



Oil Spill: Their Impact, Recovery and future prevention

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ABSTRACT

An oil spill is the release of a liquid petroleum hydrocarbon into the environment especially marine areas due to human activity. Oil is the most common pollutant in the oceans. Oil spill have a devastating and long-term impact on water ways and coastal areas around the world. Oil spill can be partially controlled by chemical dispersion, combustion, mechanical containment and adsorption. These days there are so many import and export business are going in the world. Because of expansion of business and shipping by seas in the cheapest mode it's used on large scale due to huge cargo shipping these are so many cases of oil spill in the sea. World has witnessed big oil spill accidents into the oceans and made huge impact on the industries as well as the ecosystem. Due to these oil spills there were so many deaths if sea mammals and bird species. After oil spills creates a slick (a thick layer of oil) that ensure the sunlight and oxygen pass through water. It affects the life below the water due to lack of oxygen and sunlight. As some of the oil are dangerous and poisonous they are quite harmful for human too when it comes to physical contact with them. This paper deals with the separation of oil and water to find out the better solution for oil recovery from the water surface mixture empress oil spill to produce oil free water. There are different methods to remove the oil form the water but disc type oil skimmer is mostly used and efficient. The oil skimmer is used to separate oil, from mixture of aqua and oil. It causes highly acidic alkaline and salty environment remains a great challenge to aquatic organisms and also pollute the coastal area. Every year 706 million gallons of waste oil enter the water resources and pollute the environment. Sea water has been polluted due to oil spillage, it also affects the water bodies. It the oil spill increase it result in serious damage to environment. About 90% of contaminated oil can be removed by continuous separation of oil by skimmer.

Keywords— oil skimmer, ecosystem, chemical dispersion, combustion

1. INTRODUCTION

Background of the Study

An oil spill is the release of a liquid petroleum hydrocarbon into the environment, especially marine areas, due to human activity, and is a form of pollution. Oil is the most common pollutant in the oceans. More than 3 million metric tons of oil contaminates the sea every year. The majority of oil pollution in the oceans

comes from land, runoff and waste from cities, industry and rivers carries oil into the ocean. Ships cause about a third of the oil pollution in the oceans when they wash out their tanks or dump their bilge water. The kind of oil spill we usually think about is the accidental or intentional release of petroleum products into the environment as result of human activity (drilling, manufacturing, storing, transporting, waste

management), that floats on the surface of water bodies as a discrete mass and is carried by the wind, currents and tides. They have destructive effects on coastal ecosystems. Marine oil spill is a serious consequence of offshore oil drilling and its oceanic transportation. Spill control firms specialize in the prevention, containment and clean-up of industrial oil spills. Pollution is the most significant danger which threatens the human nature. The most dangerous of these pollutants is oil pollution, because oil pollution threatens the environment as well as economy. It has been studied that recently with increasing use of oil. According to Environmental Protection Agency, almost 14000 oil spills are reported each year in the oceans alone. Many countries has made stringent safety norms for wastewater disposal content with oils mainly typically from petrochemical and process industries so that such industries are equipped with such kind of oil skimmers to separate the oils from disposal water. Based on the specific design they are used for a various applications such as oil spill response, as a part of oily water treatment systems, removing oil from the coolant and aqueous part washers and collecting fats, mixed oil and grease oil in waste water and treatment plant. Consequences of oil spill disasters from waterway accidents, the oil rig, the acts of wanton vandalism usually affected so seriously the environment, marine creatures, plants, life of other animals, and human in a long time. The ever developing and advanced technologies should be used to meet treat and recover fast, efficiently oil spills and oil slicks. The overviews of as-using technologies such as physical, chemical, insitu burning and bioremediation method were presented in this work. A large efficiency of oil recovery from physical method was shown although it was only suitable for application before oil emulsified. Meanwhile, chemical method might be concordant with all oil types but the chemical residual caused perniciously to marine environment. A oil skimmer is a device that is designed to remove oil floating on a liquid surface. The types of approaches which are used to filter the oil content from water by using oil skimmer belt. It is a mechanical device that helps in removing floating oil and tiny greasy particles from water [1]. In modern world, rapid and quick working is more important with new idea. The new invention of machines that are used to reduce the problems in the world is necessary [2]. Pollution has created lot of issues in day- to-day life. In

