



## MYCOREMEDIATION OF OIL SPILL USING HUMAN HAIR AS A SORBENT MATERIAL

Mansi Kasundra<sup>1</sup>, Avani Raval<sup>2</sup>, Mitul Patel<sup>3</sup>, Naresh Kamaliya<sup>4</sup>, Ronak Sain<sup>5</sup>

<sup>1</sup>Environmental Science & Technology, Shroff S. R. Rotary Institute of Chemical Technology

<sup>2</sup>Environmental Science & Technology, Shroff S. R. Rotary Institute of Chemical Technology

<sup>3</sup>Environmental Science & Technology, Shroff S. R. Rotary Institute of Chemical Technology

<sup>4</sup>Environmental Science & Technology, Shroff S. R. Rotary Institute of Chemical Technology

<sup>5</sup>Environmental Science & Technology, Shroff S. R. Rotary Institute of Chemical Technology

**Abstract** –Numerous methods exist for cleaning up oil spills along with their after effect as well as large financial burden. Oil exploration has large economic benefits; however these benefits are associated with environmental issues arising from oil spills. Hence, the shift to methods that are environmentally friendly and cost effective is important. This paper investigates the analysis of adsorption capacity of human hair. Hence, human hair can be altered into boom to clean up oil spills. After the adsorption of oil on hair booms, these booms can be utilized in cultivating the mushrooms as mushrooms require oil for their growth. Hence the adsorbed oil can be restored by cultivating mushroom.

**Keywords** - oil spills, hair booms, recuperation, mycoremediation, mushroom cultivation.

### I. INTRODUCTION

The world is now more and more dependent on oil based products, derived from petroleum. These oil based products are used to fuel automobiles, heat homes, produce energy, and are used for machinery in various industries. The products that come from petroleum are gasoline, diesel, motor oil, kerosene, jet oil, heating oil, asphalt, and plastics. Oil is first stored and transported in large volumes via tankers because populous countries use large quantities of oils, and it is more cost effective to transport oil this way. However, while in storage or in transport, oils may get spilled onto land or into waterways. Oil spills are caused due to various reasons: tanker accidents, offshore platforms, drilling rigs, fuel leaks from large ships, which release crude oil or refined petroleum products or waste oil into the ocean<sup>[2]</sup>. Potential oil spill volumes have been categorized by the National Oil Spill Contingency Plan, where they are broken down into three categories: a Minor Spill which is a discharge of oil less than 10,000 gallons, a Moderate Spill which is a discharge of oil of 10,000 to 100,000 gallons, and a Major Spill defined by a discharge of oil of more than 100,000 gallons. Oil spill is the contamination of the environment, due to the supply of liquid petroleum hydrocarbon. Oil spills have been a major complication from so many years. They pose a threat to the environment, causing harmful irreversible changes, physically, chemically and biologically<sup>[2]</sup>.

### II. EFFECTS OF OIL SPILL

#### 2.1 Effects on Animal Life

Oil spill affects the living beings in the sea (birds, fishes, mammals) and exposes them to risks. Because of its floating nature, oil does not allow the sunlight and the oxygen to enter into the ocean, as it is important for the fishes and sea turtles to survive. Oil coats the fur of sea otters and seals and other mammals, which reduces their insulating effect and leads to fluctuations in body temperature, leading to hypothermia<sup>[2]</sup>.

## **2.2 Effects on Local Businesses**

Due to oil spills fishing, tourism, sailing processes are affected and fishermen undergo immense losses as the fishes die due to oil spill. Boats and machines used for fishing and navigation are affected due to oil slicks present on the top of the water surface<sup>[2]</sup>.

## **2.3 Effects on Human Health**

Inhalation of oil vapour, touching oil slicks, and consuming oil contaminated seafood is injurious to health of human beings. Exposure to heavy oils sometimes cause neurological, acute toxic effects and also problems in respiratory systems. People in the locality, near an oil spill zone, may suffer nausea, throat infection, eye irritation along with migraines and headaches. Oil spills contain harmful elements that are carcinogenic to human beings, causing cancer<sup>[2]</sup>.

