Use of bamboo fiber in oil water separation

ADHITHYA, N, GOEL, Mukesh <http://orcid.org/0000-0003-2991-3439> and DAS, A

Published version

ADHITHYA, N, GOEL, Mukesh and DAS, A (2017). Use of bamboo fiber in oil water separation. International Journal of Civil Engineering and Technology, 8 (6), 925-931.

Copyright and re-use policy

International Journal of Civil Engineering and Technology (IJCIET)
Volume 8, Issue 6, June 2017, pp. 925–931, Article ID: IJCIET_08_06_100
Available online at http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=6
ISSN Print: 0976-6308 and ISSN Online: 0976-6316

USE OF BAMBOO FIBER IN OIL WATER SEPARATION

N. Adhithya, Mukesh Goel, Ashutosh Das
Centre for Environmental Engineering,
PRIST University, Thanjavur, Tamil Nadu, India – 613403

ABSTRACT

One of the environmental issues facing the society is the separation of oil from water in emulsions. Oily wastewater enters into the environment through many ways such as oil spill as well as from the industry. Natural fibers are a viable alternative to synthetic fibers in separating oil from the water. The oil physical characteristics and sorbents made from the fiber influences the sorption of oil onto the fiber. This work uses the naturally available bamboo fibers for separation of oil from water. Very high adsorption capacities were obtained for vegetable oil. Furthermore, recovery of oil was also tested and 90% recovery was obtained. Bamboo fiber has thus great advantage in treating oil-water mixture.

Keywords- Bamboo; Oil-Sorption; Recovery; Oil water separation.

Cite this Article: N. Adhithya, Mukesh Goel, Ashutosh Das, Use of Bamboo Fiber In Oil Water Separation, International Journal of Civil Engineering and Technology, 8(6), 2017, pp. 925–931.
http://www.iaeme.com/IJCIET/issues.asp?JType=IJCIET&VType=8&IType=6

1. INTRODUCTION

Oil wastewater is an important wastewater pollution being faced by the society. It has potential to seriously damage marine ecosystems leading to severe crisis for humanities as well. These wastewaters are mostly discharged from petrochemical and chemical industries, however the cause of grave concern is frequent oil spill accidents. In last 100 years, several oil-spill accidents have been reported and the catastrophic consequences from such incidents are heart-rending. Industrial development has led to increase in the amount of oil, thus increasing the exposure to oil water pollution. Although more stringent regulations have been developed to control these pollutants, improperly treated wastewaters are leading to worsening of water quality. Therefore, efficient wastewater treatment technologies have to be originated in order to take care of toxic wastewaters (Senanurakwarkul et al., 2013; Kumar et al., 2013; Goel et al., 2009).

Numerous physico-chemical treatment technologies have been developed to remove the pollutants generated from oily wastewaters (Wei et al., 2005). Incineration, micro-electrolysis, coagulation-flocculation are reported to be successful in treating wastewater (Breen et al., 2003;

Zeng et al., 2007). Advanced oxidation process are one of the best bet in treating various organic pollutants. AOPs include several methods such as: H_2O_2/UV, O_3/UV and UV/TiO_2 (Lee et al., 2010). These processes however suffers from insufficient knowledge of process design and operation of large-scale reactors as well as cost factor. These processes are comparatively costly. Biological process helps to overcome these defects and are used plenty in treating wastewaters (Irfanudeen et al., 2015). But these processes have their own limitations as they are generally slow and unpredictable.

Adsorption, with/without other supportive pre-/co-/post- treatment finds a great potential in handling the textile wastewater, by virtue of economy, ease of operation as well as robustness (handling different range of effluent). The most-widely used adsorbents are the activated carbons, derived from agricultural low value byproducts such as agro-wastes & residues, plum kernels, nutshells (Zhang et al., 2004; Banat et al., 2004). This work explores the use of bamboo fibers as sorbents in oil spill cleanup. It is categorized as a grass and not a tree, and is a sustainable resource and grows widely in Asian countries.

2. MATERIALS AND METHODS

2.1. Preparation of adsorbent from bamboo

Bamboo was first taken and fed into the roller crusher machine to make it into strips. The strips are then allowed for steaming process at nearly 110 degree temperature for about 10 hours in a conventional steamer used for textile manufacturing process. After the steaming process those strips are kept aside for biological degumming by natural enzymes already present in the bamboo. The degumming time for obtaining bamboo product was 10 days, which was then sent for carding. Now the obtained product is fed into carding machine for web formation process. We have chosen parallel laid webs because they result in good tensile strength. The web formation gives the bamboo fiber a structure of fabric. After the carding process, needle felting has to be done. In this process, the fiber layer was entangled with each other by needles which holds on the structure together. Now the final non-woven fabric of bamboo fiber has been made. This final fabric is then surface modified for hydrophobic and oleophillic properties. For that we have used poly ethylene glycol by spraying technique. Now the fabric is ready for separation process.

