ACTA SCIENTIFIC MICROBIOLOGY (ISSN: 2581-3226)

Volume 2 Issue 9 September 2019

Review Article

A Comprehensive Study on Causes of Oil Spills and Remediation - A Review

Ansh Kapoor*, Mayur Rai, Divya Agrawal and Sunil Kumar Sharma

Department of Petroleum Engineering and Energy Studies, DIT University Dehradun, India

***Corresponding Author:** Ansh Kapoor, Department of Petroleum Engineering and Energy Studies, DIT University Dehradun, India.

Received: July 31,2019; **Published:** August 28, 2019

DOI: 10.31080/ASMI.2019.02.0355

Abstract

This review aims at spreading awareness about the serious issue of oil spills. Till date, a number of discoveries have been made for its treatment. We will discuss about the remediation techniques for oil spills. The focus is mainly on marine spills, since the events of spills have occurred majorly in marine environment. The remediation techniques involve the traditional use of boom barriers, dispersants or emulsifiers, development of nanofibrillated cellulose sponge, natural disintegration of oil, development of wetting meshes, use of CuO nanowires, biosorption and use of lodestone particles. We will also discuss about how oil spills can be hazardous. We will discuss about the major oil spills occurred till date and how they have affected the ecosystem. There will be a brief discussion about causes of oil spills and the applications used in its treatment.

Keywords: Oil Spills; Environmental Degradation; Biosorption; Emulsification; Nano-materials

Abbreviation

E&P: Exploration and Production; ORMS: Oil Related Marine Snow; NFC: Nanofibrillated Cellulose; VLCC: Very Large Crude Carrier: WAF: Water Accommodated Fraction; PAH: Polycyclic Aromatic Hydrocarbon; LC: Lethal Concentration.

Introduction

Oil spill is the release of liquid hydrocarbon in the environment due to natural disaster, vandalism, crashing of systems and human activities which may include inability to handle the machinery, etc. When oil is spilled it does not mix with water immediately, it forms a layer that is a few cms thick. This slick has to be removed as it blocks the oxygen pathway for aquatic life and harms the marine ecosystem. Oil can be spilled in marine environment by offshore rigs or oil tankers that have an accident or carry out the tank cleaning process. Exposure to chemicals during the containment process can cause cardiac arrest or arterial congestion in workers. The spilled oil intoxicates the intertidal species and cause nervous system breakdown in fishes. Ocean tide, currents and weather change the movement of oil spills and make them unpredictable. Oil spill may involve spillage of heavy or light oil.

Methodology

Over the period of time various remediation techniques have been developed for the treatment of oil spills. The remediation techniques taken up by E&P companies can be classified as: (a) physical (b) chemical (c) thermal and (d) biological.

a) **Physical techniques:** It involves deploying of floating barriers/ booms to the scene. They crowd the oil above the surface and then it is removed using skimmer machines. Booms can be of different types like foam-filled, Inflatable and self-Inflating, fire booms, and trash and debris booms. These barriers slow the spread of oil and contain it in a limited region. Booms are used to reduce the possibility of polluting shorelines and other resources, and to help make recovery easier.

b) **Chemical techniques:** It involves changing of chemical properties of oil. For this purpose we use dispersants or emulsifiers that not only prevent the oil from spreading but also protect the marine environment. They reduce the surface tension of water to facilitate thorough mixing and produce a stable and uniform emulsified or dispersed liquid.

c) Thermal technique: This technique involves gathering of oil in a specified region and burning it in the presence of special equipments like igniters, fire resistant booms, etc. Its application involves mainly two requirements- fresh spill and a calm wind environment in which oil can be burnt quickly without any loss of aquatic life.

d) Biological technique: In this technique bacteria can be added to spill site which is called bioaugmentation to biodegrade the oil. We can use biostimulation that involves addition of nutrients to already present oil degraders to stimulate growth. Spartina or Cord grass found along coasts of Northern Gulf of Mexico and along the Atlantic coast can also be used. Bacterial species present in Spartina plant tissues can naturally disintegrate the oil. Studies at oil spill impacted coasts indicated that the bacterial communities inside the tissues of the plant shifted and incorporated (combined) more bacteria that helped in breaking down the oil. As in 2015, the best bacteria is to be identified from that community which can treat oil quite well so that a sponge can be made of it in lab which can be used practically to treat oil.

