REPUBLIC OF TURKEY
YUZUNCU YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
CHEMICAL ENGINEERING DEPARTMENT

TOXIC MATERIALS THAT AFFECT PEOPLE ON OIL AND NATURAL GAS FIELDS AT ERBIL-DOLLABAKRA REGION IN IRAQ

M.Sc. THESIS

PREPARED BY: Bayar Sabah MAJED
SUPERVISOR : Prof. Dr. Nahit AKTAŞ

VAN-2017

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ACCEPTANCE and APPROVAL PAGE

This thesis entitled "Toxic Materials that Affect People on Oil and Natural Gas Fields at Erbil-Dollabakra Region in Iraq" presented by Bayar Sabah Majed under supervision of Prof. Dr. Nahit AKTAŞ in the department of Chemical Engineering has been accepted as a M. Sc. thesis according to Legislations of Graduate Higher Education on 19/06/2017 with unanimity of the members of jury.

Chair: Prof. Dr. Nahit AKTAŞ Signature: N. Aktas

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This thesis has been approved by the committee of The Institute of Natural and Applied Science on 20/06/2017 with decision number 20/07/29-1

Signature

Prof.Dr. Suat SENSOY

Director of Institute

THESIS STATEMENT

All information presented in the thesis were obtained according to the ethical behaviors and academic rules frame. And also, all kinds of statement and source of information that does not belong to me in this work prepared in accordance with the rules of thesis were cited to the source of information absolutely.

Signature
Bayar Sabah MAJED

ABSTRACT

TOXIC MATERIALS THAT AFFECT PEOPLE ON OIL AND NATURAL GAS FIELDS AT ERBIL-DOLLABAKRA REGION IN IRAQ

Bayar Sabah MAJED
M.Sc.,Thesis Chemical Engineering Department
Supervisor: Prof. Dr. Nahit AKTAŞ
June 2017, 63 pages

In this research, we focus on the toxic material that's produced in oil plant process that make air and soil pollution which is heavy metals and H_2S gas. We take data from near pollution source in Erbil and Sulaimania city from soil and air, in soil measuring the concentration of heavy metals some of this heavy metals (NI, As, Cr, CO, Hg, Zn, Cd).

We take data in different distance (0.4, 4.0, 8.0) km with different depth 0-25 for heavy metals near Erbil city and near Sulaimania city after taking samples and preparing it we analysis sample by ICP-OES SPECTO.

Then this result that obtained from field we compared it with same standards us in Bergmann. W., (1992) also with WHO (world health organization) and FAW (Food and Agricultural Organization)

Also measuring the concentration of H_2S gas in Erbil city near non-standard refinery in different distance with stable temperature between 25-28.with wind direction for measures H_2S gas in Erbil city Then we take the results and compare with some standard refineries.

Keywords: FAW, Hydrogen sulfide gas, Heavy metals, Refinery, WHO.

ÖZET

IRAK'TAKİ ERBİL DOLLABAKRA MEVKİSİNDE YER ALAN PETROL VE DOĞALGAZ ALANLARINDA İNSANLARI ETKİLEYEN ZARARLI GAZLAR

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Tez Danışmanı: Prof. Dr. Nahit AKTAŞ
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Bu çalışmada petrol işleme tesislerindeki işlemler sırasında ortaya çıkan, havayı ve toprağı kirleten zehirli ürünler olan ağır metaller ve hidrojen sülfür araştırılmıştır. Erbil ve Süleymaniye şehirlerinde havadan ve topraktan alınan örnekler incelenmiştir. Toprakta özellikle bazı ağır metallerin (Ni, As, Cr, Co, Hg, Zn, Cd) yoğunlukları ölçülmüştür

Numuneler, Erbil ve Süleymaniye şehirlerine sırasıyla (0.4, 4, 8) kilometre uzaklıklardan ve 0 ile 25 santimetre arasında değişen farklı derinliklerden alınmıştır. Alınan bu numuneler hazırlanıp ICP-OES-SPECTRO cihazı ile incelenmiştir.

Ayrıca hidrojen sülfür gazı ölçümleri Erbil şehri yakınlarındaki standart dışı bir rafineriye rüzgar yönünde değişik uzaklıklardan sabit sıcaklıklarda (25-28 ^{0}C) yapılmış ve sonuçlar standart dâhilindeki diğer rafinerilere ait değerlerle karşılaştırılmıştır.

