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OIL SPILL CLEANUP & RECOVERY- A REVIEW

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Abstract- Clean up and recovery of spilled oil is a critical issue due to the environment and economic concern. Booms and skimmers are the mechanical equipment used for the efficient recovery of spilled oil while dispersant, biodegradable agents, and solidifiers are utilized for cleanup of spilled oil. Depending on the stage of a spill, different monitoring approaches need to be carefully evaluated to ensure they are relevant and will produce meaningful results.

Keywords: Crude oil ,Water,Booms,Skimmer,Dispersant,Environment

I. INTRODUCTION

An oil spill happens when liquid petroleum is released into the environment by vehicle, vessel or pipeline. It happens on a large scale and is mostly seen in water bodies. It happens due to human negligence and is a major form of pollution. The source of the spill are many. Crude oil can be released by tankers on land. In water bodies, the spill occurs due to drilling rigs, offshore oil platforms and well. An oil spills and their effects can also be experienced with refined petroleum or even waste oil from large scale industries. What is common in all of them is that the damage caused by them is permanent and takes a long time to clean up. As oil spill, it floats on water and prevents sunlight to pass through it. The shiny substance that you see sometimes on top layer of water is nothing but oil which makes it difficult for plants and sea animals to survive. Cleaning up of oil spill is no easy task. Various factors need to be considered before carrying out operations. Some of them being amount of oil spilled, temperature of water, type of beaches and many more. Oil spill can prove fatal for plant, animal and human life. The substance is so toxic that it can cause massive loss of species that live in the sea. Oil spill penetrates into the plumage and fur of birds, breaks down the insulating capabilities of feather which makes them heavier, disallow them to fly and kill them via poisoning or hypothermia.

II. EFFECT OF OIL SPILL

Environmental Effects

First of these is the environmental effect. The animal life that lives in the water or near the shore are the ones most affected by the spill. In most cases, the oil simply chokes the animals to death. Others that live face a number of other problems. The oil works its way into the fur and plumage of the animals. As a result, both birds and mammals find it harder to float in the water or regulate their body temperatures. Many baby animals and birds starve to death, since their parents cannot detect their natural body scent. Birds that preen themselves to get rid of the oil accidentally swallow the oil and die due to the toxic effects. In many cases, the animals become blind due to repeated exposure to the oil. Dolphins, sea otters, fish, countless species of birds and many oceanic mammals face these consequences. Countering these effects and cleaning the oil can take anywhere between a few weeks to many years, depending on the damage caused.

Effect on Economy

The second major effect of the oil spill is seen on the economy. When precious crude oil or refined petroleum is lost, it effects the amount of petroleum and gas available for use. This means more barrels have to be imported from other countries. Then comes the process of cleaning the oil spill, which requires a lot of financing. Although the company responsible for the oil spills and their effects has to clean it up, there is a lot of government help required at this point. The workers that are brought on board to clean up the spill face tremendous health problems later in life as well. Their medical treatment has to be paid for and becomes the responsibility of the government. Putting all the methods of recovery into place and monitoring them takes away resources from other more important work and hits the economy in subtle but powerful ways.

Effect on Tourism Industry

The local tourism industry suffers a huge setback as most of the tourists stay away from such places. Dead birds, sticky oil and huge tarballs become common sight. Due to this, various activities such as sailing, swimming, rafting, fishing, parachute gliding cannot be performed. Industries that rely on sea water to carry on their day to day activities halt their operations till it gets cleaned.One of the biggest oil spills seen in history happened during Gulf war when approximate 240 to 336 million gallons of crude oil flowed into the Persian Gulf. It was considered one of the worst disasters, beating the Ixtoc 1 Oil spill in Mexico. Recent major oil spill happened when an oil rig, Deepwater Horizon sank in the Gulf of Mexico. The spill released somewhere between 172 to 180 million gallons of crude oil into the environment. In the year 2010 alone, six oil spills were seen in the USA. Outside of the United States, oil spills have happened in Canada, Nigeria, France, United Kingdom and in China. While the long term issues causes by oil spills and their effects is yet to be fully observed, the daily problems are clear. However, most corporations still do not have a solid plan in place for when this emergency may strike.

III .CLEAN-UP & RECOVERY FOR OIL SPILL

There are basically four ways to clean-up oil spills. These are: mechanical containment and recovery, chemical methods such as dispersants, burning, and shoreline clean-up. In the open water and near shore, mechanical skimming of oil is considered the response method least harmful to the environment. First you need to contain the oil with booms; then you need to recover it using skimmers, store it temporarily, treat it (remove the water) and then dispose of it.

