

# Experimental Study On Oil Spill Recovery

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**ABSTRACT:** Over the last 30 years, oil spills have contributed significantly to coastal and marine pollution, causing disturbance of the coastal environment. This recurrent hazard has increasingly been taken into account through prevention plans in Coastal Zones Integrated Management. Numerous studies have attempted to analyse the effects of oil pollution, in particular to identify those areas that are the most vulnerable. Although several studies have considered both environmental and socioeconomic issues, most of them have focused only on environmental vulnerability. This is an attempt for combating Oil Spills. We aim at recovering oil spill from the oceans which otherwise cause huge damage to the environment and ecology. Studying about oil spills, we've learnt that it is a major International Issue till this day. We focus on finding a new solution to this problem, different from the old conventional methods. This step towards oil spill cleaning has probability of positive results. This paper covers topics about oil spill, its effects and majorly about recovering oil spills using simple methods, with day-to-day materials (or wastes), its disposal, advantages and disadvantages and other related information of the project.

## I. INTRODUCTION

Oil spill is the contamination of the environment, due to the dispensation of liquid petroleum hydrocarbon. Oil spills occur largely at sea, sometimes in rivers and on land. 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. Oil spills have been a major complication for so many years. They pose a threat to the environment, causing harmful irreversible changes, physically, chemically and biologically. Any damage caused needs a remedy, and oil spill clean-up is a major issue. Oil spills are very difficult to remove. It may take months and even years to clean up an oil spill. New methods, equipments are being innovated to aid in oil spill clean-up, leading to better results. Since protecting and saving the environment is our responsibility, this approach's 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.

## II. EFFECTS OF OIL SPILL

### 2.1 Effects on Animal Life

Oil spill affects the living beings in the sea (birds, fishes, mammals) and makes them vulnerable to risks. Because of its floating nature, oil does not allow the sunlight and the oxygen to enter into the ocean, which is important for the fishes and sea turtles to survive. Oil coats the fur of sea otters and seals and other mammals, reducing their insulating effect, and leading to fluctuations in body temperature, which leads to hypothermia.

### 2.2 Effects on Local Businesses

Due to oil spills fishing, tourism, sailing processes are affected and fishermen undergo huge losses as the fishes die due to oil spill. Boats and machines used for fishing and navigation will be affected due to oil slicks present on the top of the water surface.

### 2.3 Effects on Human Health

Inhalation of oil vapour, touching oil slicks, and consuming oil contaminated seafood may be injurious to health of human beings. Exposure to heavy oils may 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

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migraines and headaches. Oil spills contain harmful elements that may be carcinogenic to human beings, causing cancer.

**2.4 Dissolution of soluble oil compounds**

Although oil stays on the surface of the water, some 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 is spilled on the water. Fishes surviving in the area will get ingested with the oil that has been spilled. Further these fishes may be fed larger fishes, or other sea animals and they may be harmed too.

**III. CONVENTIONAL METHODS OF OIL SPILL CLEAN UP****3.1 GENERAL**

The conventional methods of cleaning oil spills can mostly recover only up to 10 to 20 % of the oil spilled. The different methodologies, so used for the purpose of cleaning up oil spills are:

**3.2 USING OIL BOOMS**

Oil booming is a very popular method of controlling the spread of oil spills. There are various kinds of oil booms, that have been 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.

**3.3 USING SORBENTS**

Sorbents are nothing but 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, leading 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.

**3.4 ON SITE BURNING**

This is the process of burning up of the spillage on site, before spreading, in order to remove or reduce the amount of oil slick on the water. But the most important 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.

**3.5 USING CHEMICAL DISPENSERS**

The dispersion of oil spillage, into smaller droplets, is carried out using certain fertilizers, generally called as dispensers. It is one of the highly recommended oil spill cleanup methods. The fertilizers help to hasten 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.

**3.6 BIOREMEDIATION**

Bioremediation is simply, the use of fungi, bacteria or other microorganisms to eat up oil spill. What actually occurs is that, 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.

**3.7 SKIMMING**

Skimming involves the removal of the oil spillage, with the help of tools and equipments, from the surface of the water. Here, only lighter oils can be separated and removed from the water, in this method of cleaning of up oil spills.

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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.

**3.8 CLEANING MANUALLY**

People in the coastal areas, beach workers and public volunteers can help to accelerate the oil spill cleanup operation. By using simple tools like spades, buckets and shovels, removing oil spillage, as much as possible, can be done. This method is only suitable for minor oil spills. Other manual methods like, using modern equipments - tractors, trucks and cranes, oil on the sea shore can be recovered easily. For the accidents which take place away from shore side, high and ultra high pressure pumps are used to suck out the oil slicks. From this mixture of oil and water, oil can be separated easily using units like gravity oil separators or API separators.

