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Impact of the Oil Components on the Soil Properties in the Surrounding Sites of the North Oil Company in Kirkuk

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ABSTRACT

This survey includes a proven analysis of polluted soils with crude oil for four sites surrounded North Oil Company in Kirkuk as an attempt to study the extent of the contaminated soil with oil components and measuring the pollution quantities. The survey indicates that the four soil samples are contaminated with oil spills and contains a big proportion of salts in particular sulphur compounds. These results confirmed the effect of the oil spills and the contaminated water flow.

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INTRODUCTION

In Iraq, a large number of oil wells are distributed along of the country. Consequently, large quantities of oil spills into the soil cause soil pollution. Kirkuk oil field which located in Kirkuk city in the north of Iraq has exposed to a great contamination in the soil and a large quantity of crude oil was flowed therefore many thousand acres were polluted (Al-Janabi, 2008). It has been reported that Iraq produced about ((175 million metric ton)) from the crude oil in 1979 as the international production was (3084 million metric ton). While in 2005 the Iraqi production was (730 million barrel) as the international production was ((26645 million metric ton)) (Al-Janabi, 2008).

The environmental damage from petroleum hydrocarbons is quite serious, it has occurred naturally since ancient times, but in recent years man-made oil spills have become quite common. There are about ((14000)) flow cases arise every year to biosphere (Philips, 2003). This clarifies the danger affected from the presence of very large quantities of crude oil into biosphere. The repeated accidents influence the environmental characteristics and particularly on the life of organisms in the contaminated sites with oily compounds , the aromatic compounds like Benzene, Toluene, Ethyl benzene and Xylem which have a very poisoning properties (Nicholson & Fathepure, 2004) . Moreover, the contaminated soil with crude oil will become inappropriate for the human life and agriculture. In addition, a soil pollution may leads to a water pollution which is a dangerous problem threatens human health especially the countries that using a ground water as a drinking water (Lehmann, 1988).

The procedure start when oil spills on land, petroleum hydrocarbons infiltrate vertically down through the unsaturated soil until they reach the water table where they spread laterally. Rapid infiltration throughout the soil reduces the evaporative and photo degradative losses of the compounds (Konečný, 2003). In addition, the soil chemical and physical properties will be engaged to various exchanges when they contaminated by a crude oil depending on the biological activities inside the soil which includes the microorganisms and plant roots. For example, the high concentrations of unsaturated and aromatic compounds make the crude oil more poisoning because they penetrate inside the plant tissues and affect on seeds germination (Al-Janabi, 2008). Furthermore, the hydrophobic nature of petroleum hydrocarbons leads to surface absorption and retention on soil particles, minimizing the rate and extent of movement of these compounds (Konečný, 2003).

In aerobic soils, petroleum hydrocarbons are biodegraded by native microbes, especially under favourable temperature and moisture conditions , but in deeper layer because of lack of oxygen, nutrients, and favourable biota reduces the biodegradation of these compounds (Robertson, 2007) Crude oil is a mixture of different chemical compounds, it may hold dissolved gases , liquids , and bituminous solids , whereas , refined petroleum products are typically a mixture of defined chemical compounds. Therefore, for remediation spills from oil products, it is important to determine the chemical compounds involved.

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MATERIALS AND METHODS

Soils samples have been taken from four different contaminated areas within Oil Field in Kirkuk. These areas are ((Lagon, Industrial Baba, Bajwan and Oil Valley)). These samples were compared with a clean and less contaminated soil, (Figure 1) & (Table 1).

Several tests were carried out on the contaminated soil to determine the Total dissolved solids (T.D.S), pH, Gypsum, SO_3, SO_4 and Oil content. The same parameters where compared with an uncontaminated soil samples. The results are summarized in Tables 2 and Table 3.