BOOMS

A boom is a floating mechanical barrier designed to stop or divert the movement of oil on water. Booms are used to enclose oil and prevent it from spreading, to protect harbours, bays, and biologically sensitive areas, to divert oil to areas where it can be recovered or treated, and to concentrate oil and maintain an even thickness so that skimmers can be used or other cleanup techniques, such as in situ burning, can be applied. Booms are used primarily to contain oil, although they are also used to deflect oil. When used for containment, booms are often arranged in a U, V, or J configuration. Booms are also used in fixed systems attached to docks, piers, harbour walls, or other permanent structures with sliding-type connectors that allow the boom to move up and down with the waves and tide. Their purpose is to protect certain areas from an oil spill.

SKIMMERS

Skimmers are mechanical devices designed to remove oil from the water surface. They vary greatly in size, application, and capacity, as well as in recovery efficiency. Skimmers are classified according to the area where they are used. For example, inshore, offshore, in shallow water, or in rivers, and by the viscosity of the oil they are intended to recover, that is heavy or light oil. Some skimmers have storage space for the recovered oil and some of these also have other equipment such as separators to treat the recovered oil.

Oleophilic surface skimmers sometimes called sorbent surface skimmers, use a surface to which oil can adhere to remove the oil from the water surface. This oleophilic surface can be in the form of a disc, drum, belt, brush, or rope, which is moved through the oil on the top of the water. A wiper blade or pressure roller removes the oil and deposits it into an onboard container or the oil is directly pumped to storage facilities on a barge or on shore. The oleophilic surface itself can be steel, aluminum, fabric, or plastics such as polypropylene and polyvinyl chloride. Oleophilic skimmers pick up very little water compared to the amount of oil recovered, which means they have a high oil-to-water recovery ratio. They therefore operate efficiently on relatively thin oil slicks. They are not as susceptible to ice and debris as the other types of skimmers. These skimmers are available in a range of sizes and work best with light crude oils, although their suitability for different types of oil varies with the design of the skimmer and the type of oleophilic surface used

Weir skimmers are a major group of skimmers that use gravity to drain the oil from the surface of the water into a submerged holding tank. In their simplest form, these devices consist of a weir or dam, a holding tank, and a connection to an external or internal pump to remove the oil. Many different models and sizes of weir skimmers are available. A major problem with weir skimmers is their tendency to rock back and forth in choppy water, alternately sucking in air above the slick and water below. This increases the amount of water and reduces the amount of oil recovered. Some models include features for self-levelling and adjustable skimming depths so that the edge of the weir is precisely at the oil-water interface, minimizing the amount of water collected.

Suction or vacuum skimmers use a vacuum or slight differential in pressure to remove oil from the water surface. Often the “skimmer” is only a small floating head connected to an external source of vacuum, such as a vacuum truck. The head of the skimmer is simply an enlargement of the end of a suction hose and a float. T Suction skimmers are similar to weir skimmers in that they sit on the water surface, generally use an external vacuum pump system such as a vacuum truck, and are adjusted to float at the oil-water interface. They also tend to be susceptible to the same problems as weir skimmers. They are prone to clogging with debris that can stop the oil flow and damage the pump. They also experience the problem of rocking in choppy waters that causes massive water intake, followed by air intake. Their use is restricted to light to medium oils. Despite their disadvantages, suction skimmers are the most economical of all skimmers. Their compactness and shallow draft make them particularly useful in shallow water and in confined spaces.

Elevating skimmers or devices use conveyors to lift oil from the water surface into a recovery area . A paddle belt or wheel or a conveyor belt with ridges is adjusted to the top of the water layer and oil is moved up the recovery device on a plate or another moving belt. The operation is similar to removing liquid from a floor with a squeegee. The oil is usually removed from the conveyer by gravity. When operating these skimmers, it is difficult to maintain the conveyor at the water line. In addition, they cannot operate in rough waters or in waters with large pieces of debris, and cannot deal with light or very heavy oils. Elevating skimmers work best with medium to somewhat heavy oils in calm waters. They are generally large and are sometimes built into specialized vessel.