**3.9 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. The particles of the oil, in due course of time evaporate and disappear. This is the slowest method of cleaning up the oil spills. Since, it affects both the environment and marine ecosystem, this method is generally not advisable to perform.

**IV. MATERIALS AND METHODS****4.1 GENERAL**

The purpose of this initiative is to effectively remove oil spills, which otherwise takes serious efforts to remove. Since, most of the time its crude oil that gets spilled, its highly viscous state makes the removal of oil spill more tedious.

The prevailing methods of oil spill clean-up consumes a lot of time, as it may take few weeks or even months to finish the cleaning process. Some of these methods (in-situ burning, using chemicals) prove harmful to the aquatic ecosystem. A few of these methods require expensive equipments and more man power. These practices pose a heavy burden on the finances of the government.

This approach targets towards quicker, uncomplicated, economical ways to purge oil spills. Easily found everyday materials are used in this method, which have the capability to make the oil spilled, ready for removal, without much problem.

**4.1.1 MATERIALS**

The materials used here are conveniently available at any time. Some of them go as wastes to landfills or sometimes get incinerated. But they can be put to use for this process, beneficially. The following materials are used for the removal of oil spill:

- 1) **String Fibre:** These are white, hair like fibres, used in telephone wires and cables to add support to them.
- 2) **Coconut husk:** This is the natural material obtained from coconut shells and is used for various purposes.
- 3) **Rice Hull:** Rice hulls are the protective coverings of rice grains. These can be used as fertilizers, building material, and fuels.
- 4) **Polyvinyl Chloride:** PVC is the world's third-most widely produced synthetic plastic polymer. Here, PVC shreds are used for oil adsorption.
- 5) **Filter Paper:** Filter papers are used to filter fine particles from liquids. Filter papers are normally made from pure cellulose.

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#### 4.1.2 EXPERIMENTATION

The materials were first collected and processed (shredding). Initially, the experiments were conducted only with the materials. Later on, few materials were collected and inspected to know their properties, whether they allow the flow of water and oil, so that the sorbents, packed into bags made of these materials, will effectively absorb/adsorb the oil. The use of a bag was found essential, in order to speed up the cleaning process and to avoid the sorbents from spreading out all over the surface of water, which makes cleaning up much more tedious. Materials like jute and filtration meshes were found suitable for the experiment. Therefore, processed sorbents were then packed into deploy bags made of filtration meshes (45 to 50 microns) or jute.

Sea water and river water was taken in separate glass containers. The samples were tested for pH. Oil was taken and poured into the containers separately, in consequent trials. The materials were added individually and the results were observed and recorded. Experiment was done with different types of oil (diesel, kerosene, etc.), as it is not fully evident that only crude oil will get spilled.

**1) Water testing:**

The collected samples were taken for testing at a private laboratory. pH tests was conducted, to find out the effect of oil spill on pH levels, in both oceans and rivers.

**2) Procedure:**

A sample (Sea water + crude oil), of 500 ml was taken in a container. The deploy bags (made for experimental purpose) was then set out on to the oil, on the surface of the water. The outcomes were observed and recorded.

After some time, the bag, which had removed all the oil was removed.

**3) Testing of the Sample after Removal of Oil Spill:**

pH test was again conducted to know the variation of pH in the sample after removal of the oil spill. Results were compared with the former test results, and the extent of damage occurring in the water, due to oil spill was found out.

### V. RESULTS AND DISCUSSION

#### 5.1 GENERAL

The experimental outcomes were found to be positive. It was seen that the oil got absorbed/adsorbed into the materials, inside the bags. The absorption/adsorption process took place speedily. When the sorbents were tested without the deploy bags, each sorbent showed good results, either by absorbing/adsorbing the oil completely. Whereas, when sorbents were tested along with the bags, it showed similar results, with extra advantage of easy removal of bags along with the sorbents, without much work.

#### 5.2 DISPOSAL OF WASTE

The wastes, containing the oil removed from the oil spill, can be separated from the oil. The oil can be refined again, but this is possible only when the oil is cleared as soon as possible, after an oil spill. The oil got from the wastes cannot be used for the purpose for which it is actually extracted, but can be used as a source of power (by burning) in cement manufacturing plants, brick kilns and other places.

In general, where PVC or string fibre is used, the wastes can be used to lay roads, as done in present times. On the other hand, if coconut husk, rice hull or filter paper is used, they decay as time goes by, as they are bio-degradable. But, maximum care must be taken to remove as much oil from the waste as possible before disposal to landfills. Care must

be taken when waste is disposed off in a landfill, following precautionary measures to prevent ground water and land pollution. Incineration of wastes must be done under controlled conditions to prevent air pollution.