Son olarak, hangi ölçümlerin yüksek değerler olarak değerlendirilebileceğini anlamak için eldeki veriler standart değerler ile kıyaslanmıştır.

Anahtar kelimeler: Ayçiçeği, FAW, Hümik asit, Verim ve verim öğeleri, WHO.

PREFACE

First of all, I am grateful to the Almighty God for establishing me to complete this research (thesis). My sincere gratitude to my teacher and research supervisor (Prof. Dr. Nahit AKTAŞ) for the help, advice, guidance, provision and support he offers me during my two years of research study. My wife, I cannot adequately express how thankful I am for the hardships you have been going through in raising me up, and the support and advices you offering me is beyond the measures, and I am hugely indebted to you.

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2017
Bayar Sabah MAJED

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SYMBOLS AND ABBREVIATIONS

Some symbols and abbreviations used in this study are presented below, along with descriptions.

Symbols	**Descriptions**
Ni	Nickel
As	Arsenic
Cr	Chromium
Cd	Cadmium
Hg	Mercury
Co	Cobalt
Zn	Zinc
H_2S	hydrogen sulfide
ppm	Part per million
ppb	Part per billion
%	Percentage
ICP-OES	Inductively Coupled Plasma - Optical Emission Spectroscopy
WHO	World health organization
FAW	Food and Agricultural Organization
M	Meter
H_2S	Hydrogen Sulfide
SO_2	Sulfur dioxide
Km	Kilo meter
CO	Carbon monoxide
°C	Celsius
N	Latitude

1. INTRODUTION

In this research is determine the concentration of heavy metals in soil in two refineries in Erbil and Sulaimania city in north of Iraq and measuring the concentration of hydrogen sulfide in non-standard in Erbil city in operation and turned off, also measuring the concentration heavy metals we determine concentrations such as Ni, Zn, Cd, Co, As, Cr, Hg.

Tremendous contamination to the nature and its environments such as air, water and soil is caused by oil plants, petrochemicals and chemical industries (Ezejiofor et al., 2013). According to Saadoun et al., (2008), because of enormous numbers of oil refineries in Iraq, it is one of countries under the danger of chemical contamination. Regularly, Refineries in Iraq are positioned close mega cities or in several circumstances inside the cities. Consequently, inhabitants are either indirectly or directly at risk. In spite of taking precautions for impeding the expansion injurious contaminants in the atmosphere which the majority of them are poisonous, the discharge of contaminant unintentionally or intentionally has continuously been something unavoidable (Pezeshki et al., 2001).

The rapid urbanization and industrialization in many south-east Asian countries has resulted in increasing amounts of untreated industrial and domestic waste water, which is discharged into rivers and lakes. The waste water is a highly complex and nutrient rich water solution used by the farmers for irrigation of their fields. It contains various potentially toxic elements including several trace metals. A better understanding of the irrigation systems use, and the distribution of the metals across arable fields is essential in order to reduce the environmental and health risks associated with the use of waste water (Bjuhr, 2007).

The contamination of air is produced by man-made and natural origins. The chief man-made origins embrace power generators, vehicles and the manufacturing activities, which characterize the key origin of air contamination, commonly petroleum production activities utilizing an enormous quantity of consumable oil for instance petroleum refineries and power plants. This industry discharges poisonous gases and solid particles in magnitude higher in comparison to all the other industries because of the high proportion emission of fume. When these industries are presented in inside the boundary of the cities or urban areas, they will be more dangerous. Examples of this case in Iraq are the oil refineries of Erbil and Sulaimania. As the amount of the discharged contaminants from oil refineries were projected to be in millions of tons every year, this industry is considered as a significant origin of air and soil contamination (Afaj et al., 2008).

The adequate protection and restoration of soil ecosystems contaminated by heavy metals require their characterization and remediation. Contemporary legislation respecting environmental protection and public health, at both national and international levels, are based on data that characterize chemical properties of environmental phenomena, especially those that reside in our food chain (wuana and okieimen, 2011).