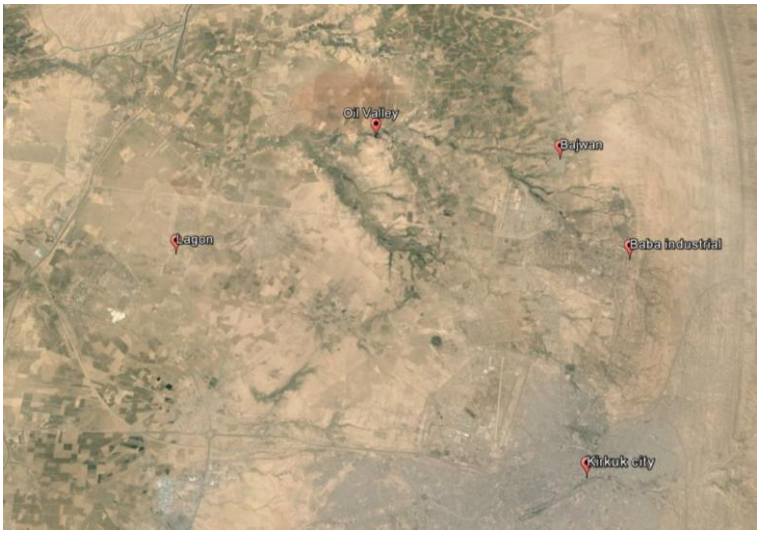

Fig. 1: Sampling areas around Kirkuk city.

Table 1: Study sites description.

No.	Site name	Area description
1.	Lagon	Pool water contaminated industrial oil
2.	Industrial Baba	Activity area industries and oil refineries
3.	Bajwan	Low for the accumulation of oil flowing from the broken oil pipeline & machines.
4.	Oil Valley	Basin to collect the waste oil sledgehammers & accumulated in the region through the discharge pipe leading to the North Oil Company Runs through agricultural land westwards.
5.	Clean Soil	Taken from agricultural fields located north-west of the oil company site

Before starting samples tests, there was two important steps had to be done. First step includes a study for the best locations to collect samples, where, samples have been taken from different locations by drawing rectangles on the ground to collecting the samples from their four angles and mixing them together after disregarding the upper level of the soil.

The second step, covers preparing the samples for the test. This process takes place by removing the unwanted impurities from the soils by sieving them then leaving the soils to dry under mediate temperatures to avoid spoiling them.

Samples Tests:

Determination of pH:

For a solution of a suspended soil, pH has been determined by using a slandered electrometric method. After leaving the samples to be dried in the air, they are crushed and sieved to 3.35 mm to prepare 30-35 g weight of the sample. 50 ml of distilled water was then added to the 20 g of the prepared sample to be left with stirring for overnight. Three readings for each of the five samples have been taken at 20^{o}C and the results are illustrated in the table 1.

Table 2. pH measurements of the five samples

	Sample	pH1	pH2	pH3	average
1	Bajwan	6.31	6.68	6.82	6.60
2	Lagon	7.04	7.01	7.07	7.04
3	industrial Baba	6.20	6.11	6.06	6.12
4	Oil valley	6.38	6.39	6.39	6.38
5	Clean soil	7.14	7.11	7.11	7.12

Determination of T.D.S:

Suspended solutions were prepared in a ratio of 1:10 of soil to water by mixing 5.0 g of each sample with water and leaving them with stirring for about 24 hours then they were left to precipitate for another 24 hours. The solutions were decanted carefully and then were filtered. 20ml of each sample were collected and were powered into clean, dry and previously weighted w_1 pans to be left in furnace of 110^{o}C. After making sure that all water evaporates, the pans weights were measured w_2.

$$\text{T.D.S ppm} = \frac{(W_2 - W_1) + 1000000}{20} \quad \text{..... (ASTM, D503 – 10)}$$

Determination of oil Ratio:

The determination of oil ratio has been carried out by evaporation methods. Different samples of soil have been dried for an hour then have been crushed. A 1L of distilled water was added to 100 g of each sample and was shacked for an hour before filtering by Buckner. Oil extracted from water by using solvent (chloroform) , then separating water and solvent by separating Funnel , the solvent layer filtered in to the glass dish through a funnel containing solvent moistened 1^P_S filter paper , the solvent with glass dish weighted to determine oil concentration (Alley , 2000) .

Determination of SO_3, SO_4 and Gypsum Ratios:

The five samples of the soils have been dried and crushed then sieved. 10 g of each sample was placed in clean and weighed pans to be set in a 70^{o}C furnace for 3-4 days. Then the pans were weighed again after cooling them. The process was returned by placing the samples in the furnace 90^{o}C, 105^{o}C and 150^{o}C. The samples have been left for two days in each time. The gypsum ratio in the soil samples were calculated by applying the following equation:

$$\text{Gypsum\%} = \frac{(Ws - W_f)}{(W_s - W_t)} 100 \left(\frac{100}{C} \right) \text{..... (ASTM, D503 – 10)}$$

The weight loss has been found depending on the weight of gypsum and the molecular weight of each of the SO_3 and SO_4.

Discussion:

Table 2: analysis of the contaminated soils.