Disposal of waste must be such that it does not cause much harm to the environment. Failure in proper handling of waste may lead to detrimental effects on the surroundings. Incineration of wastes must be done controlled.

### 5.3 COMPARITIVE STUDY

Water samples were tested before and after an oil spill, to compare the chemical characteristics of the water. Oils are majorly made up of hydrocarbons. Hydrocarbons are compounds composed of carbon and hydrogen atoms linked together by either double or single bonds. Crude oil has higher percentages of praffins, naphthenes, aromatics and lower percentages of sulphur, nitrogen, oxygen, metals and salts. Oil spills bring about changes in the pH levels and in levels of composition of different elements or salts present in water..

#### 5.3.1 pH TEST

pH testing was done to find out changes in ph before and after the oil spill. This study is done in order to know the effects due to oil spills in both oceans and rivers. Lab tests were conducted to access the value of pH in both river and sea water.

It is seen that there is considerable amount of change in the pH reading in both river and sea water after an oil spill. pH gets reduced due to an oil spill, indicating the water becomes acidic after an oil spill. The pH of sea water generally varies between 7.4 and 8.4. pH plays an important role in various processes taking place in the ocean. The pH of river water indicates how acidic or how basic is the water. pH of fresh water normally varies between 6.5 and 8.5.

At first the pH of sea water is 7.49, which is well found to be in the standard range. But, after the oil spill occurs i.e, oil spill is removed, the pH lowers to 7.26. This does not indicate much danger to the environment. Whereas the pH of river water shows a drop in the pH value. It changes from 8.02 to 6.85, it's almost lowered to 2 numbers. It goes from moderately alkaline to slightly acidic.

A lower pH range can kill small vegetation, fishes and affect the natural ecosystem, making the aquatic life more vulnerable to diseases, which in turn affects other animals and humans that consume them. However, in case of a river a slight change in pH may get altered by limestone and other minerals present in rocks and sediments. Still drastic changes will have harsh effects on the river's ecosystem.

**TABLE 5.3.1.1. PH OF THE WATER SAMPLES BEFORE EXPERIMENTATION**

SAMPLE	DESCRIPTION		
	TEST PARAMETER	PROTOCOL	RESULT
SEA WATER	pH at 25° C	IS:3025 Part 11-1983 (Reaff:2012)	7.49
RIVER WATER	pH at 25° C	IS:3025 Part 11-1983 (Reaff:2012)	8.02

**TABLE 5.3.1.2. PH OF THE WATER SAMPLES AFTER EXPERIMENTATION**

SAMPLE	DESCRIPTION		
	TEST PARAMETER	PROTOCOL	RESULT
OIL REMOVED SEA WATER	pH at 25° C	IS:3025 Part 11-1983 (Reaff:2012)	7.26
OIL REMOVED RIVER WATER	pH at 25° C	IS:3025 Part 11-1983 (Reaff:2012)	6.85

### 5.3.2 SULPHATE TEST

Sulphate testing was also conducted after the oil spill, to assess the extent of damage caused due to an oil spill. Sulphate content in water can be analyzed either by colorimetric method or by Ion chromatography. Generally the sulphate content in sea water is around 2600 parts per million. Sulphate ranges from 0 – 630 ppm in rivers.

The sea water sample is found to have 2571ppm (parts per million), whereas the river water sample has 47 ppm of sulphate. This is well under the standard safe range.

Higher levels of sulphate, in the range of 600 – 1100 ppm in drinking water, results in Carthrasis , in some cases diarrhea in human beings. Drinking water must not have sulphate levels exceeding 250 ppm. Sulphates generally have the ability to make water acidic. This accounts for the change in pH levels in water. Water having sulfates, (upto 20 mg/L) can be used for certain industrial processes such as sugar production and concrete manufacturing.

**TABLE 5.3.2.1. SULPHATE CONTENTS OF THE WATER SAMPLES AFTER EXPERIMENTATION**

SAMPLE	DESCRIPTION		
	TEST PARAMETER	PROTOCOL	RESULT
OIL REMOVED SEA WATER	Sulphate as SO <sub>4</sub>	IS: 3025 Part:24-1986 (Reaff: 2014)	2571 mg/l
OIL REMOVED RIVER WATER	Sulphate as SO <sub>4</sub>	IS: 3025 Part:24-1986 (Reaff: 2014)	47 mg/l



### 5.3.3 ADVANTAGES AND LIMITATIONS OF THE PROCESS

#### 1) ADVANTAGES

- This method does not use highly sophisticated technology or equipments, thus making the process smooth to run.
- This method deals with simple, easy-to-find, widely available materials, therefore this process becomes economical.
- This method does not require, highly skilled man power.
- This method is quick, and saves a lot of time. Whereas other methods generally followed are time consuming.
- Wastes produced (in case of coconut husk, rice hull, filter are used) are bio-degradable.
- Wastes produced ( in case of PVC, string fibre) can be used to lay bitumen pavements.
- This method does not pose much threat to the environment as it does not use any harmful chemicals.
- The absorbed oil can be reused for burning, if it is recovered in a short period of time.
- Wastes got from this method can be used for burning, to power boilers, producing steam (thermal energy) to run turbines to produce electricity.

