IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

USE OF HAIR MESH FOR OIL SPILL MANAGEMENT

[1]Janvi Manish Shah

[1]Undergrad student
[1]Biotechnology,
[1]Thadomal Shahani Engineering College, Mumbai, India

Abstract: Oil exploration has enormous economic benefits; however, these benefits are associated with environmental issues arising from oil spills. Numerous methods exist for cleaning up oil spills along with their aftereffect as well as huge financial burden. Hence, the shift to methods that are environmentally friendly and cost effective is imperative so the efficiency and mechanics of using human hair to clean up crude oil contaminated water using various parameters such as contact time, recovery and reuse, adsorbent dosage, temperature, modification. Human hair, being hydrophobic and a bio sorbent, has proven to be an efficient material in removing oil from water with a maximum adsorption capacity of crude oil as well as its recovery and reusability. It is independent of the external factors like

temperature etc. unlike other methods. Human hair can be modified into boom to clean-up oil spills. Since hair is just a waste product, it has proven to be a cost-effective method. It can adsorb up to 9 times its own weight. Lately, it has been used to clear up a few oil spills successfully and has proven to be a quick process. This is a promising area that researchers need to focus more on in order to explore the huge benefits it presents.

Index Terms **- adsorption capacity, clean-up, human hair, oil spill, hair boom, sorbent**

I. INTRODUCTION

Oil exploration, production and transportation are critical to the development of the economy of many nations across the world owing to the enormous benefits derived from it. Due to the essential nature of oil, it is very difficult for an individual or a country to complete the day's activities without directly or indirectly depending on petroleum products. However, these processes (petroleum exploration, production and transportation) over the years have impacted negatively on the environment as a legacy, ranging from oil spillages, release of dangerous substances into the air, water and land, species extinction etc. Over the years there has been cases of oil spills disaster around the world giving rise to environmental degradation, species extinction to mention a few. Notably among them are: Torrey Canyon oil spill disaster 1969, Sea Star – Gulf of Oman 1972, Atlantic Express – West India 1979, Exxon Valdez in 1989, Dalian spill into Yellow Sea 2010, Gulf of Mexico 2010. The consequence of oil spills has tremendous impact on the ecosystem e.g. the Exxon Valdez resulted in the death of about 30,000 sea bird, 2000 sea otters, 250,000 seabirds, 302 harbour seals. The disaster and other incidents contributed to the reduction of pigeon guillemots from 15000 in the 70s, to 3000 in the 90s. It also led to the increase in the concentration of THC and TPAH. In the case of the Gulf of Mexico oil spill, the ecological damage done to aquatic organisms are incalculable; however, the disaster affected about 20% of the national wetlands in the River Delta of Mississippi, which provides habitat for resting sea birds as well as resting migratory birds. The oil spill covered about 88,000 square miles and also made its way to the beaches and estuaries thereby causing a great deal of damage to tourism, fishing industries, many marine animals and bird species inhabiting areas within and around the Gulf of Mexico.

The inevitable nature of oil spills has necessitated the need to seek for ways of mitigating its environmental impacts. There are several methods employed to clean up oil spills in water such as direct burning, use of dispersants, mechanical skimmers, use of booms and sorbents. During the famous Gulf of Mexico oil spill in 2010 about 700 km of boom were deployed to clean up the spill, the application of skimmers recovered about 27 million gallons of oily water and more than 1.5 million gallons of dispersants were used as at the first of July, 2010. The use of chemicals and mechanical recovery equipment may be time consuming, increase the cost of clean-up and may also require a lot of personnel as well as equipment, hence, the need to explore other environmentally friendly and low-cost alternatives. There are materials with low sorption capacity, non-biodegradable and usually expensive, but possess high hydrophobic and oleophilic properties that are available commercially which are made from polyurethane, polyethylene and many cross-linked polymeric sorbents. The use of natural absorbents for the removal of oil spills has attracted attention and is considered among some of the most attractive options as a result of their effectiveness, reusability, low cost, environmentally friendly as well high sorption capacity. There are available literatures showing that natural bio sorbents have been used for oil spill removal in water. Notable among others are activated carbon, coconut husk, feathers, oil palm fibre, sawdust, wool fibre, rice husk, cotton grass. The idea of using human hair to clean up oil spill was initiated by Philip McCrory, an Alabama hair stylist in 1989 during the Exxon Valdez disaster. However, not much has been done in the area of exploring the efficiency of using human hair to clean up oil contaminated water. Hence, having identified the existing research gap, it becomes imperative to investigate the capacity of human hair in adsorbing oil in water as well as the mechanics behind the process, which is the cardinal point of this research.

