

Sources, Dangers and Treatments of Oily Soil Pollutants in Iraq

Ghazi M. Mutter¹, Aqeel R. Lamy^{1,*}

¹Department of Environmental Engineering, Collage of Engineering, Al-Mustansiriah University, Baghdad, IRAQ.

Abstract: Oil pollution presents significant risks to living organism and human health because it can alter the ecosystem in rivers, seas, oceans, and pollutes air and soil. Oil, for example, can even reduce the efficiency of drinking water plants. Iraq suffers a lot from oil pollution as a result of wars that not only damage the oil infrastructures but also cause loss of thousand hectare of agriculture lands. In addition, oil pollution become primary factor that contribute to the electricity, fuel shortage and traffic jam problems. Oil pollution can be easily found in many parts of Iraq, even in main streets, houses and gardens due to the residents mismanagement and misuse of oily products. Therefore, the aim of this paper is to focus in detail about the sources and dangers of oil pollution on the environment and soil, as well as to provide some suggestions and measurements that can help in limiting the impact of oil pollution in Iraq.

Keywords: Oil pollution, soil pollution, Iraq

1. Introduction

Oil is one of the most important energy sources currently used in the world. Oil is composed of carbon (83-87%), hydrogen (10-14%), sulfur (0.1-3%), oxygen (1.5%) and nitrogen (0.1%) in addition to heavy metals such as vanadium, mercury, cadmium, nickel and others with smaller quantities [1,2,3]. The high demand for oil lead to increase oil explorations by petrochemical companies, whether in land area or sea. This is also increase traffic transfer from places of production to places of consumption and manufacturing [4]. Many activities related to the oil have contributed serious problems, particularly oil pollutants on environmental and soil. There are two types of oil pollutant that have been identified; the crude oil and industrial oil. Crude oil is a complex mixture of hydrocarbons associated with other organic materials in small quantities and non hydrocarbons which include compounds containing oxygen, sulfur, nitrogen and small amounts of minerals of about 5% [5]. Meanwhile, oil pollutants that occur from the industry is due to oil products, basically consist of neutral liquids hydrocarbons and non-polarized with high viscosity and density than water [2,3,6,7].

2. Environmental Impacts of Oil and Its Products on the Soil

Oil pollutants on the ecosystem through pollution of soil and water are the result of spillage. It is then spread in the air and return to the land and water again. According to Wentz [4] and Kiely [8], some of the materials that compose oil can be considered as a hazardous materials to the environment. Consequently, all

materials that produce from the oil consumption can be classified as a hazardous waste on health and the environment. However, the influence of oil on the soil can be classified in three categories: (i) biological effect, (ii) effect of agricultural production and (iii) the effect of oil pollutant on soil engineering properties.

2.1 Biological effect

The real danger of oil mostly refer to its toxicity and compounds that do not degrade or chemically breaks up easily. Some of them are transferred in the food chain and accumulates in living organisms while others are very complicated and not easily transmitted and have low toxicity. However, the presence of oil on the surface affects the germination and water absorption by plant.

There are a large number of chemical compounds used in the petroleum industry such as the additives in the drilling process, improvement the oil and that used in the removal of fat and deadly lichens, fungi and so on. Their movement direction must be traced because most of compound have harmful effects and negative impact on the environment, especially on agricultural production. Crude oil and the accompanying materials contain large amounts of salt, such as sodium chloride and calcium chloride in addition to the materials that are added during drilling operations. These salts can contaminate the soil as a result of leakage or broken pipelines. The clay waste resulting from drilling operations can pollute the environmental when contain heavy metals. These metals are not easily decomposed by nature and can transport to a long distances by water. Most of these heavy metals are harmful to humans through drinking water or food, and their effect can be a cumulative and toxic [1,2,8].

2.2 Effect on the soil properties related to agricultural production

In addition to the toxic of the hydrocarbon components, the effects of the hydrocarbons on soil properties and plant growth can be identified as [9,10]:

- i. Lack of oxygen in soil caused by high concentrations of hydrocarbon gases and CO₂, which affect biological processes of plant roots and microorganisms.
- ii. The heavy hydrocarbon blocks soil pores and consequently decreasing the permeability and water movement, and the difficulty in plant roots penetration.
- iii. Depredating soil structure and decreasing water holding capacity.
- iv. Decreasing nutrients that should be used by plants due to element competition and pH variation.