#### 2) LIMITATIONS

- In the occurrence of an oil spill, booms must be first set up. 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 more thicker layers. There are different types of booms, classified depending upon the purpose for which they are used.
- The number of deploy bags need to be used for clearing an oil spill will depend upon the amount of oil spilled.
- The oceans must be constantly monitored for any such incidents and immediate actions must be taken in case of an oil spill, to avoid extreme damages to the environment ( death of sea birds, mammals, etc..)

## VI. CONCLUSION

There have been various advancements in oil spill clean-up methods. Latest technologies comprising of highly sophisticated equipments - booms, skimmers, pose difficulties on the government in the aspects of money. These equipments are complicated to use.

This new method of oil spill recovery can be used for all types of oil spills under certain limitations and it is found to be satisfactory, easy and economical. This aims to reduce the impact on the environment caused due to oil spills. This method, with all its advantages, is found to give expected positive results.

‘Prevention is better than cure’, therefore it is always advised that, maximum efforts should be taken to prevent an oil spill. Monitoring and preventive maintenance (in case of oil rigs, pipelines) operations must be undertaken by the authorities concerned, as oil spill and its spreading majorly occurs due to human errors.

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## REFERENCES

- [1] Desai N, Smt Vanitaben. "A study on the water pollution based on the environmental problem". Indian Journal of Research. 2014;3(12):95-96.J.
- [2] "Oil spill cleanup technology Patents and patent applications" Archived November 10, 2011, at the Wayback Machine.
- [3] "Spill Response - Dispersants". International Tanker Operators Pollution Federation Limited. Retrieved 2010-05-03.
- [4] "A slick idea" by Cara Murphy Beach Reporter Manhattan Beach section 11/14/1992.
- [5] Pezeshki, S. R.; Hester, M. W.; Lin, Q.; Nyman, J. A. (2000). "The effects of oil spill clean-up on dominant US Gulf coast marsh macrophytes: a review". *Environmental Pollution*. **108**: 129–139. doi:10.1016/s0269-7491(99)00244-4.
- [6] Sarbatly,R, Kamin,Z and Krishnaiah .D "A review of polymer nanofiber by electrospinning and their application in oil water separation for cleaning up marine oil spills"et.al., published in 2016 May 15;106(1-2):8-16. doi: 10.1016/j.marpolbul.2016.03.037. Epub 2016 Mar 24.
- [7] Fountain, Henry (2010-06-24). "Advances in Oil Spill Cleanup Lag Since Valdez". New York Times. Retrieved 2010-07-05.
- [8] David M. Bearden and Jonathan L. Ramseur "Oil and Chemical Spills: Federal Emergency Response Framework".et.al., August, 2017.
- [9] Mullin, Joseph V; Champ, Michael A (2003-08-01). "Introduction/Overview to In Situ Burning of Oil Spills". *Spill Science & Technology Bulletin. In-Situ Burning of Spilled Oil*. **8**(4): 323–330. doi:10.1016/S1353-2561(03)00076-8.
- [10] United States Coast Guard (2007). "Cumulative Spill Data and Graphics". United States Coast Guard. Archived from the original on 2008-10-08. Retrieved 2008-04-10.
- [11] "Emergency Response: Responding to Oil Spills". Office of Response and Restoration. National Oceanic and Atmospheric Administration. 2007-06-20.
- [12] "Oil Spill Response Procedure" (PDF). Chemstore UK. Retrieved 2014-02-25.
- [13] "Trajectory of Oil Spill (28.01.2017)" (PDF). Indian National Centre for Ocean Information Services (INCOIS). INCOIS. Retrieved 7 February 2017.
- [14] Henry R. Walther III "Clean Up Techniques Used for Coastal Oil Spills": An Analysis of Spills Occurring in Santa Barbara, California, Prince William Sound, Alaska, the Sea Of Japan, and the Gulf Coast.12-12-2014
- [15] Marco sampaolo 24-07-2017 "Crude oil": petroleum product began by The Editors of Encyclopaedia Britannica 20-07-1998.
- [16] Jeroen J.M.Geurts,Judith M.Sarneel, Bart J.C.Willers, Jan G.M.Roelofs, Jos T.A.Verhoeven, Leon P.M.Lamers. "Interacting effects of sulphate pollution, sulphide toxicity and eutrophication on vegetation development in fens": A mesocosm experiment.12-03-2009.