A. Properties of Petroleum

Crude oil obtained from the subsurface has many uses. Through the process of fractional distillation, the components of crude oil can be broken down into various components, usually through reaching a particular boiling temperature. Key fractions of crude oil include: fuel and refinery gas, gasoline, naphtha, paraffin and kerosene, diesel and gas oil. These fractions are generally less dense than water, thus allowing them to float at the surface of the water. Refinery gas and gasoline are extremely volatile while paraffin, kerosene, diesel have lower volatility. Components of petroleum have been demonstrated to reduce maternal weight of rates, decrease litter size, decrease fetal weight, cause irritation of the eyes and skin, result in potential chromosomal defects in successive generations, and exacerbate mortality rates of fetuses. In addition to long-term effects on biota, the highly volatile characteristics of crude oil increase the probability of fires and explosions.

B. Properties of Hair

Human hair (50-100 um in diameter) is a natural bio sorbent consisting of dead cells made up of the cuticle, water, lipids, trace elements and 6595% proteins, mainly polymers of amino acids such as keratin and cysteine, medulla and cortex. The cuticle is highly hydrophobic, which makes it water repellent. It also contains numerous peptide bonds and CO- as well as NH- group which forms hydrogen bonds between neighboring molecules on the human organic follicle surface and has a highly porous cortex [1].

II. REQUIREMENTS

Hair is hydrophobic and bio sorbent, which means it repels water and can collect heavy metals and other contaminants, like oil. Chemically, hair is a biopolymer composed largely of cysteine-crosslinked proteins termed keratins. The filaments are composed of low sulfur proteins and the surrounding matrix is made up of high sulfur proteins. Although hair of different racial origin differs in shape, degree of waviness (curl), and color, there is very little difference in the underlying chemical composition and physical structure. Different hair samples were collected from various hair salons. They were asked to separate the hair samples according to their color in three categories black, brown and blond. The hair samples were properly cleaned with soap and detergents.

The pouches were made of nylon and lycra material. The edges were sealed with hot glue. The black hair had the best adsorption properties, followed by the blond, then the brown. The oil uptake for hair in the blended nylon Lycra pouches was greater than in the straight nylon pouches. As the blended nylon pouches let the hair adsorb more oil than the pouch itself

III. ADSORPTION PROPERTY OF HAIR

Adsorption is a process by which a solid surface holds molecule of a gas, liquid or dissolved solids and forms a thin film. Human or animal hair has the ability to adsorb a variety of oils, many of which could be potentially hazardous. This includes motor oils, bilge oils and crude oils that have the major probability of being spilled. Hair can hold the oil molecules due to the many cracks present on its surface. Oil molecules get deposited in these cracks and form hydrogen bonds with the protein keratin, which is responsible for the skeleton of the hair structure

During oil spills, there is more concentration of water than oil; hence it is more probable for water to adsorb than oil, theoretically. But in actual practice it is seen that hair has more affinity for oil. When studied under a microscope oil is seen to replace water from hair surface. This is known as selective physical adsorption. The adhesive forces between oil and hair are greater than those between water and hair. Thus, oil is separated from water.

It is seen experimentally, that as the concentration of oil increases the extent of adsorption on hair surface increases. Hence this method proves to be very efficient for major oil spills. The volume of oil adsorbed is completely independent of the width of the mesh but depends upon the mass and absorbing capacity of hair.

IV. METHODOLOGY

The process of making hair mesh, usage, their improvement and degradation after use is described.

4.1 Making of Mesh

For making hair mesh, the hair has to be collected, cleaned and packed before using them.