Soil contamination is recognized as present or accumulation heavy metal in soil from natural and anthropological origins (industries). in the soil, the heavy metals comprises of Hg, Pb, Ni, As, Cr, Cd, Co, Fe, Mn, Zn, Sb, CU and Se. Several heavy metals are existed in urban and industrial regions and results in poisonous impacts to the soil and environment for instance Pb and other numerous elements (Tawfiq et al., 2015). Some possible sources for heavy metal pollution in the cities are factories and vehicle exhausts, powered generators (Hamdy et al., 2015). The crude oil from oil production processors, which is the main type of dangerous in petroleum industry, is another significant element in soil contamination (Saadoun, 2002). Additionally, oil by products is also hazardous to atmosphere (Mandal et al., 2012).

Carbon monoxide (CO), Sulfur-dioxide (SO_2), Carbon dioxide (CO_2), Nitrogen dioxide (NO_2), Hydrogen Sulfide (H_2S), Ammonia (NH_3), Dust, Ozone (O_3), Particulate Matter (PM1 – PM10) and Peroxya cetylnitrate (PAN) are the common constituents that contaminate the environments. Anthropogenic and natural sources ranging from bush fires to vehicular exhaust discharge as well as big scale industrial activities like power plants and gas flaring are recognized to be the main sources of the pollutant substances that discharged into the environment. As a consequence, urban structures, human health, flona, flora, hydrosphere and the fertility of soil are negatively affected (Narayanan, 2011 ; Weli and Ayode, 2014 ; Weli,2014 ; Okoroafor and Ikebude, 2015 ; FMEnv, 2015). It has to be mentioned that the concerns on quality of air and atmospheric contamination is not novel (Gobo et al., 2012). Even though, till lately, the considerable attention was focused on the developed regions, currently

Researches have revealed that developing regions encounter similar dilemma (Fenger, 2009 ; Ede and Edokpa, 2015).

This study was carried to estimate and analyze the levels of contamination in the air and soil the region in and around the refineries. The study utilized gas analyzer instrument for measuring the proportion of contaminant gases. In addition, atomic method isolation, anemometer, GPS were also employed. Furthermore, samples of glasses were utilized for determining the level of some heavy metals like Cadmium and Magnesium.

1.1. Nature and sources of data

Necessary data for this investigation ought to comprise some soil, air quality parameters like hydrogen sulfide (H_2S), Hg, Ni, As, Cr, Cd, Co and Zn. In addition some climatic condition like wind speed and direction, temperature and relative humidity ought to be included. These parameters ought to be recorded through the various land areas such as industrial, residential, recreational, commercial, institutional, and agricultural landfills.

Primary and secondary sources data ought to be included. Primary data should be acquired via recording the air of quality criteria contaminants directly on the field by appropriate air quality measurement apparatuses. However, present literatures like books and journals are utilized for obtaining the Secondary data. Furthermore, for the comparison, discharge limits given by WHO and present meteorological information on climate were utilized.

1.2. Scope of the study

The investigation focuses on differences in quality of air and soil through the various land uses in Sulaimania and Erbil metropolis and on its neighborhoods. It also examines the level of the subsequent air, soil quality parameters like hydrogen sulfide H_2S and several heavy metals**.**

1.2.1. Air quality

The state of air around us can be indicates as air quality. Clear, clean and uncontaminated air is referred to as a good air quality. For sustaining the gentle balance of life on earth and its whole ecosystems clean air is vital. Bad air quality demonstrated the existence of contaminants in the environment elevated enough level that threatens the human health, vegetation, wildlife, water bodies and the whole atmosphere via altering and dislocating the structure of natural elements of the air such as Nitrogen 78.00%, Oxygen 21.00%, Argon 0.03%, Carbon-dioxide 0.3% and water 0-4% (Kaushik and Kaushik, 2008 and Narayanan, 2011).