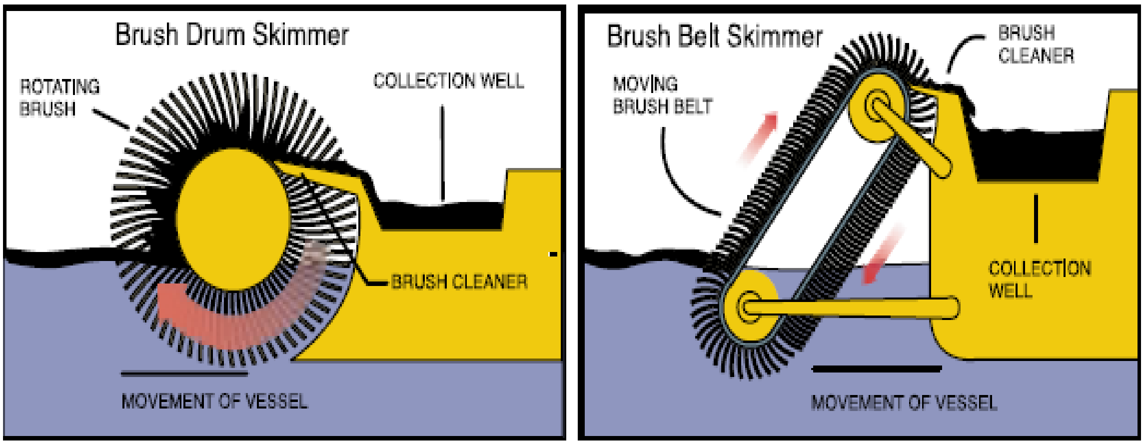

FIGURE 1.SKIMMER

IN SITU BURNING

For oil to ignite on water, it must be at least 2 to 3 mm thick. Most oils must be contained to maintain this thickness. Ignition is relatively easy. More weathered and heavier oils require a longer ignition time. Most types of oils will burn, although emulsions may require treatment before they will burn and the water in the oil affects the burn rate.Oils burn at a rate of about 3 to 4 mm per minute or about 5000 L per m^2 per day. Studies have shown that emissions from burning oil generally result in concentrations of air contaminants that are below health concern levels 500 m downwind from the fire. In-situ burning is an oil spill cleanup technique that involves controlled burning of the oil at or near the spill site. The major advantage of this technique is its potential for removing large amounts of oil over an extensive area in less time than other techniques. The most obvious disadvantage of burning oil is concerns about toxic emissions from the large black smoke plume produced. The second disadvantage is that the oil will not ignite and burn unless it is thick enough. Fire-resistant booms are used to concentrate the oil into thicker slicks so that the oil can be burned.

DISPERSANT

Dispersant is a common term used to label chemical spill-treating agents that promote the formation of small droplets of oil that “disperse” throughout the top layer of the water column. Dispersants contain surfactants, chemicals like those in soaps and detergents, that have molecules with both a water-soluble and oil-soluble component. Depending on the nature of these components, surfactants cause oil to behave in different ways in water. Surfactants or surfactant mixtures used in dispersants have approximately the same solubility in oil and water, which stabilizes oil droplets in water so that the oil will disperse into the water column. The purpose of using oil spill dispersants is to remove the spilled oil from the surface of the sea and transfer it into the water column where it is rapidly diluted to below harmful concentrations and is then degraded. Spraying oil spill dispersants onto spilled oil while it is still at sea may be the most effective, rapid and maneuverable mean of removing oil from the sea surface, particularly when mechanical recovery can only proceed slowly or is not possible. The use of oil spill dispersants reduces the damage caused by floating oil to some resources, for example sea birds, and minimizes the damage that could be done to sensitive shorelines by dispersing the oil before it drifts a shore. Oil spill dispersants are not capable of dispersing all oils in all conditions Natural dispersion of an oil slick occurs when waves cause all or part of the oil slick to be broken up. When a breaking wave (at > 5 m/s wind speed) passes through an oil slick at sea, the oil slick is temporarily broken into a wide range of small and larger oil droplets. Most of the oil droplets are large (0.1 - several mm in diameter), and rise quickly back to the sea surface where they coalesce and reform a thin oil film when the wave has passed, while the very smallest oil droplets will become dispersed into the water column. The addition of dispersants is intended to accelerate this natural process and rapidly convert a much larger proportion of the oil slick into very small oil droplets. Figure below illustrates the mechanism that occurs when dispersants are sprayed on to an oil spill at sea. When the dispersant droplets containing the surfactants hit the oil surface, the surfactants (the active ingredients) diffuse into the spilled oil or emulsion. The emulsion-breaking properties of the surfactants can cause the water droplets in the emulsion to coalesce into larger water oil droplets that eventually will separate from the oil phase. The formation of these small oil droplets enhances the biological degradation of the oil in the marine environment by increasing the oil surface area available to micro-organisms capable of biodegrading the oil. The use of oil spill dispersants can be controversial. To many people, dispersants can be a very useful oil spill response method; a rapid and effective means of minimizing the damage that might be caused by an oil spill. Other people feel that the use of dispersants is adding to the problems caused by the oil pollution. Some environmental pressure groups are against dispersant use because they perceive it as a way of 'hiding' the problem of oil pollution rather than 'solving' it. Explaining the purpose, capabilities and potential benefits of dispersant use can be difficult when seemingly contradictory views are being put forward by 'experts' from various sources.