that water pollution is uncontrollable. Due to water pollution, the tourism, fishing and aquatic organisms are greatly affected. An oil skimmer is a device that is designed to remove oil floating on a liquid surface. Oil is one of the most important raw materials for synthetic polymer and chemicals [3]. The release of oil into natural environment is termed as oil spill or spillage. The oily material in the contaminated water can be removed by using belt in the oil skimmer. Since, oil is lighter than the water they can be easily stuck to the belt of the skimmer. Oil skimmers are very effective tool for removing dirty, uncleaned and sticky fluids that are present in the ocean water. Oil spills over the sea, river and water resources becomes a serious issue to the public welfare. The separated water can achieve the level of purity and level of Ph for re-use. The water is mainly used for cutting purpose and drilling purpose. Separation of oily and greasy particles based upon the specific gravity, viscosity etc. Generally mechanical belt skimmers operate simply by lifting the oil from the mixed water surface to the collection point [4]. The function of oil skimmer, its various design aspects and performance. All the results of experimental studies indicate that slight design improvement of typical oil skimmers towards to include additional belt shaft and use of belt with steel material instead of rope; significantly improve the oil recovery rate and efficiency. This paper has illustrated the practical overview of oil spills by using current oil spill technology. Further extensive research & testing can improve the existing techniques and equipment to have better control for oil recovery exercise. A set of experiments had been conducted by using various oils and different materials of belt to understand the oil recovery performance and viscosity deviation of oils before and after separation. These oil spills have caused a great collision on ecological life around the spillage. He had conclude that the oil spillage is not only harmful but also result in loss of lives and money. So the recovery of spilled oil is very necessary. He studied various oil skimmer belts and their properties [6]. The separation of oil is based on surface tension, specific gravity and viscosity. He studied the operation of oil skimmer on various positions of the belt like inclined, vertical, horizontal [7].



Fig.1.1 Oil Skimmer in ocean

Physical Properties of Oil:

The Term Oil Describes a broad range of hydrocarbon based substances. Hydrocarbons are chemical compounds composed of the elements hydrogen and carbon. This includes substances that are commonly thought of as oils, such as crude oil and refined petroleum products, but it also includes animal fats, vegetable oils, and other non-petroleum oils. Each type of oil has distinct physical and chemical properties. These properties affect the way oil will spread and break down, the hazard it may pose to aquatic and human life, and the likelihood that it will pose a threat to natural and man-made resources. The rate at which an oil spill spreads will determine its effect on the environment. Most oils tend to spread horizontally into a smooth and slippery surface, called a slick, on top of the water. Factors which affect the ability of an oil spill to spread include surface tension, specific gravity, and viscosity.

- Surface tension is the measure of attraction between the surface molecules of a liquid. The higher the oil's surface tension, the more likely a spill will remain in place. If the surface tension of the oil is low, the oil will spread even without help from wind and water currents. Because increased temperatures can reduce a liquid's surface tension, oil is more likely to spread in warmer waters than in very cold waters.
- Specific gravity is the density of a substance compared to the density of water. Since most oils are lighter than water, they float on top of it. However, the specific gravity of an oil spill can increase if the lighter substances within the oil evaporate. Heavier oils, vegetable oils, and animal fats may sink and form tar balls or may interact with rocks or sediments on the bottom of the water body.
- Viscosity is the measure of a liquid's resistance to flow. The higher the viscosity of the oil, the greater the tendency for it to stay in one place. (Honey is an example of a highly viscous liquid).

Chemical Characteristics:

The hydrocarbons with 50% to 98% of oil total components dominated complex chemical properties of oil. Furthermore, oil also included non-hydrocarbon compounds such as oxygen, nitrogen, sulphur and trace metals. Hydrocarbons listed in oil components and classified following nomenclature by The International Union of Pure and Applied Chemistry (IUPAC) Oils might be divided into saturated and unsaturated hydrocarbons, aromatic hydrocarbons, resins and asphaltenes, refined products.

How does oil spill happen?