2.2 Analysis of surface morphology

The changes in surface morphology of the coated and washed samples are analyzed by scanning electron microscopy (SEM) using JSM 6360, Jeol, Japan with an accelerating voltage of 4.0 kV and 100 x magnification.

2.3. Test for Sorption Capacity

The test reactor contains 40 g of oil in 400 ml of distilled water (*p*H 6.20) inside glass beaker. One gram of dry material is then placed in the beaker and shaken in a laboratory shaker at a frequency of 110 rpm for 15 min. Water content is determined by distillation using a mixture of toluene and xylene (20/80 v/v) as a solvent.

The oil sorption capacity (q) is determined by the following relationship:

$$q = \frac{mf - (mo + mw)}{mo}$$

Where mf is the weight of the wet material after draining (g); mo, the initial weight of the material (g);and mw, the water content in the material (g).

2.4. Test for Recovery of Sorbed Oil

The sorbent with oil is squeezed between two rollers at a pressure of 98 N/cm before it is reweighed to determine the amount of recovered oil. The squeezed sorbent is again used in the sorption process as before. The efficiency of sorbent reusability is determined by oil sorption capacity of each sorbent after repeated sorption and desorption cycles. In all cases, the separation process is gravity driven. After the separation processes, the oil and water recovery (%) are determined to be the volume ratio of the separated over the initial oil or water respectively.

$$\text{Oil Recovery (\%)} = \frac{V_{\text{collected oil}}}{V_{\text{initial oil}}} \times 100$$

3. RESULTS AND DISCUSSIONS

3.1. Adsorption capacity of the fiber

The bamboo fibers were tested for their adsorption capacity. Five different oils were used, viz., petrol, diesel, kerosene, sesame oil and sunflower oil. The results are presented in Figure 1 – 5. High adsorption capacity of 16 mg/g was obtained in case of petrol. The adsorption capacity decreased with the increase in number of cycles. The saturated fiber resulted in 10 mg/g after 15 cycles. The results were more or less similar for diesel (Figure 2). However, the adsorption capacity was found to be higher for kerosene. It subsequently increased for sesame and sunflower oil. The adsorption capacity of fiber with sesame oil was found to be 26 mg/g in the first cycle, which decreased to 12.5 mg/g by the 15^{th} cycle. The high capacity of banana fiber for vegetable oils could be due to the high viscosity of these oils compared to fuel oil. High viscosity helps in better adhesion of oil to the surface and thus better extraction from oil-water mixture. The decrease in adsorption capacity with increase in the number of cycles was the result of fiber becoming saturated with oil. When compared with other natural fibers, like cotton, kapok fiber, milkweed fiber, polypropylene fiber, flax etc. bamboo fiber has more durability. It withstands more wear and tear since it has smooth texture. The life cycle of bamboo filters will be more of other fibers. Once the sorbents are saturated, the oil can be squeezed from the pads and managed with used oil if the squeezed oil is not contaminated with hazardous waste. The used sorbents can further be disposed in landfills. Since the bamboo fiber is biodegradable, it does not require any prior treatment before dumping into the landfills site. This makes the bamboo fiber a viable alternative to synthetic fibers for oil-water separation. Figure 6 presents the SEM image of oil adsorbed on bamboo fiber.