## **2.4 Dissolution of soluble oil compounds**

Although oil stays on the surface of the water, but some of the oil compounds may dissolve in the water which leads to change in pH and other salts composition. Because of the property of immiscibility, oil slicks are formed whenever oil spillage takes place on the water. Fishes surviving in the area will ingest the oil that has been spilled. Further these fishes may be fed by larger fishes, or other sea animals and they may be harmed too<sup>[2]</sup>.

### **III. NEED TO PREVENT**

These oily wastes are one of the significant pollutants of the aquatic environment. Separation of oil from water is necessary due to following reason: Oil slick on surface of water prevents oxygen transfer from atmosphere to water and lead to over low dissolved oxygen level due to microbial & oxidative attack on the hydrocarbon molecules. It is necessary to remove oil because it can hinder the process. Oil in boiler feed causes foaming & so treatment is necessary; oil & waxes solidify at low temperature that cause clogging in pipes & sewer line; oil slick is reason for the death of birds; the oil penetrates in their feathers there by affecting their insulation & buoyancy; birds become colder & more vulnerable to diseases & experience difficulty in floating & flying<sup>[6]</sup>

Consumption of oil contaminated water will result in health hazards such as eye irritation, increased blood pressure, headache, loss of appetite, poor coordination, difficulty in concentrating, kidney damage, human cancer and decrease in the ability of blood clotting.

Oil layer in wastewater reduces the efficiency of wastewater plant and sometimes inhibits the overall process of the plant by reducing the oxygen dissolving which is very essential to aerobic bacteria.

The oily water badly affects to the wildlife and marine life and because of that it unbalances ecosystem process. As example, oil can affect respiration of fish by adhering oil on the gills and oil destroys the algae and planting.

The penetrated oil from water to earth may initiate long term problems by making a barren ground.

Oily water surface affects to aesthetic appearance of the environment.

### **IV. METHODS OF OIL SPILL CLEAN UP**

Any damage caused needs a remedy, and oil spill clean-up is an important issue. Oil spills are very difficult to remove. It may take months and even years to treat an oil spill. New methods, equipments are innovated to aid in oil spill clean-up, leading to better results. Since protecting and saving the environment is our responsibility, this approached target is an effective and economical oil spill recovery. We intend to formulate new, simple ways to remove oil spills from oceans, leading to positive results<sup>[2]</sup>. Spill containment technology methods which are used currently to clean up oil in coastal environments are: the use of booms, hard booms, sorbent booms, fire booms, skimmers, vacuum trucks, in situ burning, dispersants, and chemical cleaners. The different methodologies used for the purpose of cleaning up oil spills are:

#### **4.1 Using sorbents**

Sorbents are the materials that are placed on the surface of the water, where the oil is floating. These sorbents draw and absorb the oil from the surface of the water which leads to an oil spill cleanup. Even though this method of cleaning is a conventional technique, still many new sorbents can be discovered which absorb or adsorb the oil without leaving any traces in the water<sup>[2]</sup>.

#### **4.2 On site burning**

This is the process of burning up of the spillage on site, before its spreading, in order to remove or reduce the amount of oil slick on the water. But the drawback of such an on-site burning is that, the exhaust gas that is released, contains toxic particles which can lead to severe levels of contamination in the air. In addition, the marine life also gets affected<sup>[2]</sup>.

#### **4.3 Using chemical dispensers**

The dispersion of oil spillage, into smaller droplets, is carried out using fertilizers called as dispensers. It is the highly recommended oil spill cleanup methods. The fertilizers help to increase the growth of micro-organisms, which help to diffuse the components of the oil, spilt in the water. In simple words, dispensers are the catalysts, to speed up the reaction of degradation of the oil, by increasing the growth of micro-organisms<sup>[2]</sup>.

#### **4.4 Bioremediation**

Bioremediation is the use of fungi, bacteria or other microorganisms to eat up oil spill. These microorganisms break down oil into more simpler matter, thereby allowing biodegradation to take place. This method is less harmful to the environment, as it involves only biologically active material<sup>[2]</sup>.