4.1.1 Collection

Human hair can be collected from 5 major sources which include:

1. Barbers and Hair Stylists Shops: Barber shops are one of the most convenient sources of the hair, obtained from haircuts. These shops predominantly collect long hair (>6 inches), usually obtained from women's haircut, for making wigs. Short hair is mostly thrown away. This hair could be used for making hair meshes and can be obtained at very low prices or even free.
2. Trash Sorting and Scavenging: In many places (usually urban areas), where the fallen hair is not formally collected, it is thrown away in the household trash, dumpsters, or drains. This hair is then scavenged by waste pickers who collect and clean it. Currently, in many Indian cities rag pickers collect hair out of trash coming from households, salons, hospitals etc.
3. Religious places
4. Hair harvesting
5. Charity

The hairs obtained from the last three sources are generally of very good quality and hence are most often used for making hair wigs. Thus, they are seldom used for making hair meshes. But there are many people who actively donate their hair for making hair meshes.

Animal fur and fleeces can also be used in making the mesh, which is collected from pet shops, slaughter houses, etc.

4.1.2 Cleaning

After collection, proper cleaning is necessary to remove any moisture, pathogens which may harm the handlers and the marine ecosystem, oil and any harmful chemicals increase the shelf life of the hair and to inhibit any unwanted microbial growth. The following steps are undertaken while cleaning the hairs. 1. Separation of Hair from Other Waste: Depending on the source, the collected hair often has other

wastes such as cotton, blades, and household waste, which can be harmful and needs to be removed. This separation, in almost all cases, is done manually by several workers. 2. Washing: The sorted hair is washed by boiling it in soda water for 15 minutes before use. Washing can also be done by adding caustic soda, soap or other detergents or chemicals. 3. Drying: The hair is then sun dried for 48 hours or dried in an oven, or with hot air blowers. After drying, the hair can be stored without any concern for decay or odor.

4.1.3 Packing

The packing of hair does not require any particular caution because cleaned and well-dried hair is stable in atmospheric conditions. The collected hair and fur are filled into recycled nylon hosiery to make sausage-shaped booms. Hair soaks up fast, thus it can seep below the waterline. Whereas fur and fleece float on top of the waterline, so it is better to get a mixture of them. The adsorption property of the mesh could be improved by using pouches made from a nylon and Lycra blend.

4.2 Usage

The hair mesh or booms are strung together and laid on the water surface. But, the heavier oils, dirt and sand in the water can make the meshes sink by weighing them down. Thus, they have to be replaced periodically, when the start sinking. The oil can also wash up to the coast. Hence the meshes are also laid out on the beaches near to the site of spillage.

4.3 Storage

Newly made meshes can be stored without any particular caution. But, once used, the meshes have to be made oil free and cleaned well before drying and storing them. The mesh can be used 34 times before disposing them off.

4.4 Disposal

The hair does not degrade easily and the same problem persists even after using the mesh. The hair is conventionally incinerated at energy plants. But this causes pollution and wastage of the material. They can also be burned as fuel but this has to be done in a closed system that is conscious of particulates and toxins. The oily hair can then be used to grow oyster mushrooms which decompose the oil. The entire refined mess left behind can then be fed to worms to break it down into fertilizers. Even if this takes more, it is greener and profitable approach.

V. RECOVERY

Oil can be recovered by wringing out the hair from the hair booms or mats which then can be reused many times. With this method, up to 98% of the spilled oil can be recovered.

There are different methods in which the adsorbent can be recovered and reused. The two methods generally used are chemical method and physical method. In chemical method different types of chemical treating agents can be used to treat oily water for controlling, cleaning up and removing the oil. These include dispersant, chemical washing agent and bioremediation. Since adsorption is a surface phenomenon the oil that is only physically attached to the hair can be separated easily by physical methods e.g. compression, centrifugation, solvent extraction. Out of these the solvent extraction method was employed the most. Solvent extraction is a method to separate compounds, based on their relative solubility in two different immiscible liquids, usually water (polar) and an organic solvent (nonpolar). The organic solvent used here is n-hexane. The adsorbent is first washed with hot and cold water to remove oil from hairs. All remaining oil now present in the water is then extracted using nhexane. This ensures maximum oil recovery. In evaluating the reusability of human hair for oil adsorption, the adsorbent was first washed with hot and cold water. The recovered adsorbent was then dried and reused for the batch adsorption experiments in four continuous cycles after each desorption test.