In Iraq, an experimental study was conducted on plates of clay soil that contaminated with kerosene and gas oil (5% contamination), refer Al-Azaawi [11]. The results showed that these two materials have adversely affected the production of yellow corn. It was found that the increasing of the production is related to the decomposition rate of the oil products, and the decreasing of the infiltration rate to the decreasing of the pollution concentration. Meanwhile, there were no variation in the pH and electrical conductivity of polluted soils.

2.3 Effect of oil pollutant on soil engineering properties

The Atterberg limits of clay soil test using hydrocarbons liquid instead of water show that soil may loss viscosity and behaves as a coarse soil. This happen as hydrocarbons liquids are neutralized, non-polarized and cannot contain clay particles (as water dose) [12,13,14]. When mixing the hydrocarbons liquid (low isolation rate) with clay soil, it cause shrinking of the double layer that contain soil particles and reduce their flocculation, consequently reduce the speed of settlement. In case of compaction using organic hydrocarbons liquids, it was found that the permeability is directly proportional to the isolation rate, because of the variation of the double layer thickness that contain the particles of the soil [13]. In Iraq, Nashat and Dalaly [15] have conducted an experiment to study the influence of some oil products on the engineering properties on clay and silt soil. The results show a negative effect on soil as can be seen in Table 1.

Table 1 Effect of the Kerosene and gasoline on soil properties [15].

Liq. Type	Liq. Limit (%)	Plas. Limit (%)	Plas. Index (%)	Void Ratio	Comp. (kN/m ²)
Water	92	41	51	0.78	284
Kerosene	119.5	42.8	76.7	0.82	33
Gasoline	114.2	40.8	73.4	0.88	450

Note: Liq.=Liquid, Pls.=Plastic/Plasticity, Comp.=Compressibility.

3. Oil Pollutants Impact on the Soil Properties

In order to understand the oil impact on the soil properties, a simple laboratory experiment was performed to study the effect of mixing used motor oil (10%) with clay soil. The mixture then burned in a furnace at a temperature of 700-800 °C, simulating burning as one of the methods used in the treatment of oil-contaminated soils. The results as shown in Table (2) match with the experiments results conducted by Al-Azaawi [11], and Nashat and Dalaly [15]. It was found that the used oil increase the Atterberg limits for both mixed soils and burned soils. Thus, oil has a negative impact on the soil properties which may affect the plant production.

Table 2 The impact of motor used oil on the soil properties before and after burning.

A - Effect of used motor oil on some soil properties related to agricultural production			
Characteristic	Uncontaminated soil	Contaminated soil with used oil	
		Before burning	After burning
Organic matter (%)	1.28	10.48	0.8
Bulk density (kg/m ³)	1.41	1.47	1.43
Porosity (%)	42.8	45.4	41.5
Infiltration rate (cm/hr)	7.3	0.9	3.1
Electrical conductivity (mmohs/cm)	2.1	2.6	2.4
pH	7.6	7.9	7.8
B - Effect of used motor oil on some characteristics of the soil			
Permeability (cm/hr)	1.25	0.14	0.65
Liquid limit (%)	57.5	61.2	56.8
Plasticity limit (%)	29	30.4	28.7
Coefficient of plasticity (%)	28.5	30.8	28.1
Void ratio	0.75	0.83	0.71

3.1 Kuwait war, 1991

The Kuwait war in 1991 was considered as an environmental disaster on Iraq and Gulf region. The war led to burn and leakage thousands of tons of oil and its products to the Iraqi environment (Table 3). It was found that as a result of the Kuwait war, air pollution is the most effected , followed by contamination of soil and water [7]. Soil tests that were conducted by Jubouri [16] at various depths revealed higher concentrations of hydrocarbons (up to 20%) in the surrounding areas near

oil facilities. The pollutants spread to a radius of about 7 km, but there is no proof of ground water contamination [16]. Due to the improper and lack of maintenance of treatments units, oil pollution also has extended effects on the Iraqi rivers. The pollutants concentration that discharged to rivers were 89 mg/l of crude oil, 1.4 mg/l Ammonia and 460 mg/l of COD [7].

