heavy sailcloths and thick-piled velveteens, suitable for a great variety of wearing apparel, home furnishings, and industrial uses. Cotton fabrics can be extremely durable and resistant to abrasion. Cotton accepts many dyes, is usually washable, and can be ironed at relatively high temperatures. It is comfortable to wear because it absorbs and releases moisture quickly. When warmth is desired, it can be napped, a process giving the fabric a downy surface. Various finishing processes have been developed to make cotton resistant to stains, water, and mildew; to increase resistance to wrinkling, thus reducing or eliminating the need for ironing; and to reduce shrinkage in laundering to not more than 1 percent. Nonwoven cotton, made by fusing or bonding the fibres together, is useful for making disposable products to be used as towels, polishing cloths, tea bags, tablecloths, bandages, and disposable uniforms and sheets for hospital and other medical uses. Cotton is the most important apparel fiber throughout the world. It is a fiber that was used fairly extensively during the early, developmental period of the Nonwovens business primarily because the emerging dry-laid producers came from the textile industry and had an intimate knowledge of cotton and its processing characteristics.

B. *Bamboo fibres*

Bamboo is a regenerated cellulosic fibre produced from bamboo. A starchy pulp is produced from Bamboo stems and leaves through a process of alkaline hydrolysis and multi-phase bleaching. Further chemical processes bamboo fibre is produced.

C. *Oils*

Three types of oils were used for the process. They are Diesel oil, crude oil and Engine oil. The different types of oils were chosen with respect to different density ranging from low, medium and heavy.

D. *Preparation of surface modified nonwoven*

Nonwoven bamboo/cooton pad was treated with required amount of fatty acid in the presence of one to three drops of concentrated sulfuric acid as catalyst. The mixture was refluxed in a Dean-Stark apparatus at required temperature for an optimized period of time. The treated fabric was washed with n-hexane, dried in oven at 70°C till constant weight and stored in an air tight container till further use (Banerjee, 2006). The amount of grafted fatty acid was estimated by weight percent gain (WPG) as follows.

$$WPG = W_2 - W_1 \; W_1 \times 100$$

E. *Oil sorption capacity*

Oil sorption capacity was determined by using method reported in literature (Sun, 2004). A fixed quantity of machine oil (50 g) which is suspended with water in a beaker. The modified non-woven fabric was added and mixed for 1 min at room temperature and allowed to absorb oil for 1hr. The fabric was then removed and held to drain off the excess amount of oil. The fabric was then reweighed to determine the oil absorptivity.

F. Oil absorbency

The oil absorbency is calculated by using the formula

$$Q = (m_2 – m_1) / m_1$$

m_1 = weight of sample before oil absorption in g/g
m_2 = weight of sample after oil absorption in g/g

G. Recovery of Sorbed Oil and Reusability of Sorbents

In order to examine the reusability of these sorbents, method described by Choi and Moreau (1993) was followed which has limitation that gives only an approximate value of oil sorption. The sorbent with oil was weighed and then squeezed between two rollers at a pressure of 10kgf/cm before it was reweighed to determine the amount of recovered oil. The squeezed sorbent was again used in the sorption process as before. The efficiency of sorbent reusability was determined by oil sorption capacity of each sorbent after repeated sorption and mechanical desorption cycles (Ansari, 2003).

III. TESTING

A. OIL ABSORBENCY IN VARIOUS OILS

Oil absorption capacity was analysed for three different sample ratios are 50/50, 30/70 and 70/30 in petrol, diesel and kerosene. Density of petrol is 0.77Kg/M^3, density of kerosene is 0.81g/Cm^3 and the density of diesel is 1 g/Cm^3.

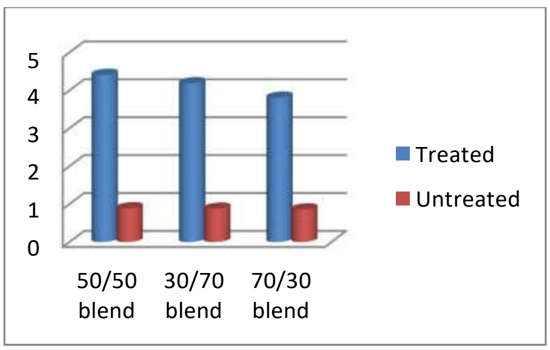

Figure 3.1 oil absorption capacity for different samples in petrol.