The percentage recovery achieved for vegetable oil, diesel and crude oil were 96.20%, 94.68% and 99.41% respectively. In a similar experiment conducted by Nguyen the result shows a percentage recovery of 91.63% for crude oil, 97.27% for diesel and 99.87 for vegetables respectively. This indicates that the process is not 100% efficient, although crude oil showed a very high percentage recovery

VI. CONCLUSION

From the comparative study conducted between the use of microorganism and hair mesh for oil spill management, it can be concluded that the use of hair mesh is a more cost effective and eco-friendly method.

Microbial degradation is a time-consuming method and it requires a large surface area for the microbes to adhere to. Also, the microbes degrade the oil into simpler products, so extraction of oil is not possible, which means all that oil is wasted! This makes it difficult to be used as a primary remedy. It is preferably used as a secondary clean up method for shorelines and small droplets of oil. It demands highly skilled personnel.

On the other hand, oil adsorption by hair mesh is faster and has the most important advantage of the recovery of oil. This method can be used primarily to clean up bulk oil spills. The hair mesh is environmentally friendly and also encourages the principle of converting waste to wealth. According to the results obtained it was estimated that there was a rapid increase in the uptake of oil in the first 5 minutes after which it proceeds at a slower rate until equilibrium at 60 minutes. The adsorption isotherm experiment established a relationship between an increase in the dosage of human hair with the uptake efficiency as well as the concentration of oil adsorbed. The Freundlich isotherm model shows that the elements of chemisorption and oil retention occur on heterogeneous sites with a non-uniform distribution of energy. The efficiency of human hair to adsorb oil was found to be almost equally effective during the fourth reuse as well. Though this method needs constant supervision, since, as the hair booms adsorb oil, it can become heavy and sink below the water surface. Thus, the booms must be changed periodically. Thus, it can be advantageous and more feasible when in a time crunch.This method has the most important advantage of recovery of oil which can then be used as fuel.

VII. ACKNOWLEDGEMENT

I am grateful to Dr. Rita Sharma for giving us the opportunity to present this research paper and for her expert guidance and continuous encouragement throughout the project.

REFERENCES

[1] https://matteroftrust.org/hair-can-be-used-to- clean-up-oil-spills/
[2] https://pdfs.semanticscholar.org/b773/2e807604 22518dddc959c2fe1f218bb31669.pdf
[3] https://www.hindawi.com/jour(Gupta,2014)nals /jwm/204/498018/
[4]https ://www.researchgate.net/publication/272795935_Liquidphase_sorption_characteristics_of_human_hair_as_a_nualoil_spill_sorbent
[5] https://pubs.acs.org/doi/abs/10.1021/jp071616e
[6] https://matteroftrust.org/wpcontent/uploads/201 2/01/Hairboom.experiment.pdf
[7] https://www.core77.com/posts/78720/BrilliantMaterials-Insight-Human-Hair-Can-be-Used-toClean-Up-Oil-Spills
[8] https://www.dailymail.co.uk/sciencetech/article4685040/Oil-spills-cleaned-human-HAIR.html
[9] https://scihub.tw/https://link.springer.com/articl e/10.1007/BF0012909
[10] https://www.environmentalpollutioncenters.org /oil-spill/control/
[11] https://scihub.tw/https://www.sciencedirect.co m/sciencearticle/pii/0964830595000309
[12] **h**ttps://onlinelibrary.wiley.com/doi/full/10.111 1/j.1751-7915.2008.00079.x
[13] https://www.sciencedirect.com/science/article/ pii/030438949187011P
[14] https://www.leaf.tv/articles/why-does-hairabsorb-oil/
[15] https://www.sciencedirect.com/science/article/ abs/pii/S0040603110000912
[16] https://link.springer.com/chapter/10.1007%2F9 78-3-642-25611-0_9