Spills can be caused by:

- People making mistakes or being careless.
- Equipment breaking down.
- Natural disasters such as hurricanes.
- Deliberate acts by terrorists, countries at war, vandals or illegal dumpers.

Oil floats on saltwater (the ocean) and usually floats on freshwater (rivers and lakes). Very heavy oil can sometimes sink in freshwater, but this happens very rarely. Oil usually spreads out rapidly across the water surface to form a thin layer that we call an oil slick. As oil continues spreading, the layer becomes thinner and thinner, finally becoming a very thin layer called a sheen, which often looks like a rainbow. (you may have seen sheens on roads or parking lots after a rain). Depending on the circumstances, oil spills can be very harmful to marine birds and mammals and also can harm fish and shellfish. You may have seen dramatic pictures of oiled birds and sea otters that have been affected by oil spills. Oil destroys the insulating ability of fur-bearing mammals, such as sea otters, and the water-repelling abilities of bird's feathers, thus exposing these creatures to the harsh elements.

Environmental Effects of Oil Spills

The effects of oil spills can have wide ranging impacts that are often portrayed by the media as long lasting environmental disasters. Such perceptions are understandable as they are often fueled by distressing images of oiled birds and other wildlife. It is true that an Oil Spill can have severe short term effects, especially when organisms are considered on an individual basis. However, environmental impacts should always be

measured in a scientific context and should be appraised at an ecosystem rather than individual level. In other words, it is important (or more representative of long term environmental effects) to base the extent of environmental damage on the effects to ecosystems. For example, has the ecosystem retained its normal functions or how quickly will they resume following an oil spill? Under normal conditions many of the ecosystems most frequently affected by marine oil spills are accustomed to natural disturbances. For example, shallow coral reefs are some of the most dynamic environments, frequently exposed to the intense forces of typhoons and tsunamis. Disturbances of this nature typically create space for new organisms to settle and grow. In time, natural processes repair damage caused by such events, returning an ecosystem to its previous functions, albeit potentially comprised of different individual organisms.

Natural recovery processes are also important in remediating the effects of oil spills. Recovery can be assisted by the removal of oil through well-conducted clean-up operations, and may sometimes be accelerated with carefully planned restoration measures.



Fig1.2 Environmental effects on Animal

How Can Oil Spills Cause Damages to the Environment?

The effects of an oil spill will depend on a variety of factors including, the quantity and type of oil spilled, and how it interacts with the marine environment. Prevailing weather conditions will also influence the oil's physical characteristics and its behaviour. Other key factors include the biological and ecological attributes of the area; the ecological significance of key species and their sensitivity to oil pollution as well as the time of year. It is important to remember that the clean-up techniques selected will also have a bearing on the environmental effects of a spill. Oil spills may impact the environment in the following ways: Physical smothering

of organisms: This is caused by oils with a high viscosity, in other words heavy oils. Smothering will affect an organism's physical ability to continue critical functions such as respiration, feeding and thermoregulation. Chemical toxicity: This is characteristic of lighter chemical components which are more bio-available, i.e. absorbed into organs, tissues and cells, and can have sub-lethal or lethal toxic effects.

Ecological changes: This is caused by the loss of key organisms with a specific function in an ecological community. They can be replaced by different species undertaking similar functions in which case the implications for the ecosystem as a whole may not be severe. • Indirect effects: Loss of shelter or habitat through oiling or clean-up operations.

How Can Oil Harms Animals and Plants In Marine Environments?

In general, oil spills can affect animals and plants in two ways: from the oil itself and from the response or clean-up operations. Understanding both types of impacts can help spill responders minimize overall impacts to ecological communities and help them to recover much more quickly. Spilled oil can harm living things because its chemical constituents are poisonous. This can affect organisms both from internal exposure to oil through ingestion or inhalation and from external exposure through skin and eye irritation. Oil spills penetrate into the structure of the feathers of birds and the fur of mammals, reducing its insulating ability, and making them more vulnerable to temperature fluctuations and much less in the water. The birds may die of hypothermia (they lose the ability to keep themselves warm). Many birds and animals also ingest (swallow) Oil when they try to clean themselves which can poison them. Depending on just where and when a spill happens, from a few up to hundreds or thousands of birds and mammals can be killed or injured. Since most oils float, the creatures most affected by oil are animals like sea otters and that are found on the sea surface or on shorelines if the oil comes ashore. During most oil spills, seabirds are banded and killed in greater numbers than other kinds of creatures. Sea otters can easily be harmed by oil, since their ability to stay warm depends on their fur remaining clean. If oil remains on a beach for a while, other creatures, such as snails, clams, and terrestrial animals may suffer.