1.2.2. Normal soil suality

Naturally, heavy metals are existed in soil.Nevertheless, pollution originates from indigenous origins such as agriculture, manufactory, waste incineration, fossil fuels combustion and road traffic (Asgari, 2011; Suciu et al., 2008). Theoretically, every tone standard soil comprises 0.2 kg of Chromium, 0.08 kg Nickel, 0.16 kg of Lead, 0.0005 kg of Mercury and 0.0002 kg of Cadmium. Therefore, assigning a certain source for the increase of content of heavy metals is highly complicated. The gravity (density) of heavy metals is normally surpassing 5g/cm3. The existence of some levels of heavy metals is regarded vital for the survival of all forms of life. These heavy metals are defined as essential trace elements. On the other hand, when they are existed beyond the standard concentration, they are considered contaminants. In this case, heavy metals pose a great potential danger to ecological environment. This is because these cannot be biodegraded as they are discharged into environment (Li et al., 2010).

2. LITERATURE REVIEW

In soils of North of Iraq, the level of some heavy metals were discovered to be (196.74, 107.13, 136.12, 27.14, 5.80, 0.78, 19.66) ppm, for Ni, Zn, Cd, Co, As,Cr, and Hg correspondingly. The contents of heavy metal in soil samples altered by the positions of sampling for example (0.4, 4 and 8) km far away from the contamination origin resulted in the decrease in the content of these heavy metals in the soil. It was observed that average amount of Ni, Cd and Hg were greater compared to tolerable amount, reported by Bergmann, (1992), and (W.H.O and FAW) of such components as (50, 3, 2) ppm correspondingly. In addition, because of the locations soil sampling, the content of heavy metals demonstrated the variation Ni, As, Cd, Cr, Hg, Co and Zn. numerous sources like anthropogenic and natural have affected the level of heavy metal in every location (Bergmann, 1992).

Normally, while the distances from the sources of pollution escalated, the content of all heavy metal were reduced.

Schroder et al. (2000) studied the impact of petrochemical waste on the content of heavy metals. The investigation stated that petrochemical waste resulted in the pollution of soils by some heavy metals like Cd, Cr, Ni, and Zn. The study found that Cd, Ni, Hg discharged to the ecosystem particularly via petroleum industry, fossil fuels combustion, mining, metal refining.

Coyne (1999) expressed that heavy metals and petroleum hydrocarbons impacts soil and the ecosystem. In addition, it also declared that sufficient quantities of substances could result in momentous losses in the quality of soil. Furthermore, microorganisms, which are responsible on catalyzing biological procedures in the soil, are adversely impacted by the content of heavy metals and petroleum hydrocarbons pollution.

Alloway and Ayres, (1994) and Ogoke (1996) also demonstrated that the development of Nigerian petroleum industry and the marketing of petroleum products resulted in soil contamination via oil spills including leakages, blow-outs and discarding of petroleum waste.

Khwedim (2013) indicated that the contamination of soil by heavy metals might be affected via severe industrial activities which gather huge amounts of contaminants in the soil of North of Iraq.

Saadoun (2002) Mandal et al. (2012) demonstrated that crude oil processing and its product are significant factors in polluting soil and environment. In addition, they also the wastes of petroleum industry are the chief hazardous element to the environment and the soil. In this examination, the determined quantities of heavy metals might result in to worsening the quality of soil. The escalation of concentration of these substances in soils might also result in the escalation of the amount of these pollutants in surface and ground waters. Thus, the escalation of concentration of heavy metals in metal industry and oil production disposal or waste has to be taken into consideration.

This experiment carried out during 2013 at Basra City, Southern Iraq. Air pollutant concentrations were measured by using the portable detection instrument Dragger CMS. The measured air pollutants were CO, CO_2, NO_2, NOx, SO_2, HCs, and H_2S. The selected emission sources divided into a variety of stationary and mobile sources. The obtained results indicated that mean concentrations for CO, CO_2, NO_2, NOx, SO_2, HCs, and H_2S were ≥ 150, $2426 \leq 0.5$, 12.6, 0.7, 42.0, and ≤ 0.2 ppm, respectively. Most of these concentrations exceeded the maximum permissible limits for National Emission Standards in Iraq. As well, some of the recorded emission concentrations at this experimental study are higher than those that at other studies which dealt with ambient air pollution, because effect of diffusion and dispersion on the ambient air pollutants (Al-Haseen et al., 2015).

