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Fate of oil spill and its effect on Marine Life

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Abstract: Humanity has relied on fossil fuel oil and gas reserves as a major source of energy since more than a century. Such reliance has proven dangerous and risky to the environment and all living creatures on earth since fossil fuel is a very hazardous substance. Oceans and seas are projected to contain large reserves of oil and natural gas and thus, drilling and extraction of oil and gas from sea bed is an active industry. Offshore drilling activities are not new, however, there are significant environmental concerns associated with offshore drilling for oil extraction such as the increased risk of rig explosions, mechanical damages and leaks, which all expose marine ecosystems to great risks. Environmental significance and concerns can result from several activities associated with oil and gas industry such as: exploration, drilling, production, gathering, transportation and distribution, refining and processing, and each of these activities has unique vulnerabilities. The greatest vulnerability leading to large-scale environmental damage comes from pipelines infrastructure – given the overall length, age and condition of existing pipelines and their proximity to shorelines. In this review the impact of oil spills on marine ecosystem is discussed with referral to both long term and short term physiological impacts of petroleum hydrocarbons on marine creatures.
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Introduction

Aquatic oil spills can be caused by leaking from damaged tankers, pipelines and offshore oil rigs and frequently leads to long-term environmental hazard and immediate negative impact on aquatic ecosystem. The environmental impacts of oil spills can last for decades and despite great removal efforts, residual oil from oil spills decline by less than 4 percent annually [1]. When oil spills it covers marine water surface due to its low density, and this leads to killing aquatic creatures due to blocking oxygen penetration into surface water leading to suffocation of marine creatures. Oil can clog blowholes of some aquatic creatures such as whales and dolphins leading to their inability to breath and disrupt their communications. Oil also coats body of otters and seals leaving them vulnerable to hypothermia [2].

After petroleum is spilled into water bodies from leaks, mechanical damages and explosions of rigs and tankers, it undergoes different transformations (physical, chemical and biological) that depend on the conditions of the marine environment and that also depend on the properties of the petroleum spill. Such processes include spreading, evaporation, emulsification, dissolution and sedimentation as well as photochemical oxidation that can occur to petroleum hydrocarbons under sun light and oxygen **[3].**

Petroleum transformations in oil spills can be summarized as follows:

A. Spreading and movement of oil spills: Spreading of oil spill means the increase of dimensions of the spill while movement means the change of the location of oil spill without any change in its dimensions. Such processes are largely dependent on water motion, winds and water currents. Oil draft velocity is 3-3.5 % of the wind velocity [4].

B. Evaporation and Dissolution: The initial changes in oil spilled into seawater are evaporation and dissolution of volatile hydrocarbons, while about 70 % of the total dissolved aromatic compounds are benzene and toluene. These processes occur within hours and only traces of hydrocarbons (1-50 µg/L) remain unaffected after these processes [4].

C. Emulsification and Dispersion: These processes occur within days. Less viscous oils are emulsified or dispersed with water and are often not visible on the surface after 2-5 days [4].

D. Photo-oxidation: During daytime, spilled oil is exposed to the sunlight and photo-oxidation occurs;

E. this process affects the high molecular weight aromatic fractions, increasing their solubility, and enhancing their biodegradation and emulsification rates. [4].

F. Biodegradation: biodegradation process occurs by microorganisms, leading to degradation of high molecular weight hydrocarbons and converting it to low molecular weight hydrocarbons, thus increasing their dissolution and emulsification rates. [4].

G. Sedimentation: This process occurs only when oil gravity is higher than the water gravity or when oil adheres to particulate matter that can settle by gravity [4].

All the aforementioned processes can overlap and can affect each other and in return affect the properties of the spilled oil [5].

Moreover, oil spills contaminate the food supply of marine creatures leading to their poisoning. If the oil spill is so dense and large in amount, oil can reach its critical micelle concentration and immerses into water leading to beneath water contamination and furthermore the contamination to bed reeves. Poisoning of marine creatures takes place when marine creatures feed on oil contaminated water [1]. Thus, oil spills can be deadly to fish, shellfish and all other marine life and if fish eggs or larvae are exposed to or coated by oil, the embryos will die. Oil spills not only block oxygen but also sunlight from penetrating surface water, leading to creation of nuisance condition and the flourish of anaerobic bacteria. Such consequence can lead to creation of anaerobic gases as methane and the existence of toxic conditions [3].

Long-term impacts on species and their habitats and the on or offshore nesting or breeding creatures is one of the most far-reaching environmental effects caused by oil spills. Even species that spend most of their lives at sea, such as various species of sea turtles, must come ashore to nest. Sea turtles can be harmed by oil they encounter in the water or on the beach where they lay their eggs, their eggs can be damaged by oil and fail to develop properly, and newly hatched turtles may be covered by oil as they rush toward the ocean across an oily shore. When birds touch oil spill on ocean or sea surface, they get trapped or covered by oil. Oil-covered birds are a universal symbol of environmental damage caused by oil spills. Some species of shore birds might escape by relocating if they sense such danger, but sea birds that swim and dive for their food are most likely to be covered in oil following a spill [3]. Oil spills also damage nesting grounds, potentially causing serious long-term effects on entire species. Even if a small amount of oil coats birds it can be deadly to a bird. By coating feathers, oil not only makes flying impossible but also destroys birds' natural waterproofing and insulation, leaving them vulnerable to hypothermia or overheating. As birds frantically clean their feathers to restore their natural protections, they often swallow oil, which can severely damage their internal organs and lead to their death [1,3].