The result shows that the oil absorption capacity for the various blended bamboo cotton sorbents of treated and untreated samples. In fig.3.1 shows treated 50/50 bamboo cotton blend sample is having higher oil absorption capacity of 4.41g and the other sorbents of 30/70 having medium value 4.19g and 70/30 is 3.81g. Untreated samples having very low absorption values compared to treated samples.

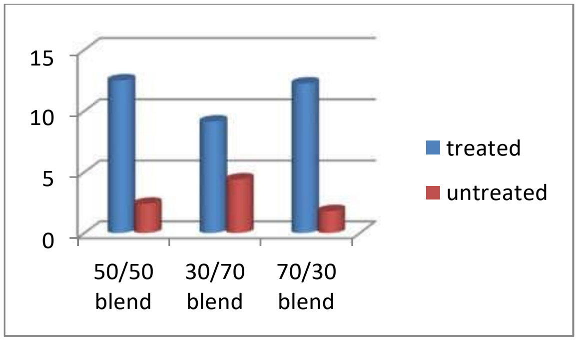

Figure 3.2 Oil absorption capacity for different samples in diesel.

The result shows that the oil absorption capacity for the various blended bamboo cotton sorbents of treated and untreated samples. In fig.3.2 shows treated 50/50 bamboo cotton blend sample is having higher oil absorption capacity of 12.50g and the other sorbents of 70/30 having good oil absorption value is 12.18g and 30/70 is 9.14g. Untreated samples having very low absorption values compared to treated samples. In untreated sample having the maximum absorbency of oil is 3.15g in 50/50 blend sorbent and poor absorbency in both 30/70 & 70/30 blend is 1.25g & 2.18g.

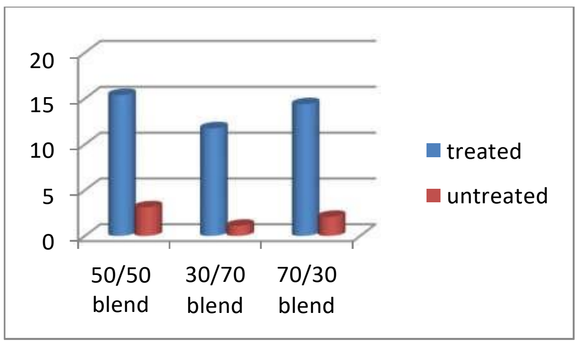

Figure 3.3 Oil absorption capacity for different samples in kerosene.

The result shows that the oil absorption capacity for the various blended bamboo cotton sorbents of treated and untreated samples. In fig.3.3 shows treated 50/50 bamboo cotton blend sample is having higher oil absorption capacity of 15.38g and the other sorbents of 70/30 having good oil absorption value is 14.38g and 30/70 is 11.75g. Untreated samples having very low absorption values compared to treated samples in 50/50 it is having the maximum oil absorbency of 3.12g, for 30/70 blend it is having very low value of 1.10g and 70/30 blend having medium absorption of 2.28g in kerosene.

B. Airpermeability test

The air permeability of a fabric is a measure of how well it allows the passage of air through it. It is very important for this kind of sorbent materials. It's defined as the volume of air in mm, which is passed in one second through 100's mm2 of a fabric at a pressure difference of 10 mm head of water. In 50/50 bamboo cotton blend having 26.1825 $cm^3/sec/cm^2$ per 0.5 inches of water. Then the sample of 30/70 b/c blend sample having the air permeability value of 30.322 $cm^3/sec/cm^2$ per 0.5 inches of water. Then the sample of 70/30 b/c is having 26.0306 $cm^3/sec/cm^2$ per 0.5 inches of water. The sample of 50/50 bamboo-cotton blend is found good than other bamboo-cotton blend samples.

