



Emergency Response for Oil spillage in seas and Ocean

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Abstract: *Afcons Infrastructure Ltd (Oil & Gas BU) one of largest companies in India specialist in Engineering, procurement, construction, installation and commissioning. Afcons has recently completed Commissioning & redevelopment of HRD process platform at Mumbai high using Float over technology and ICP-R project in the past by using conventional type technology. We are committed to do our projects with zero marine pollution and now oil spill becomes a major global threat to marine aquatic life by changing the physical, chemical and biological. Here we discussed about the various methods that can be used if oil spillage occurs in the seas.*

I. Introduction

Afcons Infrastructure Ltd (Oil & Gas BU) one of largest companies in india specialist in Engineering, procurement, construction, installation and commissioning . Oil spill are one of the major modern day threats to the environment as it directly impacts on water and other living things. Oil is one of the major pollutants which we can see visibly at most of the times. Sources say around three million metric tons of oil is spilled in seas every year. The greater part of oil pollution in the oceans comes from land. Runoff and waste water from cities, industry and rivers takes oil into the ocean. Ships and barges sources around one third of the oil pollution in the oceans when they clean their tanks or leave their bilge water. Bilge water is an by-product of the storage and transportation of oil and petroleum and causes the occasional spill. Oil spills are very hard to clean up. Normally we think that oil spillage is accidental release of crude oil into the marine environment as a result of human activities like drilling rigs and wells, transport, storing or transferring to ports. That oil floats on the water surface as an isolated mass and is carried by winds, ocean currents and tides as well. These oil spillages may be somewhat managed by chemical dispersion, combustion, mechanical containment and adsorption. But they have destructive consequences on marine ecosystems. Examples of oil spillages are offshore well blowouts, pipeline breakages, ship accidents or groundings, overfilling of gas tankers and bilge pumping from ships, leakage from underground storage containers, and oil-polluted storm water runoff from streets during rain seasons. Marine oil spillage is a major effect of off-shore oil drilling and its marine transportation. There are some Spill control firms specialize in the prevention, containment and cleaning up of industrial oil spillages.

II. Characteristics of oil spillage

The major spillages of petroleum products in the seas happen during their transportation by oil tankers, loading and unloading operations, blowouts, etc. When oil gets mixed up with sea water the oil passes some many changes that involves physical, chemical and biological alterations. Physical and chemical property changes starts immediately once crude oil gets spilled into the sea. There will be certain changes in the sea like evaporation, widening, blending, dissolution, sea-atmospheric air exchange and sedimentation. Due to the presence of sunlight, Chemical oxidation of some of crude oil products is also encouraged. The degraded products of these processes include floating of tar lumps, dissolved and suspended particulates of hydrocarbon material in the water and there are some materials which will be deposited on the sea bed. Biological alterations may be slow but those changes also act simultaneously with physical and chemical property changes. The important biological property changes includes degradation by microorganisms to various products like carbon dioxide or organic material in intermediate oxidation stages, uptake by big organisms and successive metabolism, storage and release.

III. Types of oil spill

Basically Petroleum products are the mixture of highly complex compounds. The destiny of petroleum products in the marine environment is depended on the composition of the spilled product, a basic idea of major petroleum components and types is required for understanding the life of petroleum products when they are

spilled on water(Source : <http://response.restoration.noaa.gov/oil-and-chemical-spills/oil-spills/oil-types.html>). The different type of oil that can be spilled in seas are

- 1) Type 1 – very light oils (Jet fuels, Gasoline)
- 2) Type 2 – Light oils (Diesel, No 2 fuel oil, light crudes)
- 3) Type 3 - Medium oils (Crude oils)
- 4) Type 4 – heavy oils (Heavy crude oils)

IV. Properties of oil spillage in marine ecosystem

(a) **Spreading** – After spilling of crude oil on the water is immediately it will starts spreading. Apart from chemical compositions of the oil, the extent of spreading of the oil is controlled by wind, waves and tidal currents. Due to the power of hydrostatic and surface forces, the oil spreads quickly to attain an average thickness of less than 0.03 mm within 1 day. Once the oil spillage has become thinned upto 0.03mm, then surface forces starts playing an vital part, the oil layer will no longer be continuous and uniform but it will become scattered by wind and waves to the islands where thicker layers of oil are in equilibrium with thinner oil films.