The negative impacts of oil spills are not only natural but also economical due to the consequences of the destruction of the aquatic biota on fisheries and fishing industry. Such impacts can be huge on regions and communities that rely on fishing is a major source of income and nutrition. Petroleum hydrocarbon is classified as hazardous waste and is toxic in all forms [3]. Petroleum hydrocarbons contain several toxic compounds that include methane gas, high molecular weight tars, asphaltenes, resins, waxes and bitumens. They also include straight and branched hydrocarbons, single or condensed rings and aromatic rings such as the monocyclic (benzene, toluene, ethylbenzene and xylene). They also include polycyclic aromatic hydrocarbons (PAHs) such as naphthalene, anthracene and phenanthrene [6].

The aliphatic hydrocarbons including n-alkanes generally constitute the major fractions of petroleum, which may be used to detect its presence in the environment. In addition, n-alkanes, particularly, are the major fractions of saturated hydrocarbons, the distribution patterns of n-alkanes characterize by carbon-number (carbon chains) ranges and its predominance is depending on thenature of the source material and its microbial or geochemical alteration **[7].**

PAHs are a widespread airborne pollutant and mainly originate from fossil fuel combustion and the release of petroleum and petroleum products [7,8,9]. Chemically, PAHs are compounds contain two or more fused aromatic rings in linear, angular or clustered arrangements. They generally possess high chemical stability, which results in high levels of environmental loads and accumulation in environment and high levels of bio-accumulation [10, 11,12]. Many PAHs have toxic, mutagenic and/or carcinogenic properties. Although large number of individual PAHs exist as hazardous contaminates in nature, most regulations, analyses, and data reporting focus on only a limited number of PAHs, typically between14 and 20 individual PAHs. Such compounds are given the priority because they are of the most concern and such PAHs are toxic or carcinogenic pollutants [13,14].

PAHs are hydrophobic compounds and their hydrophobicity increases with increasing of molecular weight. Due to their high hydrophobic properties, PAHs tend to adsorb strongly on particle matter surfaces and thus can be deposited in sediments [15,16,17]. Therefore, marine sediments often contain concentrations of PAHs of higher magnitudes than those in the overlying or surface waters [12]. The contamination of the sediment may pose a high toxic threat to the marine fauna, which tend to biologically accumulate organic pollutants. Uptake of PAHs by marine organisms is dependent on the environmental bioavailability of the PAHs as well as the physiology characteristics of the organisms [18,19].

Gastropods molluscs are excellent bio-accumulators of a wide range of pollutants [20,21]. They are filter feeders, herbivores or carnivores and have the potential to bio-concentrate contaminants, which would normally be present in the water or within sediments at concentrations too low for detection by routine monitoring techniques. They are also ideal species for environmental monitoring, because their sedentary nature does not require consideration of complex migratory factors in the interpretation of the bioaccumulation data [21,22].

When oil hydrocarbons are ingested by marine creatures, these compounds reach liver where enzymes degrade PAHs into more toxic and reactive by-products. The metabolites of PAHs and aliphatic hydrocarbons can be highly toxic and carcinogenic to exposed creatures. Additionally, when oil spills get exposed to oxygen and sunlight at water surface, the can oxidize and decompose into numerous harmful by-products of lower molecular weight that can exist in water or volatilize into lower atmosphere creating pollution [6].

Conclusion

Oil spills from different offshore sources such as marine rigs, tanker leaks and mechanical damages in ships are found to be a major source of hazardous aquatic contamination from petroleum hydrocarbons. The toxic impacts of offshore oil spills affect the entire marine environment and it can also have an extending economic and social impacts on communities that rely on fishing as a source of income and nutrition. Oil spills can have different mechanism through which it can alter the aquatic ecosystem balance. Such effects include blocking sunlight and oxygen leading to suffocation of aquatic creatures and flourishing of anaerobic microorganisms and the creation of nuisance conditions. Moreover, it can kill birds and seals through poisoning their food and hindering birds' ability to fly and coating their bodies which can cause hypothermia. Petroleum hydrocarbons are known to be entirely toxic if ingested by aquatic creatures and the toxicity can even extend to humans through fishing of poisoned fish.