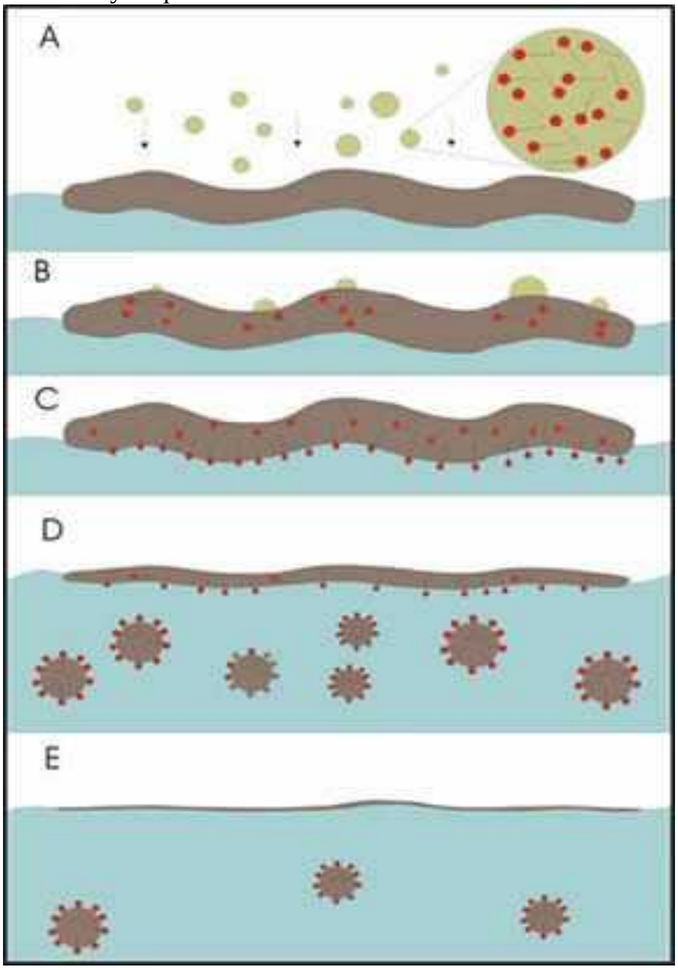

FIGURE 2. MECHANISM WHEN APPLYING DISPERSANT

SOLIDIFIERS
Solidifiers are intended to change liquid oil to a solid compound that can be collected from the water surface with nets or mechanical means. They are sometimes referred to as gelling agents or collecting agents. Collecting agents are actually a different category of agent that are the opposite of dispersants and are not yet fully developed. Solidifiers consist of cross-linking chemicals that couple two molecules or more, or polymerization catalysts that cause molecules to link to each other. Solidifiers usually consist of powders that rapidly react with and fuse the oil. Solidifiers have not been used in the past for a number of reasons. Most importantly, if oil is solidified at sea, it makes recovery more difficult as skimming equipment, pumps, tanks, and separators are built to deal with liquid or very viscous liquid.

BIODEGRADATION AGENTS
Biodegradation agents are used primarily to accelerate the biodegradation of oil in the environment. They are used primarily on shorelines or land. They are not effective when used at sea because of the high degree of dilution and the rapid movement of oil. Many studies have been conducted on biodegradation and the use of these agents. Hundreds of species of naturally occurring bacteria and fungi have been found that degrade certain components of oil, particularly the saturate component, which contains molecules with 12 to 20 carbon atoms. Some species will also degrade the aromatic compounds that have a lower molecular weight. Hydrocarbon-degrading organisms are abundant in areas where there is oil, such as near seeps on land or in water. Biodegradation agents include bioenhancement agents that contain fertilizers or other materials to enhance the activity of hydrocarbon-degrading organisms**,** bioaugmentation agents that contain microbes to degrade oil, and combinations of these two.

IV. CONCLUSION
Many methods available for removing oil from shoreline. Most of costly them carry out. The appropriate selection based on type of substrate,the depth of oil in sediment,the amount and type of oil and is present form/condition The extent to which an oil penetrates and spreads, its adhesiveness, and how much the oil mixes with the type of material on the

shoreline are all important factors in terms of cleanup. Cleanup is more difficult if the oil penetrates deeply into the shoreline. Penetration varies with the type of oil and the type of material on the shoreline. A very light oil such as diesel on a beach can penetrate to about a meter under some conditions and is difficult to remove. On the other hand, a weathered crude deposited on a fine sand beach can remain on the surface indefinitely and is removed fairly easily using mechanical equipment.

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