Fig1.3 Effects on Marine Plants

Effects of Oil Spills on Humans and Land Animals:

Spilled Oil not only harms aquatic plants and animals but can also have serious effect on humans and land animals. *Effect of Oil spill on Humans- *Effect of Oil spill on Animals The main effects Of oil spills on humans may be due to direct and indirect contact with the spill. The main oil spill effects on humans include a variety of possible health effects, economic impact, as well as recreational and aesthetic.



Fig.1.4 Effects on Animal



Fig.1.5 Effects on Human

Effects of Oil Spill on Land or Terrestrial

Animals Direct effect of oil spills on wildlife:

Oil spills can impact wildlife directly through three primary pathways:

- Ingestion — when animals swallow oil panicles directly or consume prey items that have been exposed to oil.
- Absorption — when animals come into direct contact with oil.
- Inhalation — when animals breathe volatile organics released from oil or from 'dispersants' applied by

response teams in an effort to increase the rate of degradation of the oil in seawater.

Indirect effect of oil spills on wildlife:

Oil spills can also have indirect effects on wildlife by causing changes in behaviour:

- Relocation of home ranges as animals search for new sources of food
- Increases in the amount of time animals must spend foraging disruptions to natural life cycles Oil consumptions can also result in some internal effects which includes:
 - The destruction of red blood cells, important for the immune response,
 - Alterations of liver metabolism,
 - Adrenal tissue damage, Pneumonia,
 - Intestinal damage
 - Reduced reproduction ability, Reduction in the number of eggs lay,
 - Decreased fertility of eggs.

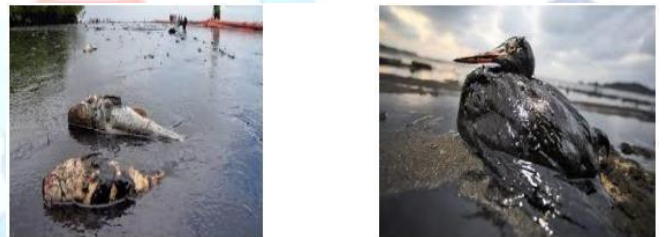


Fig.1.6 Effects on Terrestrial Animals

2. LITERATURE REVIEW

1) Oil Spill Cleanup Project: Scott Post suggests a project that would allow teachers to teach engineering design while also cleaning up an oil spill. Simple, inexpensive equipment was used in the endeavour to clean up an oil spill.

II) A Review of Mobile Oil Skimme: Sathiyamoorthy, Arumugam, Arun Pragathish, Barath B., Baskar, and Balamurugan present the oil skimmer belt, a mechanical tool that aids in the removal of oil particles and floating oil from water. The basic method of operation for mechanical belt skimmers is to raise the oil from the surface of mixed water to the collection point.

III) Professor P.A. Patil concluded that viscosity, specific gravity, and surface tension are the main factors in the separation of oil. He looked at how the oil skimmer worked in several belt positions, such as inclined, vertical, and horizontal.

IV) MervFingas Spill Science Edmonton's Review of the Literature on Oil Spill Dispersants The study lists and highlights recent developments in the biodegradation, toxicity, and effectiveness of dispersants. There are also discussions on other subjects like usage, application, behaviour, and fate.