Some other methods are as follows

- Sponge of chemically modified wood called nanofibrillated cellulose was developed by an institute. It soaks up oil and leaves water behind. NFC is the basic material for sponges which is extracted from cellulose containing materials by adding water to them and pressing the aqueous pulp through several narrow nozzles at high pressure. This produces a suspension with gel-like properties containing long and interconnected cellulose nanofibres. It is not in practice yet. It was in early development stage in 2015.
- Dispersion of lodestone particles that stick to the oil and isolate it from water through magnetism- We use magnetite (also called lordstone) as it sticks to the oil and when oil is absent it sinks into water. This is a solution through magnetism as magnetite is the original reason behind discovery of magnetic force.
- Development of MnO_2 coated inverse wetting meshes- MnO_2 nano-crystal coated inverse wettability meshes can be of 2 types:
    - Superhydrophobicity mesh- It attracts heavy oil and water is deposited in mesh pores. It reduces contact angle of heavy oil.
    - Underwater Superoleophobicity mesh- It reduces contact angle of water and helps to rise up whereas light oil is stuck in pores.
- Cu surfaces with laser induced microholes and CuO nanowires- CuO nanowires are produced on Cu substrate due to presence of heat and oxygen but they are exfoliated (shed) quickly. We pass a nanolaser through Cu surface to produce microholes in it which lead to increased adhesion of nanowires. The surface becomes superhydrophilic (i.e., oil rises up and water is stuck in the pores) and can be used to treat oil spill.

Results and Discussion

As a result of old and damaged equipment, human error, and bad luck, extracting oil from ground and moving it to refineries releases oil into the environment. The largest spill has released tens millions of gallons of oil and has resulted in fouled coastlines, dead and injured wildlife. The most destructive oil spills are:

1. **The Amoco Cadiz Oil Spill (1978)-** The Amoco Cadiz, a very large crude carrier (VLCC) stocked with nearly 69 million gallons of light crude oil, ran aground on shallow rocks off the coast of Brittany, France, on the morning of March 16, 1978. This spill was caused due to bad sea condition and environment (storm). In this spill about 1.6 to 1.7 million barrels of oil was spilled which polluted about 200 miles of French coast and killed millions of invertebrates. In 1992, US oil giant Amoco has decided not to appeal against the US court order that it must pay US$200 million to the French government in damage to fisheries and tourist amenities.
2. The Castillo de Bellver Oil Spill (1983) - A fire aboard the oil tanker Castillo de Bellver in August 1983 was responsible for the tanker's capsizing. When the fire broke out on August 6, the Castillo de Bellver was located in the South Atlantic Ocean roughly 70 miles from Cape Town, South Africa. In this spill about 1.8 million barrels of oil, drifted to within 24 miles of the coast before it sank in deep water.
3. BP's Deepwater Horizon Oil Spill (2010) - The largest accidental oil spill in history began in the Gulf of Mexico on April 20, 2010, after a surge of natural gas blasted through a cement well cap that had recently been installed to seal a well drilled by the Deepwater Horizon oil platform. It was caused due to the negligence of the workers and members, where it ignited, killing 11 workers and injuring 17. In this spill about 206 million gallons of oil spilled from Texas to Florida and 60 billion dollar was paid by the United States for the damage.
4. Taylor oil spill (2004)**-** The 2004 Taylor oil spill is an ongoing spill located in the Gulf of Mexico, around 11 miles (18 km) off the coast of state of Louisiana, which resulted from the destruction of a Taylor Energy oil platform during Hurricane Ivan. As of 2018 it was estimated that 300 to 700 barrels of oil per day are being spilled. Taylor Energy reached an agree-

ment with the federal government to establish a $666 million trust in order to fund the response to the spill according to The Washington Post.