#### **4.5 Skimming**

Skimming is the removal of the oil spillage, with the help of tools and equipments, from the surface of the water. Only lighter oils can be separated and removed from the water in this method of cleaning of up oil spills because, the density of spilled oil should be comparatively lower than the density of water. Only then, it will be easy to separate oil from water, using skimmers<sup>[2]</sup>.

#### **4.6 Cleaning manually**

People in the coastal areas, beach workers and public volunteers can help to hasten the oil spill cleanup operation. By using simple tools like spades, buckets and shovels, removing oil spillage can be done. This method is suitable only for minor oil spills. For the accidents which take place away from shore side, high and ultra high pressure pumps are used to remove the oil slicks. From this mixture of oil and water, oil can be separated easily using units like gravity oil separators or API separators<sup>[2]</sup>.

#### **4.7 Natural decomposition**

This is nothing but the process of allowing the spilled oil to decompose on its own, by the help of sun, oxygen and wind, naturally and the particles of the oil evaporate and disappear. This is the slowest method to clean up the oil spills. Since, it affects both the environment and marine ecosystem, this method is generally not advisable to perform<sup>[2]</sup>.

#### **4.8 Using oil booms**

Oil booming is a very common method of controlling the spread of oil spills. There are various kinds of oil booms that are designed for various needs, in different locations where the oil spill might occur, thus leading to a quite thorough oil spill cleanup. Simply, boom is floating barrier used temporarily, to contain an oil spill, preventing the oil from getting dispersed<sup>[2]</sup>.

#### **4.9 Using hair booms**

Hair booms are nothing but barriers to the movement of oil, preventing the oil from spreading, which otherwise has a higher chance of polluting the shoreline. They make clean-up process easier. Booms float on water, trapping oil into thicker layers. Compared to existing methods, the oil recovery process is low cost, effective, and used friendly. It uses waste products as compared to new ones and is able to recover a significant amount of spilled oil for reuse<sup>[6]</sup>.

## **V. WHY USING HAIR BOOMS IS BENEFICIAL**

Human hair has been proven an efficient material in removing oil from water with a maximum adsorption capacity of 7470mg/g for crude oil as well as its recovery and reusability. A comparative analysis was conducted using the maximum adsorption capacity of different adsorbents revealed that human hair performed better than organoclay, rice husks, reed bed canary grass, treated sludge, modified oil palm leaves, peat moss and activated carbon, but less than exfoliated graphite, kapot and recycled wool based non-woven material. Hence, human hair can be modified into boom to clean-up oil spills<sup>[6]</sup>.

Human hair (50-100  $\mu\text{m}$  in diameter) is a natural biosorbents which consists of dead cells made up of the cuticle, water, lipids, trace elements and 65-95% 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 neighbouring molecules on the human organic follicle surface<sup>[6]</sup>.

Thousand of tones of human hair are cue everyday & thrown into landfills as a waste produces which no direct benefits. Hair is not an easily degradable substance these are matter of time. Our project looked at the possibility of finding a use for waste hair that could be used to clean up oil spills and that the oil could be recovered by cultivating mushrooms. As the process is eco-friendly and does not require any chemicals, it can lead to development of a new technique of separating oil water emulsion, which is simpler. Since hair is very cheap and not easily biodegradable, the method may find a good usage for it<sup>[6]</sup>.

## **VI. HOW ADSORPTION OF OIL ON HAIR TAKE PLACE?**

Since water is taken in larger concentration than oil, it is more probable for water to be adsorbed in larger quantities than oil, but reverse is found to be true when experiments are conducted. Moreover, when the phenomenon is studied under optical microscope it is seen that oil replaces water from the hair surface. It can be explained in terms of selective physical adsorption. The adhesive forces between oil and hair are greater than the force existing between water and hair. Thus, hair selectively adsorbs oil in presence of oil and water. Thus, oil is separated from water when a mixture is passed through a bed of hair<sup>[6]</sup>.