IV. CONCLUSION

From this, non-woven pad is manufactured and it is surface modified by using acetic anhydride in the presence of concentrated sulfuric acid to replace the hydroxyl group of the cellulosic fibres. So fibre get hydrophobic nature. The bamboo and cotton fibres seperatively used in the various literature, from that oil sorption capacity, reusability of sorbents and oil recovery was good in this fibres. Thatsway only I choose the above blend as my materials for this sorbent manufacturing. The following conclusion were observed from this research study.

- Oil absorption capacity for different samples in petrol is analysed. In this oil 50/50 bamboo cotton blended needle felted fabric having maximum oil absorbency of 4.41g than other blended fabrics.
- Oil absorption capacity for different samples in kerosene is 50/50 bamboo cotton blend is 12.50g than other blended fabrics.
- Oil absorption capacity for different samples in diesel is 50/50 bamboo cotton blend is 15.38g than other blended fabrics.
- Thus the oil absorption test result shows that all the samples of 50/50 bamboo cotton blended samples having maximum absorption value than other blends 30/70 & 70/30.
- The air permeability of a bamboo cotton blended needle felted fabric is higher than other blended needle felted fabric.

REFERENCES

[1] *Abd-El-Aziz A., Said Adriance, G.Ludwick and Heshmat A.Aglan (2009) 'Usefulness of raw bagasse for oil absorption: A comparison of raw and acylated bagasse and their components', Bioresourse Technology, Volume 100, pp.2219-2222.*

[2] *Abdullah. M.A, Anisa Ur Rahmah, Z. Man. (2010) 'Physicochemical sorption characteristics of Malaysian Ceibapentandra(L.) Gaertn. as a natural oil sorbent',Journal of Hazardous Materials, pp. 683-691.*

[3] *Abijith Majumdar, Sanchi Arora. 'Bamboo fibres in textile applications',PP.285-304.*

[4] *Adhithya. N , Mukesh Goel, Ashutosh Das. (2017) ' Use of bamboo fiber in oil water separation', International Journal of Civil Engineering and Technology,Volume 8, Issue 6, pp. 925-931.*

[5] *Amr S. Ismail.(2015) 'Preparation and Evaluation of Fatty-Sawdust as a Natural Biopolymer for Oil Spill Sorption', Chemistry Journal, volume 5, pp.80-85.*

[6] *Annonciado T. R, Sydenstricker T.H.D and Amico S.C (2005) Experimental investigation of various vegetable fibers as sorbent materials for oil spills', Volume 81, pp.531-990.*

[7] *Anthony.W.S (1994) 'Absorption of oil with cotton products and kenaf', The A merican Society Of Agricultural and Biological Engineering,*

[8] *Asha Sreenivasan, Thiruvenkatachari and Viraraghavan (2008) 'Removal of oil by wallnut shell media'.*

[9] *Atlas. R. M.(1975) 'Effect of temperature and crude oil composition on petrolium biodegradation', American Society of Microbiology, volume 30, pp.396-403.*

[10] *Atlas. R. M.(1981) 'Microbial degradation of petroleum hydrocarbons: An environmental perspective Microbiol', Rev. 45, pp.180-209.*

[11] *Atlas. R. M.(1981) 'Microbial degradation of petroleum hydrocarbons: An environmental perspective Microbiol', Rev. 45, pp.180-209.*

[12] *Beom-Goe Lee, James S. Han, and Roger M. Rowell. (1999) 'Oil spill cleanup by lignocellulosic fibers', ISBN 0-9670559-0-3., pp. 423-433.*

[13] *Choi.H.M.,Kwon.H.W and Moreau.J.P (1993) 'Cotton nonwoven as oil spill cleanup sorbent', Textile Research Journal, Volume 63, pp.211-218.*

[14] *Erasmus.E. and Barakhuysen.F.A (2009) 'Superhydrophobic cotton by fiurosilane modification', Indian Journal for Fibre and Textile Research, Volume 34, pp.377-379.*

[15] *Francisco Claudio and Luis Constantino (2014) 'Removal of petrolium spill in water by chitin and chitosan', The Electrical Journal of Chemistry, Volume 6, pp.*

[16] *Gerald Des Champs, Herve Carvel, Marie Elisabeth Borredon, Christopher Bonnin and Christian Vignoles (2003) 'Oil removal by the water by selective sorption on hydrophobic cotton fibres', Volume 37, pp.1013-1015.*