A research took place in 2018 which developed a relation between oil spill dispersants and formation of oil-related marine snow (ORMS) [1]. Oil spillage causes formation of oil slick that blocks pathway of oxygen through water thus harming the aquatic life forms [3]. People living in close proximity with oil spill have better chances of catching a heart disease than those living far away [4]. A research took place in 2019 on factors of oil spill, preventive measures, risks caused and dealing with oil spill (understanding oil trajectory helps)[2]. Magnetite nanoparticles and yeast-based magnetic bionanocomposite emerged as cure of oil spill [6]. MnO_2 nanocrystal coated meshes exhibit quick separation rate for the permeable liquid and high intrusion pressure (>1.38 kPa) for the intercepted liquid [7]. CuO nanowires are produced on Cu substrate due to presence of heat and oxygen but they are exfoliated (shed) quickly [8]. The monoliths with macroporous structure can undergo switchable wettability under reversible pH stimulation [9].

Conclusions

The type of oil spilled matters because different types of oil behave differently in the environment, and animals and birds are affected differently by different types of oil. We should distinguish between light and heavy oils. Light oils are very volatile and they don't remain in aquatic environment for a long time, whereas heavy oils appear black and persist in environment for a long time. Over the period of time, studies have been made on effects of WAF concentration of source oil, weathered crude oil and source oil with dispersant on freshwater and saltwater fishes. Weathering and dispersant have almost similar effect in both freshwater and saltwater. Except that PAH concentration in source oil + dispersant WAF in saltwater is slightly higher than freshwater equivalent. Higher the LC50 (lethal conc.) value in terms of %WAF greater the damage caused to a particular species. Exposure to these oils can cause heart electrophysiology dysfunction (heart muscle damage) and nervous system breakdown. It can also cause enzyme enhancement which may or may not be beneficial to a species.

Bibliography

1. Odd G Brakstad., *et al*. "A critical review of marine snow in the context of oil spills and oil spill dispersant treatment with focus on the Deepwater Horizon oil spill". *Marine Pollution Bulletin* 135 (2018): 346-356.

2. Bing Chen., *et al*. "Chapter 22: Marine Oil Spills—Preparedness and Countermeasures". World Seas: an Environmental Evaluation (Second Edition), (2019): 407-426.

3. Baiyu Zhang., *et al*. "Chapter 21: Marine Oil Spills—Oil Pollution, Sources and Effects". World Seas: an Environmental Evaluation (Second Edition), (2019): 391-406.

4. Jean Strelitz., *et al*. "Self-reported myocardial infarction and fatal coronary heart disease among oil spill workers and community members 5 years after Deepwater Horizon" *Environmental Research* 168 (2019): 70-79.

5. Danielle A Philibert., *et al*. "Field-collected crude oil, weathered oil and dispersants differentially affect the early life stages of freshwater and saltwater fishes". *Environmental Research* 168 (2019): 70-79.

6. Karina B Debs., *et al*. "Oil spill cleanup employing magnetite nanoparticles and yeast-based magnetic bionanocomposite". *Journal of Environmental Management* 230 (2019): 405-412.

7. Jintao Wang., *et al*. "A pair of MnO2 nanocrystal coatings with inverse wettability on metal meshes for efficient oil/water separation". *Separation and Purification Technology* 209 (2019): 119-127.

8. Si Ying Khew., *et al*. "Nanosecond laser ablation for enhanced adhesion of CuO nanowires on copper substrate and its application for oil-water separation". *Applied Surface Science* 465 (2019): 995-1002.

9. Zanru Guo., *et al*. "Macroporous monoliths with pH-induced switchable wettability for recyclable oil separation and recovery". *Journal of Colloid and Interface Science* 534 (2019): 183-194.

Volume 2 Issue 9 September 2019