	Samples	pH	T.D.S (ppm)	Gypsum ($CaSO_4.2H_2O$)	SO_3	SO_4	Oil (ppm)
1	Bajwan	6.60	1465	10.023	5.594	4.662	19
2	Lagon	7.04	2020	7.181	4.068	3.340	15
3	industrial Baba	6.12	1665	10.762	6.010	5.006	22.3
4	Oil valley	6.38	3265	16.150	9.014	7.512	30
5	Clean soil	7.12	170	3.190	1.788	1.484	0.1

The results of the research show oil pollution in the study areas. It has been observed the increasing of the oil pollution in Oil valley area (30 ppm) followed by the Baba Industrial (22 ppm) and lowest percent is reported in Lagoon (15 ppm). These results are so high compared with the uncontaminated soil samples taken from areas near the sampling site. The increase may be happen due to the fact that the area of Oil Valley are the basin to collect the waste oil sledgehammers and accumulated in the region through the discharge pipe leading to the North Oil Company (picture 2) with noting that the Industrial Baba area is a place of liquidation units.

Fig. 2: Different sites of Oil Valley

The results also shown an increase in the concentrations of $SO_3$and SO_4 in the Oil valley (9.01, 7.51) ppm respectively , followed by the Industrial Baba area (6.1, 5.0) ppm, Bajwan (5.59, 4.66) ppm and Lagoon (4.0, 3.33) ppm , compared to uncontaminated area where they found the proportion of sulfate (1.48, 1.78) ppm .

Table 3: Oil components tacked by the oil company laboratories (14 – 17 / 12 / 2013).

No.	Oil Component	Oil Pipe line	Oil well
1.	Hydrogen Sulphide ppm.	16.0	180
2.	Salt content ppm	-	Nil
3.	Sculpture % w.t	2.25	-
4.	Ash % w.t	0.007	0.005

Table 3 contains the oil contaminated study of Hydrogen Sulphide and free sulphur. The table show that the percent of these compounds when extracted from oil fields is 180 ppm, and in the pipeline 2.25 ppm after being processed by the pumped into the pipe. The accumulation of waste oil over time is increasing the proportion of polluted soil by Sulphur. On the other hand, it has been proven in the neighbouring areas of Kirkuk city the presence of acid rains and sediment accumulations resulting from the sulphur extraction plant south of Kirkuk (Edward and Charles, 1983).

The effects of them appeared clearly on the site soils and constructions. As a result of increasing the concentration of sulphur in the soil, pH value decrease too which make the soil more acidity (Taraf & others 2009). This research confirmed by the results the soils of the four areas have reached the highest degree of pollution.

On the other hand, Table 2 has shown a high T.D.S (Total dissolved solids) values. This is a measure of a combined content of all organic and inorganic substances contained in a liquid, which increased with increasing of the proportion of oil pollution in the study areas especially in Oil Valley (3265 ppm).

Other indication of pollution appear in Gypsum ratio ($CaSO_4.2H_2O$), it increase with increasing of oil pollutions in soils according to the equation that was described by (Al-Dusoqi, 2012).

$$X2SO_2 + 2Ca(OH)_2 \longrightarrow 2CaSO_3.\ 1/2\ H_2O + H_2O$$
$$X3H_2O + 2CaSO_3.1/2\ H_2O + O_2 \longrightarrow 2CaSO_4.2H_2O$$

Note that the Iraqi soils are calcareous soils in most regions (Adnan, 2011) These soils caused a problem in building construction especially, in the foundations that may lead to more treatments (Ministry of Science & Technology, 2012) .

Finally, from the comparison of the four regions results, we found that the area of Lagoon has showed the lowest rate of pollution and the reason is due to the fact that the source of pollution in the region is the contaminated water with waste oil and not contaminated by the oil directly, which was confirmed by (Eman, 2003).

From the comparison of the four soil samples with clean soil sample, it has been observed that the soil of Oil valley is the most contaminate one followed by the soil of Industrial Baba then the soils of Bajwan and Lagon. The results proved that the increasing of the soil pollution and increasing of the salts ratios and sulphur ratios in chosen soil samples are not naturally but they arise as consequences to the oil wastes and to the water flow in addition to the acid reins.

Recommendations:

It is highly recommended that this project should be studied by the oil company to make remediation and demanding to treat the contamination resources. In addition an attempt to peel these lands to remove the contaminated soil should be done. Also these areas can be exploited in reconstructions.

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