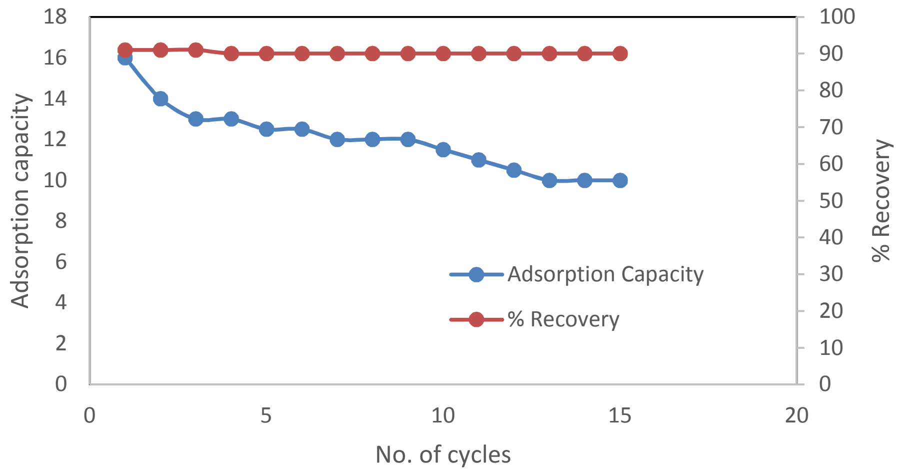

Figure 1 Adsorption capacity and oil recovery for petrol

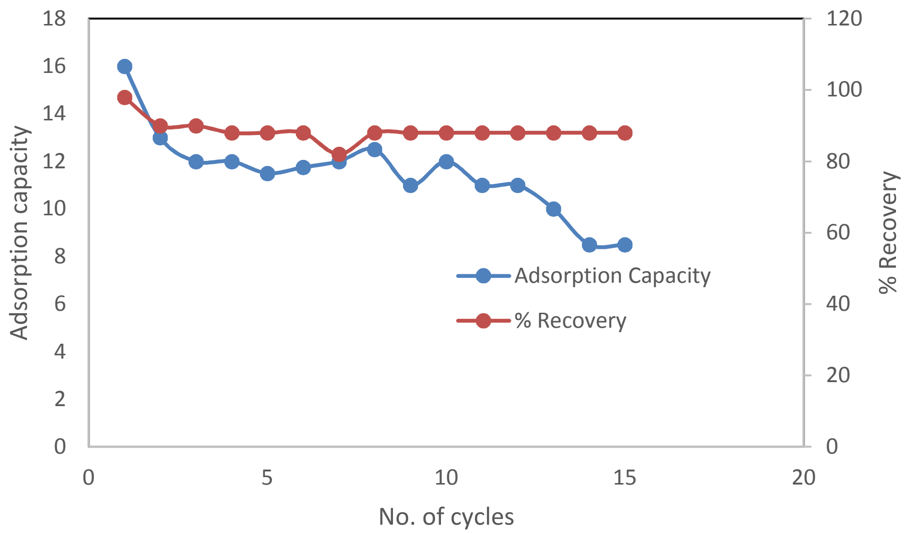

Figure 2 Adsorption capacity and oil recovery for diesel

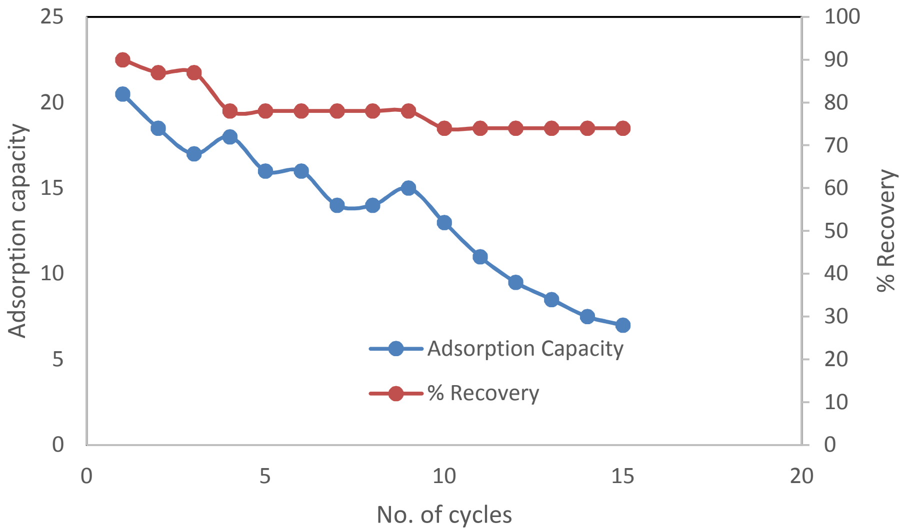

Figure 3 Adsorption capacity and oil recovery for diesel

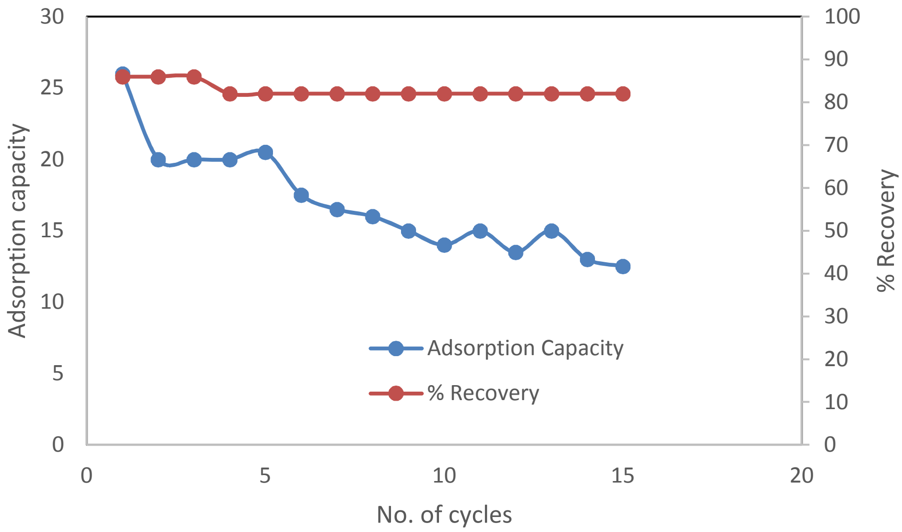

Figure 4 Adsorption capacity and oil recovery for sesame oil

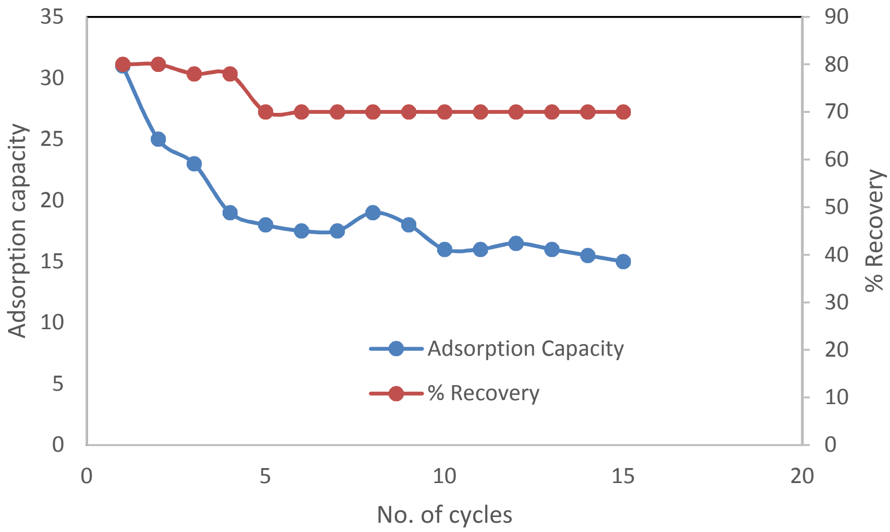

Figure 5 Adsorption capacity and oil recovery for sunflower oil

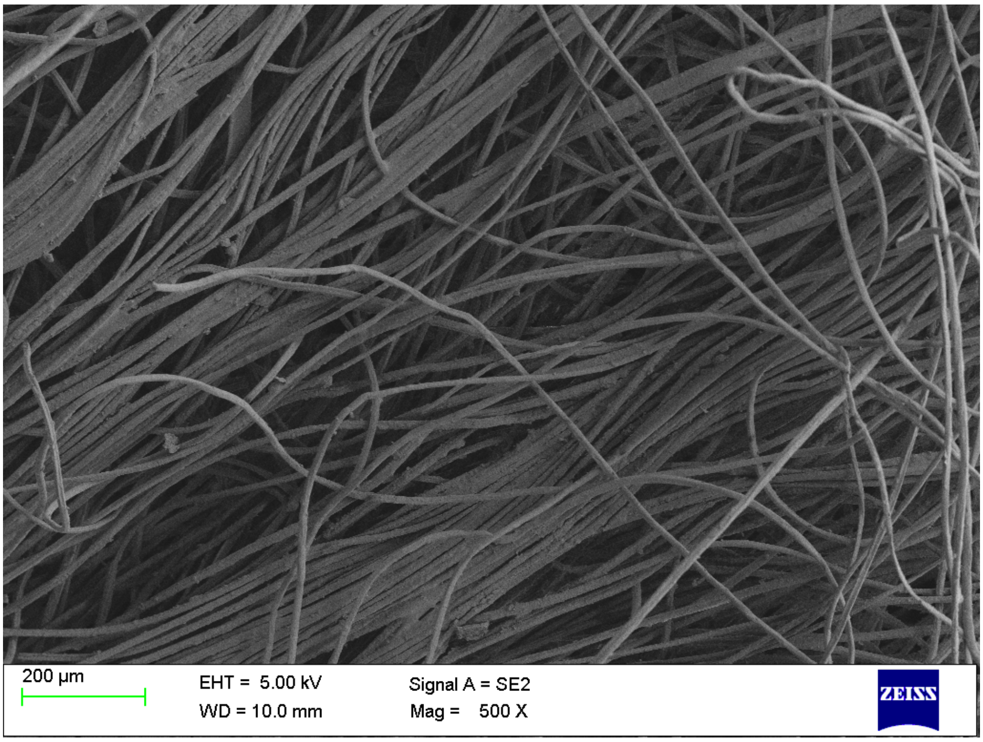

Figure 6 SEM image of oil sorbed on bamboo fiber adsorbent

3.2. Recovery of oil

Experiments were also conducted for recovering the oil from the fiber. The results are shown in Figure 1 – 5. It can be noted that recovery was faster for petrol and diesel. 98% recovery was obtained for diesel and 90% recovery for petrol. On the other hand, only 80% recovery was resulted for sunflower oil. Besides, the recovery further reduced to 70% with the increase in number of cycles.

4. CONCLUSION

This work presents a novel method to separate oil and water by using natural bamboo fiber. The fiber possesses excellent oil-water separation efficiency up to 90%. Of the oils tested, vegetable oils resulted in better adsorption capacity compared to fuel oil. Bamboo fibers with their desirable qualities have the potential to be an effective sorbents for oil-water separation.