References

1. https://oceanservice.noaa.gov/facts/oilimpacts.html#:~:text=Oil%20spills%20are%20harmful%20to,well%20as%20fish%20and%20shellfish. & text=When%20exposed%20to%20oil%2C%20adult,fin%20erosion%2C%20and%20reproduction%20impairment.
2. National Research Council (US) Committee on Oil in the Sea: Inputs, Fates, and Effects. Washington (DC): National Academies Press (US); 2003.
3. https://www.intechopen.com/books/emerging-pollutants-in-the-environment-current-and-further-implications/impact-of-oil-spills-on-marine-life.
4. ITOPF (2011): Fate of Marine Oil spill. The international tanker owners pollution federation limited, London, 3-7 pp.
5. Gong Y., Xiao Z.; Zhengqing C., S. E. O'Reilly and *et al.*; (2014): A review of oil, dispersed oil and sediment interactions in the aquatic environment: Influence on the fate, transport and remediation of oil spills. Marine Pollution Bulletin, 79, 1–2; 16-33.
6. Mona S. Zaki; Nagwa S. Ata; Mostafa F. Abdelzaher and Abdel Mohsen M. Hammam. Effects of Environmental Oil Spills on Commercial Fish and Shellfish in Suez Canal and Suez Gulf Regions (Review Article). Life Science Journal;11(2):269-274; 2014.
7. El Nemr, A.; El-Sikaily, A.; Khaled, A.; Said, T. O. and Abd-Allah, A. M. A. (2004): Determination of hydrocarbons in mussels from the Egyptian Red Sea coast. Environ. Monit. Assess., 96:251–261.
8. Andres, H.; Arias, A. H.; Vazquez-Botello, A.; Tombesi, A.; Ponce-Vélez, G. and Freile, H. (2010): Presence, distribution, and origins of polycyclic aromatic hydrocarbons (PAHs) in sediments from Bahía Blanca estuary, Argentina. Environ. Monit. Asses., 160 (1-4): 301–314.
9. Chao, M.; Lun, F. X. and Shen, X. Q. (2010): Distribution characteristics and ecological risk of polycyclic aromatic hydrocarbons in surface sediments of south branch of Yangtze River estuary. Chin. J. Ecol. 29: 79–83.
10. Di-Toro, D. M.; McGrath, J. A. and Hansen, D. J. (2000): Technical basis for narcotic chemicals and polycyclic aromatic hydrocarbon criteria. I. Water and Tissue Environ. Toxicol. Chem., 19(8):1951–1970.
11. Arey, J. and Atkinson, R. (2003): Photochemical reactions of PAH in the atmosphere. P.E.T. Douben (Ed.), PAHs: an ecotoxicological perspective, John Wiley and Sons Ltd, New York, 47–63.
12. El Nemr, A.; Said, T. O.; Khaled, A.; El Sikaily, A. and Abd- Allah, A. M. A. (2007): The distribution and sources of polycyclic aromatic hydrocarbons in surface sediments along the

Egyptian Mediterranean coast. Environ. Monit. Assess., 124:343–359.

13. Ruiz, Y.; Suarez, P.; Alonso, A.; Longo, E.; Villaverde, A. and San, F. (2011): Environmental quality of mussel farms in the Vigo estuary: pollution by PAHs, origin and effects on reproduction. Environ. Pollut., 159:250–265.
14. Liu, L.Y.; Wang, J. Z.; Wei, G. L.; Guan, Y. F. and Zeng, E. Y. (2012a): Polycyclic aromatic hydrocarbons (PAHs) in continental shelf sediment of China: Implications for anthropogenic influences on coastal marine environment. Environ. Pollut., 167:155-162.
15. Means, J. C.; Wood, S. G.; Hassett, J. I. and Banwart, W. L. (1980): Sorption of polynuclear aromatic hydrocarbons by sediments and soils. Environ. Sci. and Techno., 14:1524– 1528.
16. Kim, G. B.; Maruya, K. A.; Lee, R. F.; Lee, J. H.; Kon, C. H. and Tanabe, S. (1999): Distribution and sources of polycyclic aromatic hydrocarbons in sediments from Kyeonggi Bay, Korea. Mar. Pollut. Bull., 38: 7–15.
17. Ko, F. C.; Baker, J. E.; Fang, M. D. and Lee, C. L. (2007): Composition and distribution of polycyclic aromatic hydrocarbons in the surface sediments from the Susquehanna River. Chemosphere, 66: 277-285.
18. Juhasz, A. L. and Naidu, R. (2000): Bioremediation of high molecular weight polycyclic aromatic hydrocarbons: a review of the microbial degradation of benzo [a] pyrene. Intern. Biodeterior. & biodegrade., 45:57-88.
19. Meador, J.; Stein, J.; Reichert, W. and Varanasi, U. (1995): Bioaccumulation of polycyclic aromatic hydrocarbons by marine organisms. Reviews of environmental contamination and toxicology. Springer, 79-165.
20. Simkiss, K.; Taylor, M. and Nason, A. Z. (1982): Metal toxicity and bioaccumulation in molluscs. Mar. Biol. Lett., 3:187 –201.
21. Livingstone, D. R. (1991): Organic xenobiotic metabolism in marine invertebrates. Advan. in Compar. and Environ. Physio., 7: 45-185.
22. Short, J. W. and Sharp, J. L. (1989): Tributyltin in bay mussels (*Mytilus edulis*) of the Pacific coast of the United States. Environ. Sci. Technol., 23 (6):740–743.

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