3. WORKING

3.1 DISC TYPE OIL SKIMMER METHOD:

Oil skimmers are the equipment that removes oil floating on the surface of a fluid. In general, oil skimmers work because they are made of materials to which oil is more likely to stick than the fluid it is floating on. At the same time, the fluid has very little attraction to oil skimmers. Oil skimmers are usually all that is necessary to remove oil from a liquid. In some cases, however, oil skimmers may be used to pre-treat a fluid. In this case, the oil skimmers remove as much of the Oil as possible before more expensive and time-consuming measures are employed. Pre-treating the fluid with oil skimmers reduces the overall cost of cleaning the liquid. Disk Oil skimmers are not a good choice for shallow liquids or for places where the liquid level fluctuates, because they are most effective when the entire disk is immersed. The basic function is to systematically float over sections of contaminated water & skim the oil off the surface.

3.2 PRINCIPLE:

The principle behind how it works is to use the adhesive properties of hydrocarbon to recover them selectively from surface water. The skimmer works on the physics principle of the difference in surface tension of oil and water allowing the rotating disk to attract waste oil and reject water. Imagine dipping your finger in a glass of water with oil floating on the surface and then remove it. Your finger will be coated with oil.



Fig: 3.1 Working Model

3.3 CONSTRUCTION:

1. WATER TANK (REPRESENTATION SEA):

A water tank is a component in which the water is stored which represents sea water which content spreader oil in it. Whose length and width is of 12 X 18inch.

2. OIL ABSORBING DISC OR ARCYLIC DISC:

Oil absorbing disc or acrylic disc which act as a wiper which attract oil and hold it for some time and passing through tray and collected into tank. Acrylic is artificial made from a special group of vinyl compounds, primarily acrylonitrile. Acrylic fibres are thermoplastic (i.e., soften when heated, re-harden upon cooling), have low moisture regain, are low in density, and can be made into bulky fabrics. They wash and dry easily and are dimensionally stable. They are resistant to bleaches, dilute acids, and alkalis, and to weathering and microbiological attack.

3. OIL COLLECTING TRAY OR PLASTIC CHASSIS: Plastic chassis is consisting of acrylic disc having various joint as per requirements. In the chassis various components are mounted like motor, plate or disc, etc.

4. MOTOR:

A DC motor is any of a class of rotary electrical machines that convert direct current electrical energy into mechanical energy. The motor is having rotation speed of 60rpm. It is a geared type of motor producing high torque. The most common types rely on the forces produced by magnetic fields. Nearl all types od DC motors have some internal mechanism, either electromechanical or electronic, to periodically change the direction of current flow in part of the motor. 5. AC TO DC CONVERTER A power converter is n electrical or electro-mechanical devices for converting electrical energy. This could be as simple as a transformer to change the voltages of AC power to DC power, but also includes far more complex systems. The term can also refer to class electrical machinery that is used to convert one frequency of alternating current into another frequency.

These oil skimmers rotate a disk-shaped medium through the liquid. Oil is wiped off and discharged into a collection container in manner similar disc oil skimmers. It is important to consider reach, the portion of the disk that gets immersed, when looking at a disk oil skimmer. Fewer disks in the fluid means less oil removed. Obviously, fluctuating fluids can be a real problem for disk oil skimmers.

4. SALIENT FEATURES OF DISC OIL SKIMMER

- Most inexpensive way to remove oil from water.
- Saves coolants by removing tramp oil.

- Conserves parts wash water by removing oily waste.
- Prevents plugging of spray heads and filters.
- Reduces fluid disposal costs.
- Skimmed oil can be recycled and reused as a lubricant or fuel.

5. GENERAL CALCULATION OF OUR MODEL

According to our basic model

1 Lit - 6 min

10 Lit - 60 min

Suppose if 10,000 Lit of oil spill happens

As, we know, 10 lit- 60 min 10,000lit- 60,000min (i.e. 1000 hours) If we use 25 ship then, $1000 / 25 = 40$ hours only. If we use these models on actual site by in Ingra scales, then it will increase the efficiency by (5 x times) $40 / 5 = 8$ hours. In Actual 8 hours is required to clean 10,000 liters of oil.

6. CONCLUSION

1. Disc skimmer methods is the best efficient and economical among above methods of removing oil spills.
2. These methods will remove 82% of oil spills.
3. This method is the best method compared to among all oil recovery methods.
4. Skimmed oil can be recycled and reused as a lubricant or fuel.
5. Reduces fluids disposal costs.
6. It does not use any type of chemicals and many more.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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