REFERENCES

[1] Senanurakwarkul, C., Khongsricharoen, P., Pejprom, D., Tantayanon, S., & Khaodhiar, S. 2013. Effects of the Composition and the Preparation Methods on Oil Sorption Capacity of Recycled Rayon Waste-Kapok Mixtures (RRWK) Sorbent. *International Journal of Environmental Science and Development*, 4,3

[2] Kumar, A. Das, A., Goel, M. KR Kumar, Subramanyam, B, Sudarsan. JS. 2013. Recovery of nutrients from wastewater by Struvite crystallization. Nature Environ Pollut Technol 12, 479-482

[3] Goel M, M Ramesh, TR Sree Krishnan. 2009. Mixed culture acclimatization and biodegradation of chlorophenols in shake flasks: effect of the inoculum source. Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management 13, 29-34

[4] Wei, Q.F., Mather, R.R., & Fotheringham A.F. 2005, Oil removal from used sorbents using a biosurfactant, Bioresource Technology, 96, 331–334.

[5] Breen, P.J.; Yen, A. and Tapp, J. 2003. Demulsification of Asphaltene-Stabilized Emulsions—Correlations of Demulsifier Performance with Crude Oil Composition," Petroleum Science and Technol., 21, 437-447.

[6] Zeng, Y.; Yang, C.; Zhang, J. and Pu, W. 2007. Feasibility investigation of oily wastewater treatment by combination of zinc and PAM in coagulation/flocculation. J. Hazardous Materials, 147, 991-996.