## **VII. EXPERIMENTAL WORK**

The experimental work includes various steps:

- Step 1: Collection of waste hairs from various salons and barber shops, which they simply dump it into waste.
- Step2: After collection of hair, washing of hair was done. It was done in two phases, first the bigger dirt particles present in it was cleaned and then second phase included cleaning hair with mild shampoo so that no other impurities stays in it.
- Step 3: The hairs were kept to dry under sunlight to kill any kind of germs or pathogens present in it.
- Step 4: the dried hairs were collected and packed into bundles of booms, providing area for the adsorption of oil from the oil spill.
- Step 5: Synthetic spillage was done to test the effectiveness of the hair booms to adsorb. The synthetic spill was of 250 ml of motor oil into 2.5 liter of water. This was done both in used oil and unused oil.
- Step 6: After the synthetic oil spillage was done, the booms that were made to adsorb the oil in the plastic trough which ought to represent the mini ocean. After an hour, hair booms were rolled in spilled area, as hair has attraction towards oil rather than water, oil get adsorbs on hair booms.
- Step 7: After synthetic oil spill removal, mushroom cultivation is done. For that, mushroom seeds, straws, hair booms containing oil, plastic bag, etc are collected.
- Step 8: A plastic bag is taken and then a layer of straws is kept and above the layer of straws, booms containing hair is kept. On the booms, mushroom seeds are spread and the mouth of the bag is closed using a thread.
- Step 9: Holes are made in plastic bag and regular spraying of water is done to cultivate mushroom. Also, the temperature is maintained below 23° C for the proper growth of mushrooms.

## VIII. MYCOREMEDIATION OF OIL SPILLS

The recovered oil can be re-used in different ways. One of the ways includes cultivating mushroom in the hair booms as mushroom requires oil for its growth. Mushrooms are the product of biological origin and they can be developed from biological wastes, agricultural wastes, agro-industrial wastes and industrial wastes. Besides this, mushrooms are also used as a source of proteins, amino acids and several biological active molecules which not only provide nutrition but also use for therapeutic purposes. Besides, use for edible purpose, mushroom is used for other industrial processes like bio-pulping and bio-bleaching. Hence, the importance of this as product cannot be ignored<sup>[11]</sup>.

### 8.1 Mushroom as mycoremediation tool

Remediation through fungi is also called as mycoremediation. Mycoremediation tool refers to mushrooms and their enzymes due to having ability to degrade a wide variety of environmentally persistent pollutants, transform industrial and agro-industrial wastes into products<sup>[11]</sup>.

Mycoremediation of waste from the environment by mushroom has many advantages but at the same time it is a difficult task for the researchers and engineers. Mycoremediation of wastes can be done in situ and ex situ conditions. If it is carried out on site, it eliminates the need to transport the toxic materials to treatment sites. It is an environmentally friendly approach that needs only a small space, low cost, less skilled persons and can be applied easily in the field. Besides above advantages, there are some disadvantages in applying this mycoremediation tool. Mushrooms require some time to adapt to the environment and cleanup wastes. Mushroom cultivated on industrial wastes may possess toxicity/genotoxicity. Genotoxicity of mushrooms is influenced by genotoxicants present in waste used for their cultivation. Therefore, it is necessary to assess toxicity/genotoxicity of mushrooms if used for bioremediation purpose<sup>[11]</sup>.

## IX. CONCLUSION

This process of separation of oil from water by human hair as an adsorbing medium is very efficient at laboratory scale. This method does not use high sophisticated technology or equipments, thus making the process smooth to run. It deals with simple, easy-to-find, widely available materials, therefore this process becomes economical. The method does not require, highly skilled man power and is quick, and saves a lot of time. Whereas other methods generally followed are time consuming. Wastes produced are bio-degradable. This method also does not pose threat to the environment as it does not use any harmful chemicals. The absorbed oil can be reused for cultivating mushrooms. But in the occurrence of an oil spill, booms must be first set up. This method of cleaning up oil spills is a more efficient and a less costly way to protect our environment<sup>[6]</sup>.

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