Table 3 Quantities of burned spilled oil and as a result of war in Kuwait [7].

Oil Material	Quantity
Crude oil burned or leaked into neighboring lands form oil facilities	11,173,000 barrels
Crude oil from Burned tankers	3,400,000
Natural gas burned	2,266,289
Hydrogen sulfide	30,000,000
Oil products burned	1,378,982

During the post-war in Kuwait and in order to control the oil spills, the Ministry of Oil in Iraq (Department of Studies and Planning, 1993) has issued many measures, which, unfortunately, were not applicable because of the lack of physical effort and weak monitoring on the production and of the less awareness on the environment. The measures are:

- i. Urging all oil companies to fixed respective laboratories and oil facilities with sophisticated devices and installation of remote monitoring equipment, as well as portable devices and field pollution control equipment, such as boats and floating traps, tanks, etc.
- ii. Supplying the oil industry with technicians specialist in oil pollution combating and the arrangement of scientific seminars and courses for workers and support scientific researches related to the study the oil pollution.
- iii. In regard to reducing water pollution, the Iraqi ministry of oil has confirmed the necessity of recycling of industrial water contaminated with oil. The ministry received monthly reports from oil companies. All data of spillage, released products and the amount of water used are used for documentation, including for development a program to monitor any oil pollution and the treatment.
- iv. The ministry has confirmed that the economic return is not the only consideration of oil projects and the environmental effect study for any project is the key in decisions making relating to the establishment or changing the location of oil project.
- v. The ministry has confirmed that the researchers must move from the theoretical field to the practical fields.

3.2 American war, 2003

After the last war in 2003 known as American war, a lot of environmental problems were emerged. The oil pollution become an important aspect in the Iraqi environment pollution due to the following reasons:

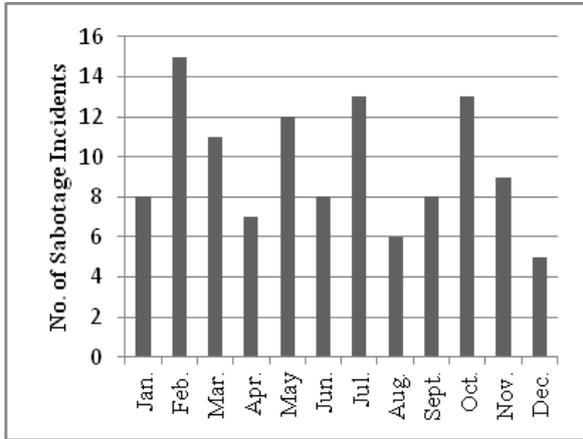
- a) Before and during the war:
 - i. In preparation to the war, the government installed fuel tanks under and over the ground near all governmental offices. Meanwhile, there are additional storage of the oil in small tanks by the people in houses and gardens.
 - ii. During the war, the government burned hundreds of tons (about 540 m³ per day) of black oil to mislead the enemy air forces.
 - iii. The pipelines, oil facilities, and fuel storage tanks were targeted approximately 160 times and led to the burning of more than 63,000 m³ of crude oil, 2.5 million units of gas and more than 82,000 m³ of other petroleum products.
 - iv. The ground war, near the city of Umm Qasr, which is an important oil port.
- b) After the war:
 - i. The continuing destruction of oil infrastructure and, oil and gas pipelines by some armed groups to disrupt the development of Iraqi oil exports. The quantities of crude oil leaked as a resultant of sabotage of the pipelines is shown in Fig. 1.
 - ii. Oil smuggling and the accompanying waste during loading and transport, etc.
 - iii. Damage and malfunction of most of the fuel pumps at filling stations which increases waste and pollution.
 - iv. Fuel crises that prompted the government to use road transport tanks. Therefore, citizens and hawkers use of unsealed containers which cause some spillage.
 - v. Electric power crisis that encourage residents to acquire diesel and gasoline generators. These applications contribute to the pollution of the environment in one way or another.
 - vi. The increase number of imported used cars or old cars and traffic jams due to traffic systems malfunction that contribute to huge amount of oil pollutant.
 - vii. Existing auto-repair shops that use oil products near residential areas in uncontrolled way. However, the number of washing and lubrications shops in Iraq was 434 which don't have any environmental requirements .