(b) **Evaporation** – Evaporation and dissolution are The key methods involving in degrading of crude oil when spilled on water are evaporation and dissolution. The chemical composition of the spilled oil, its surface area and its physical properties, current wind velocity, air and sea temperatures, turbulence and intensity of sunlight, all play a major role in the evaporation rates of crude oil. Evaporation process can alone remove around 50% of hydrocarbons in an medium crude oil which are on the sea surface. The loss of volatile hydrocarbons which are present in the spilled oil increases the relative density and the kinematic viscosity of oil. When more volatile hydrocarbons are lost, the kinematic viscosity of the resulting oil increases and this results in breakup into smaller patches.

(c) **Photo-oxidation** – When natural sunlight combines with oxygen at normal atmospheric condition can lead to transformation of crude hydrocarbons into aldehydes and ketones and ultimately leading to low molecular weight carboxylic acids. As these products are hydrophilic, they change the solubility property of the spill.

(d) **Dispersion** –Oil starts dispersing very fastly when it comes in contact to water and the most considerable spreading is during the first ten hours.

(e) **Degradation** – Bio-degradation process influences the life of crude oil in marine environment includes microbial degradation, eating by zooplankton. Aquatic Microorganisms are capable of oxidizing the crude hydrocarbons and its related compounds. The rate of microbial degradation of crude hydrocarbons varies with the chemical properties and complex nature of the crude, the micro organism populations and also depends on the many of the environmental conditions.

V. Effects of petroleum crude on marine bio-system

Oil spillage makes a severe risk to surface water and also marine environment, by affecting surface sources and a extensive variety of subsurface microbes that are linked to each other in a complex food chain which includes human food resources. Oil Spillage will directly affect the environment in numerous systems which include physical damages that directly affect wildlife and their habitats (such as oil coating on birds or mammals with a layer of oil in their skin), and that toxic nature of the oil itself will poison to the organisms which are directly exposed to. The impact of the severity of an oil spill depends on some many factors which include physical properties of the oil, whether it is crude based oil or non crude based oils, and the surrounding weather conditions of the water over which oil is spilled up.

The biological effects of oil include:

- (a) Hazards to man through eating contaminated sea foods by the method of bio accumulation,
- (b) shortage of fishes or spoiling of wild life such as sea birds and marine animals,
- (c) Decrease of aesthetic values because of oiled beaches,
- (d) Change in marine ecosystems by reduction of some species with an initial decrease in diversity and productivity,
- (e) Change in habitats, delaying or preventing re-colonization.

When an oil spillage occurs in the sea there are many factors to be considered while determining the spillage caused is heavy or may have long lasting biological damage or comparatively small or zero damage or some quantity of damage. Thus for an example, if there is a oil spillage in a small confined place so that the oil is unable to disperse, damage will be more for the volume of oil spilled and also depends on the type of oil spilled. In mid sea if oil spill occurs then the possible impact will be on phytoplankton, zooplankton, fishes, seabirds etc. whereas if the same happens in shorelines then impact will also be on inter-tidal flora and fauna, aquaculture, seaweeds and mangroves.

VI. Mitigation measures when spillage occurs

- (a) Controlling at sea – Use proper Response techniques when the oil is still in the sea and not reached the shores.
- (b) Controlling on land – Use proper Response techniques when the spillage oil is so very close to the shores or has already stranded.
- (c) Prevention at sea – Take measures to make extraction and transportation of oil at sea in a safer way.
- (d) Prevention on land – Take measures that oil spillages are avoided from being released from land-based causes into the marine environment.
- (e) **Shipboard Oil Pollution Emergency Plan (SOPEP)** – Ship onboard oil pollution emergency plan is a prevention plan carried on board tankers greater than 150 Gross Tonnage and other vessels greater than 400 GT. SOPEP will give an possible procedures in case of an oil spill and also whom should be contacted (list of authorities, oil cleanup teams and port state control) and how to report this event to the nearest coast guard station.

Shipboard oil pollution plan contains:

- an action plan with instructions for the oil pollution prevention team. This is a list of duties the crewmembers have to fulfil in case of an oil spill
- an emergency plan
- General information about the ship
- Procedures to discharge the oil into the sea in accordance to MARPOL 73/78 Regulations Chapter 8, Regulation 40,41,42
- Drawings of fuel/oil lines
- Location of SOPEP boxes

VII. Control of Oil Spillage

Spillage of Oil may occur when problem is within an oil well or cracks in pipeline or leakages or due to accident while transporting. Since conditions are different with each spill, different methods of spill control may be used.