2.1. Heavy metals

It is a kind of contaminant that has an excessive potential danger to the environment. When these metals are discharged into the environment, they are biodegraded (Li et al., 2010). Variety of health impacts are related to metals. In an animal experiment, it was found that severe poisonous impacts on different organs like liver, kidney, pancreas, and lung (by inhalation) was produced by cadmium. Furthermore, chrome ulcers, acute irrelative dermatitis, corrosive reactions on the nasal septum and allergic eczematous dermatitis observed among subjects who have been exposed to chromium (VI) compounds. Also, the poisonousness of lead could be mainly illustrated by its intrusion with various enzyme systems. Additionally, the outcomes indicated that these enzymes are inactivated by lead via dislocating other essential metal ions or by combining to SH-groups of its proteins (Leili et al., 2008).

2.2. Nickel

It is a chemical transition component with a Ni symbol that has molecular weight of 58.69 and atomic number of 28. The metal is present in the formula of the nickel us ion, Ni (II) in low pH zones. It separates as nickel us hydroxide, Ni $(OH)_2$, which is a constant composite in neutral to marginally alkaline solutions. However, in highly alkaline conditions, this precipitate willingly melts in acid solutions to form nick elite ion Ni (III), $HNiO_2$ which is water soluble. This substance is present in form of the constant nickelo-nickelic oxide, Ni_3O_4, which is soluble in acid solutions, in highly alkaline and oxidizing circumstances. Nevertheless, nickel oxides components like nickelic oxide, Ni_2O_3, and nickel peroxide, NiO_2, are unbalanced in alkaline solutions and decay via releasing oxygen. Nonetheless, these solids melt producing Ni^{2+} in acidic zones.

This component is happened in the environment merely at extremely low concentration. Nickel is vital in tiny doses, however when the highest tolerable quantity is surpassed, it is hazardous. Nonetheless, Ni becomes higher moveable and frequently leaks down to the nearby groundwater. Because of the existence of Ni, microorganisms suffered from decline in the growth. However, after a while, they regularly develop resistance to Ni. This metal dose not amasses in animals or plants and consequently Ni has not been discovered to biomagnified up the food chain. Ni is an essential foodstuff in tiny quantities for animals.

2.3. Arsenic

It is period 4 in the periodic table, and it is a metalloid in group VA that happens in a widespread variety of minerals, mostly as As_2O_3. In addition, from processing of ores comprising mainly Cu, Pb, Zn, Ag and Au, arsenic metal can be recovered. In ashes from the combustion of coal, this compound is also present. Arsenic has atomic number 33, atomic mass 75, density 5.72 g cm^{-3}, melting point 817°C and boiling point 613°C. As it is present in numerous oxidation conditions (−III, 0, III and V), it displays fairly complicated chemistry. Frequently, As (V) is dominant in aerobic atmosphere, in the form of arsenate (AsO_4^{3-}) in different protonation states: H_3AsO_4, $H_2AsO_4^{-}$, $HAsO_4^{2-}$, and AsO_4^{3-}. When metal cations are existed the other forms of anionic arsenic perform as chelates and can precipitate. Merely under particular circumstances, metal arsenate complexes are stable. Below acidic and moderately decreasing situations, Arsenic (V) is also co precipitate with or adsorb onto iron oxy-hydroxides. Even though arsenic mobility escalated by increasing pH, Co precipitate are immobile under these circumstances. Below decreasing circumstances As (III) dominates, present as arsenate (AsO_3^{3-}), as well as its pronated configuration H_3AsO_3, $H_2AsO_3^{-}$, and $HAsO_3^{2-}$. It is can also precipitate with or adsorb metal sulfides as well as it has a high attraction for other sulfur mixtures. It does not create compounds with easy anions like Cl^{-} and SO_4^{2-} as arsenic is regularly existed in anionic configuration. Arsenic speciation also comprises organometallic configurations like dimethyl arsenic acid $(CH_3)_2AsO_2H$ and methyl arsenic acid (CH_3) AsO_2H_2. Numerous Arsenic complexes powerfully adsorb to soils, and therefore are only transferred over short spaces in surface and groundwater water. Skin impairment, augmented hazard of cancer and issues with circulatory system are related to Arsenic (Eriksson, 1997).

2.4. Zinc

It is a chemical transition metal with atomic number 30, period 4, atomic mass 65.4, group IIB, density 7.14 g cm^{-3}, melting point 419.5 °C and boiling point 906 °C. Naturally, Zinc happens in soil (about 70 mg kg^{-1} in crustal rocks).