3.3 Oil pollution in Shat Al-Arab

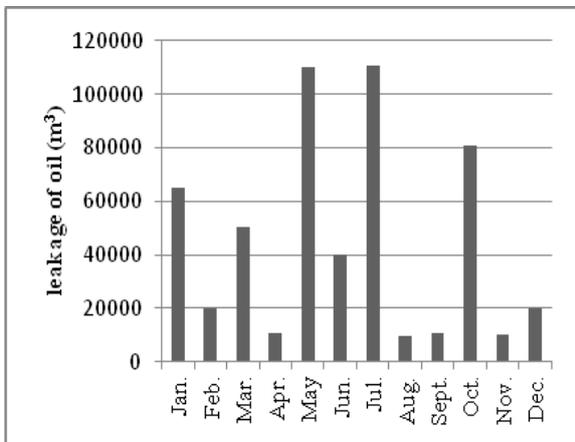
Oil pollution in Shat Al-Arab could be the result of the following activities:

- i. Leakage of large quantities of crude oil into the water from the pipeline and/or manual loading or due to negligence and lack of awareness
- ii. Oil uploading and downloading between ships and the port which held without the authority monitoring.
- iii. Cleaning and repairing of the ships and ports from remaining product after oil downloading that mostly without authority consent.
- iv. Pollution that happen from non-Iraqi marine that roam in Iraqi territorial waters because of poor monitoring, as well as the role of tidal phenomena that increase the spread of contamination.

- v. Lack of safety conditions for ships and ports, where some of about existing 180 sunk ships and boat ships that scattered around the water of Shatt al-Arab. In addition, the oil pollutant also occurs due to illegal activities of the throwing balancing water containing oil products to the water.



(a)



(b)

Fig. 1 Quantities of crude oil leaked as a resultant of sabotage of the pipelines in 2006: (a) number of sabotage incidents and (b) leakage of oil.

3.4 Soil pollution in Iraq with crude oil in 2006

The total amount of oil spilled is 565,149 m³ and the quantities of liquid and dry gas leaked were 3560 tons as a result of 113 sabotage accidents of the pipeline in 7 provinces. Most of the incidents were in Baghdad, Kirkuk, Salahuddin and Basra. On the other hand, fire accidents are perpetual in an average of 20 days during the year and mostly in January, August and September.

The contaminated soil with crude oil looks like black film (tar mat) or oil droplets splashing from the pipes that have been blown up. The percentages of hydrocarbon compounds in soil samples in light polluted soil were 0.02-0.08% and 0.49-13.2% in highly polluted soils. These percentages decreased with the depth of soil.

4. Conclusions

The risk of oil pollution was and still exists in all parts of the world, particularly in Iraq, as the country is rich with oil sources. In addition, the misfortunes of wars and few crises that still exist also contribute to the oil pollution of environment and soil. The oil and its products have a cumulative effect, whether direct and indirect on human health and other living beings. The oil and its products have an adversely affect on the ecological balance because of the large quantities of oil that can spread rapidly, which represents a summary of the cycle of oil pollutants in nature. The biological and agricultural characteristics of the soil also suffered damage and loss.

Therefore, Iraqi environmental authorities have to take intensive studies, researches and actions on the dangers oil pollution and provide efficient treatment. This could happen by using the international experience and the procedures approved by the Iraqi Oil Ministry. In the case of soil pollution with oil, there are many ways to treat the pollution using physical, chemical and biological methods. These methods have been successfully applied around the world and proven globally. It is also suggested the Iraqi government to invite international organizations to tackle and intervene the oil pollution. The international organizations are also able to help in solving the problems of rehabilitation of the oil facilities and fuel stations.

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