- (a) **Booms:** Booms are the floating barriers which are used to clean oil from the water surface and also prevents spreading. A boom shall be placed around the tanker vessel which is spilling oil. Booms will collect the oil from the water. A boom may be placed somewhere before oil spill. Booms can also be kept around a habitat with many animals living there. These booms absorb any oil that flows around it.
- (b) **Skimmers:** Skimmers are the boats that can used in removing the oil from the water. In Skimmers we use pumps or vacuums to suck the oil as it float on water.
- (c) **Sorbent:** Sorbents absorb oil when they are placed in a spill area and spilled oil can be collected easily.
- (d) **Dispersant:** Sometimes chemicals called dispersants are used to break the oil structure and the spilled oil can be removed from the top of the water. An aircraft which is normally used to fly over the water which has oil spillage by dropping chemicals into the ocean. The chemicals can break down the oil into the ocean.
- (e) **Bioremediation:** Bioremediation is a process which may be used to accelerate the process of biodegradation of the oil after a spill. In this process, bacteria or other microbes are introduced to the environment to help oxidize the oil. Unfortunately, this process can work slowly and is not very useful for large spills.
- (f) **Controlled Burning:** incidentally the slick caused by an oil spill can be removed through a controlled burning on spillage area. It is easy to burn freshly spilled oil with fireproof booms to contain the oil. But this method works under certain conditions like wind and weather. Controlled burning is to be kept as a final option because it causes air pollution.
- (g) **Oil spill control on sea shores/land:** This is repeatedly conducted manually. Scooping, cleansing and scraping of the rocks and sand will be done till the oil has been removed completely. Vacuum trucks may be used on the beaches to vacuum up the oil that was spilled. Simple shovels or road equipment can be used to collect all the oil from the shorelines.

VIII. Oil Spill Response Procedures

Spill response procedures should include elements such as;

- A listing of appropriate protective clothing, safety equipment, and cleanup materials required for spill cleanup (gloves, respirators, etc.) and an explanation of their proper use
- Appropriate evacuation zones and procedures;
- Availability of fire suppression equipment;
- Disposal containers for spill cleanup materials; and
- The first aid procedures that might be required.

IX. Conclusion

Oil spillage either by accidental or incidental or of operational discharges and spills from ships, especially tankers, offshore process platforms, well heads, rigging operations and pipelines, is the most clear and evident cause of oil pollution in the marine environment. So many natural, physical, chemical and biological changes and degradation processes are the cause of oil spills into marine environment. The impact of oil spills can be far away from an environmental perspective and as well as a socio-economic perspective. Marine and coastal habitats, wildlife species, recreational activities, local industry, and fisheries, are among the resources and sectors that can be affected drastically due to these oil spills. It affects seabirds, marine mammals, fish and shellfish, and bottom-living animals. It destroys beaches, destroys aquaculture, fisheries and deteriorates health effects from cleanup operations.

X. Chennai Oil spillage case study

Recent oil spillage in Chennai had created fear the local people as the spill occurred due to the spillage of oil due to the collision between two ships and a large quantity of oil was released into the sea which will affect marine life and people who are all living in that coastal areas.



Picture of oil spillage and its effects in Chennai 2017

References

1. <http://environmentengineering.blogspot.com/2008/04/oil-spill-and-its-adverse-effects-on.html>
2. <https://saferenvironment.wordpress.com/2008/09/17/oil-spill-adverse-effects-on-marine-environmental-bio-system-and-control-measures/>
3. <http://gcaptain.com/maritime/blog/historys-10-most-famous-oil-spills/>
4. <http://stats.oecd.org/glossary/detail.asp?ID=1902>
5. <http://www.rivermedia.com/consulting/er/oilspill/effects.htm>
6. <http://www.umbi.umd.edu/~scitech/pdf/oil.pdf>
7. <http://knol.google.com/k/partha-das-sharma/marine-oil-spills/oml631csgjs7/15>
8. <http://www.insightsonindia.com/2017/02/04/insights-editorial-tarred-oil-spill/>
9. <http://www.dttas.ie/node/19324>
10. https://en.wikipedia.org/wiki/Ship_oil_pollution_emergency_plan