Eriksson, (1997) nevertheless, unnaturally the concentrations of Zn are increasing because of anthropogenic activities. The majority of Zinc is supplemented throughout industrial activities, like coal mining, and combustion waste and the processing of steel. Certain level of Zinc contained in drinking water and several

Foodstuffs. Poisonous waste locations or industrial sources might result in the increase in the level of Zinc in drinking water to reach concentration that affect human and animal health. Zn is an essential trace element for the health of human being. Its deficiency might give the rise to birth imperfections. It might escalate the water acidity as well. When some kinds of fish live in Zn-polluted waterways, the collect Zinc in their bodies. Zn is capable of biomagnifying up the food chain; When It enters the bodies of these fish. Groundwater can be polluted by Water-soluble zinc which is situated in soil. Owing to the Zn accumulation in soils, plants regularly have an uptake of Zn that their systems cannot deal with. In conclusion, since Zn adversely impacts the microorganisms' activity and earthworms, it can interject the activity in soils. Therefore, it delays the organic matter decomposition.

2.5. Chromium

It belongs to the group VIB in the periodic table, and is chemical metal has melting point 1875 °C, atomic number 24, density 7.19 g cm^{-3}, atomic mass 52 and boiling point 2665 °C. Chromium is less general components and naturally does not happen in elemental configuration, nevertheless merely in mixtures. It is extracted as a major ore product in the configuration of the chromite minerals, $FeCr_2O_4$. The origins of Chromium-pollution comprise the discharges from the process of electroplating and the disposal of wastes containing Chromium. At polluted location, regularly Chromium (VI) is found. Relying on redox and pH circumstances, Chromium can also happen in the +III oxidation state. In shallow aquifers in which aerobic conditions is present, Chromium (VI) is the prevailing form of Cr. under anaerobic conditions regularly faced in deeper groundwater, Chromium(VI) is reduced to Cr(III) by organic matter in the soil, S^{2-} and Fe^{2+} ions. Chromate (CrO_4^{2-}) and dichromate are the main Cr (VI) species ($Cr_2O_7^{2-}$) which precipitate willingly in the existence of metal cations particularly Ba^{2+}, Pb^{2+}, and Ag^{+}. On soil surfaces, dichromate and Chromate are adsorbed, particularly aluminum oxides and iron. at low pH (lower than 4), Chromium (III) is the prevailing configuration of Cr. with NH_3, OH^-, Cl^-, F^-, CN^-, SO_4^{2-}, and soluble organic ligands, Cr^{3+} forms solution composites. The more poisonous and mobile form of chromium is

Chromium (VI). Because of the formation of Cr(OH)3(s), the mobility of Chromium (III) is declined by adsorption to clays and oxide minerals under pH 5 and low solubility above pH 5. As soil pH escalates, Cr (VI) leach ability surges. The majority of Cr discharged into natural waters is particle associated, nevertheless, and is eventually dumped into the sediment. In humans, Chromium is related to allergic dermatitis.

2.6. Mercury

Mercury, Zn and Cd all belong to the identical group of the periodic table. Mercury has atomic weight 200.6, melting point −13.6 °C, density 13.6 g cm^{-3}, atomic number 80 and boiling point 357°C. This metal is regularly recovered as a waste of ore processing. The main source of Hg pollution is the discharge of Hg from coal combustion. Discharges from manometers at pressure-calculating stations along the pipelines gas/oil participate in the Hg pollution as well. Hg commonly is present in mercuric (Hg^{2+}), mercuries ($Hg_2{}^{2+}$), elemental (Hg^o), or alkylated form (methyl/ethyl mercury) subsequent the discharge to the environment. The stable forms of Hg that will be present is determined by the redox potential and pH of the system. Under oxidizing circumstances, mercuries and mercuric mercury are more stable. Inorganic or organic Hg might be declined to elemental Hg, which might after that be altered to alkylated forms by abiotic or biotic processes, when mildly dropping existed conditions. Alkylated forms, which are soluble in water and volatile in air, are less poisonous than mercury. By different inorganic and organic ligands, mercury (II) produces powerful composites making it highly soluble in oxidized aquatic systems. For the abstraction of Hg from solution, sediments, sorption to soils and humid substances is a significant mechanism. As pH escalated Sorption escalated as well. The co-precipitation with sulfides might remove mercury from the solution.