[7] Lee, M and Oh, J. 2010. Sonolysis of trichloroethylene and carbon tetrachloride in aqueous solution, Ultrason. Sonochem. 17, 207-212,

[8] Irfanudeen, NM, Prakash, I, Saundaryan, R, Alagarraj, K, Goel, M, Raviklumar K. 2015. The potential of using low cost naturally available biogenic substrates for biological removal of chlorophenols. Bioresource technology 196, 707-711

[9] Banat F.A, Al-Asheh S, Al-Makhadmeh L. 2004, Utilization of raw and activated date pits for the removal of phenol from aqueous solutions, Chemical Engineering Technology 27: 80–86.

[10] H. Ajith Hebbar and K.S. Jayantha, Separation of Organic Based Oil and Grease From Restaurant Wastewater Using A Horizontal Flow Batch Reactor Containing Laterite Medium, 5(2), February (2014), pp. 152-155, International Journal of Advanced Research in Engineering and Technology.

[11] T. Balamurali B. Preetha, The Separation of Copper, Nickel and Chromium Metal Ions Using with Ultrafiltration Membrane: Effect of Polymer Membrane Compositions, International Journal of Advanced Research in Engineering and Technology, 5(6), June (2014), pp. 144-162

[12] Zhang, Q., & Chuang, K. T. 2001. Adsorption of organic pollutants from effluents of a Kraft pulp mill on activated carbon and polymer resin. Advances in Environmental Research, 53, 251-258.