[17] *Guoliang Wang, 'Use of Sorbent materials in oil spill response', ITOPF, Technical Information Paper.*

[18] *Haitao Zhu, Shan Shan Qiu and Wei Jiang (2010) 'Evaluation of electrospun polyvinyl chloride / polystyrene fibres as sorbent materials for oil spill cleanup', Journal of Environmental Science and Technology, Volume 45, pp.4527-4531.*

[19] *Hammound A.H. 'Enhanced Oil Spill Recovery Rate using the weir skimmer', Beirut Arab University.*

[20] *Henry R. Walter (2014) 'Cleanup techniques used for costal oil spills: An analysis of spills occuring in Santa Barbara, California, Prince William Sound, Alaska, The sea of Japan and The Gulf Coast'.*

[21] *Hiroshi Moriwaki, Shiori Kitajima, Masahiro Kurashima and Ayaka Hagiwara (2009) 'Utilization of silkworm cocoon waste as a sorbent for the removal of oil from water', Journal of Hazardous Material, Volume 165, pp.266-270.*

[22] *M.Hussein, A.A.Amer and I.I.Sawsan (2008) 'Oil spill sorption using carbonized pith bagasse: Trial for practical application', International Journal for Environmental Science and Technology, Volume 5, pp.233-242.*

[23] *M.Hussein, A.A.Amer and N.A.Taha (2009) 'Availability of barley straw application on oil spill cleanup', International Journal For Environmental Science and Technology , Volume 6, pp.123-160.*

[24] *M.Hussein, A.A.Amer and I.I.Sawsan (2009) 'Oil spill sorption using carbonized pith bagasse. Application of carbonized pith bagasse as loose fiber', Volume 11, pp.440-448.*

[25] *M.Hussein, A.A.Amer and I.I.Sawsan (2011) 'Heavy oil spill cleanup using low grade raw cotton fibres: trial for practical application', Journal of Petroleum Technology and Alternative Fuels, Volume 2, pp.132-140.*

[26] *M.Hussein, A.A.Amer and N.A.Taha 'Oil spill removal from water by using corn stalk: Factors affecting sorption process', International Journal For Environmental Science and Technolog.*

[27] *Hyung Min Choi and Rinn M Cloud,(1992) 'Natural sorbents in oil spill cleanup', Environmental Science And Engineering, Volume 26, pp.772-776.*

[28] *Hyung Min Choi (2008) 'Needle punched cotton nonwovens and other natural fibres as oil cleanup sorbents', Volume 31, pp772-225.*

[29] *Ibrahim.S, Wang Shaobin and Ang.H (2010) 'Removal of emulsified oil from oily waste water using agricultural waste barley straw', Volume 49, pp.78-83.*

[30] *Indu G.K and Dr.Senthilkumar.P (2016) 'Development of Nonwovens from Natural Fibres for Various Applications', International Journal of Applied Engineering Research, Volume 11, pp.1879-1882.*

[31] *Jenifer Alexandra Brown (2011) 'Modification of cotton fabric by silane coupling agents and assessment for use in oil spill remediation'.*

[32] *Jintao Wang, Yian Zheng and Aiqin Wang (2012) 'Effect of kapok fibre treated with various solvents an oil absorbency', Industrial Crops and Products, Volume 40, pp.178-184.*

[33] *H.Koseoglu (2016) 'Bio-templated luffa cylindrica for the oil spill cleanup from sea water',Volume 57, pp.25591-25599.*

[34] *J. Lin, Yan Wei Shang and Bin Ding (2011) 'Nanoporous polystyrene fibres for oil spill cleanup'.*

[35] *Li Yu, Mei Han and Fang He (2013) 'A review of treating oily waste water', Arabian Journal of Chemistry, Volume 10, pp.1913-1922.*

[36] *Maja M.Radetic, Dragan M.Jocic, Petar M.Jovancia, Zoran L.Petrovic and Helga I.Thomas (2003) 'Recycled wool based non woven materials as an oil sorbent', Journal of Environmental Science and Technology, Volume 31, pp.1008-1012.*