2.7. Cadmium

It is sited at the finale of the second row of transition elements. Cadmium has atomic number of 48, density 8.65 g cm^{-3}, atomic weight 112.4, melting point 320.9 °C and boiling point 765 °C. Cd, Pb and Hg are the huge three heavy metal toxics that do not recognized for any necessary biological function. In the periodic table, cadmium is straightly under Zn. In addition, it has a chemical similarity to that of Zn. This might represent a part of poisonousness of Cadmium. As Zinc is a necessary trace element, its replacement by Cadmium might result in the faulty metabolic processes.

The accumulation of cadmium might resulted in itai itai (ouch ouch) disease. Painful osteomalacia (bone disease) united with the malfunction of kidney are the symptoms of cadmium poisoning. As a result of irrigated rice polluted from an upstream mine generating Pb, Cd and Zn, Cadmium poisoning in the Jintsu River Valley occurred. Long-lasting accumulation in the kidneys resulting in kidney dysfunction is the main threat to human health. The major paths by which Cd enters the body are food intake and tobacco smoking.

2.8. Cobalt

With symbol **Co** and atomic number 27. Like nickel, cobalt is found in the Earth's crust only in chemically combined form. Cobalt is a hard ferromagnetic, silver-white, hard, lustrous, brittle element. It is a member of group VIII of the periodic table. Like iron, it can be magnetized. It is similar to iron and nickel in its physical properties. The element is active chemically, forming many compounds. Cobalt is stable in air and unaffected by water, but is slowly attacked by dilute acids.

Most of the Earth's cobalt is in its core. Cobalt is of relatively low abundance in the Earth's crust and in natural waters, from which it is precipitated as the highly insoluble, cobalt. Although the average level of cobalt in soils is 8 ppm, there are soils with as little as 0.1 ppm and others with as much as 70 ppm. In the marine environment cobalt is needed by blue-green algae (cyanobacteria) and other nitrogen fixing organisms. Cobalt is not found as a free metal and is generally found in the form of ores. Cobalt is usually not mined alone, and tends to be produced as a by-product of nickel and copper mining activities. The main ores of cobalt are cobaltite, erythrite, glaucodot, and skutterudite. The world's major producers of cobalt are the Democratic

Republic of the Congo, mainland China, Zambia, Russia and Australia. It is also found in Finland, Azerbaijan, and, Kazakhstan. World production is 17.000 tons per year.

As cobalt is widely dispersed in the environment humans may be exposed to it by breathing air, drinking water and eating food that contains cobalt. Skin contact with soil or water that contains cobalt may also enhance exposure.

2.9. Remediation of heavy metal in contaminated soils

Soils may become contaminated by the accumulation of heavy metals and metalloids through emissions from the rapidly expanding industrial areas, mine tailings, disposal of high metal wastes, leaded gasoline and paints, land application of fertilizers, animal manures, sewage sludge, pesticides, wastewater irrigation, coal combustion residues, The overall objective of any soil remediation approach is to create a final solution that is protective of human health and the environment Martin, T. A., and Ruby, M. V. 2004. For heavy metal-contaminated soils, the physical and chemical form of the heavy metal contaminant in soil strongly influences the selection of the appropriate remediation treatment approach. Information about the physical characteristics of the site and the type and level of contamination at the site must be obtained to enable accurate assessment of site contamination and remedial alternatives. The contamination in the soil should be Immobilization, soil washing, and phytoremediation techniques are frequently listed among the best demonstrated available technologies (BDATs) for remediation of heavy metal-contaminated sites characterized to establish the type, amount, and distribution of heavy metals in the soil.

2.9.1. Immobilization techniques

Immobilization techniques are practical approaches to remediation of metal-contaminated soils. This technique is applied in areas where highly contaminated soil must be removed from its place of origin, and its storage is connected with a high ecological risk (e.g., in the case of radio nuclides).

Immobilization technology often uses organic and inorganic amendment to accelerate the attenuation of metal mobility and toxicity in soils.

2.9.1.1. Solidification/Stabilization (S/S)

Solidification involves the addition of binding agents to a contaminated material to impart physical/dimensional stability to contain contaminants in a solid product and reduce access by external agents through a combination of chemical reaction, involves the addition of reagents to the contaminated soil to produce more chemically stable constituents. S/S is an established remediation technology for contaminated soils and treatment technology for hazardous wastes in many countries in the world (Evanko, C. R., and Dzombak, D. A. 1997). S/S treatment processes involves mixing or injecting treatment agents to the contaminated soils. Inorganic binders, such as clay (betonies and kaolinite), cement, fly ash, blast furnace slag, calcium carbonate, Fe/Mn oxides, charcoal, zeolite, and organic stabilizers (Fawzy, E. M. 2008). Such as bitumen, composts, and manures, or a combination of organic-inorganic amendments may be used. The dominant mechanism by which metals are immobilized is by precipitation of hydroxides within the solid matrix (Perkins, et, al. 2010).

2.9.1.2. Verification

The mobility of metal contaminants can be decreased by high-temperature treatment of the contaminated area that results in the formation of vitreous material, usually an oxide solid. During this process, the increased temperature may also volatilize and/or destroy organic contaminants or volatile metal species (such as Hg) that must be collected for treatment or disposal. Most soils can be treated by verification.

2.9.2. Soil washing

Soil washing is essentially a volume reduction/waste minimization treatment process. It is done on the excavated (physically removed). These techniques are physical and/or chemical procedures to extract metal contaminants from soils.

2.9.2.1. Principles of soil washing

Soil washing is a volume reduction/waste minimization treatment technology based on physical and/or chemical processes. With physical soil washing, differences between particle grain size, settling velocity, specific gravity, surface chemical behavior, and rarely magnetic properties are used to separate those particles which host the majority of the contamination from the bulk which are contaminant-depleted. The equipment used is standard mineral processing equipment, which is more generally used in the mining industry. Mineral processing techniques as applied to soil remediation have been reviewed in literature (Gosselin, et al., 1999).

With chemical soil washing, soil particles are cleaned by selectively transferring the contaminants on the soil into solution. Since heavy metals are sparingly soluble and occur predominantly in a sorbet state, washing the soils with water alone would be expected to remove too low an amount of cations in the leachates, chemical agents have to be added to the washing water. This is achieved by mixing the soil with aqueous solutions of acids, alkalis, complex ants, other solvents, and surfactants. The resulting cleaned particles are then separated from the resulting aqueous solution. This solution is then treated to remove the contaminants (e.g., by sorption on activated carbon or ion exchange) (Dermont, et al., 2008).

2.9.2.2. Chemical extractants for soil washing

Chemical extract ants for Soil Washing extracting solutions that can optimally remove them must be carefully sought during soil washing. Several classes of chemicals used for soil washing include surfactants, co-solvents, cyclodextrins, chelating agents, and organic acids.

All these soil washing extract ants have been developed on a case-by-case basis depending on the contaminant type at a particular site. A few studies have indicated that the solubilization/exchange/extraction of heavy metals by washing solutions differs considerably for different soil types. Strong acids attack and degrade the soil crystalline structure at extended contact times.

Natural, low-molecular-weight organic acids (LMWOAs) including oxalic, citric, formic, acetic, malic, succinic, malonic, maleic, lactic, aconitic, and fumaric acids are natural products of root exudates.

2.9.3. Phytoremediation

Phytoremediation also called green remediation, botanoremediation, agro remediation, or vegetative remediation, can be defined as an in situ remediation strategy that uses vegetation and associated micro biota, soil amendments, and agronomic techniques to remove, contain, or render environmental contaminants harmless (Cunningham, S. D., and Ow, D.,1996 ; Helmisaari, H. S et al., 2007). The idea of using metal-accumulating plants to remove heavy metals and other compounds was first introduced in 1983.

However, it has been tested successfully in many places around the world for many different contaminants. Phytoremediation is energy efficient, aesthetically pleasing method of remediating sites with low-to-moderate levels of contamination, and it can be used in conjunction with other more traditional remedial methods as a finishing step to the remedial process.

2.9.3.1. Phytoextraction (phytoaccumulation)

Phytoextraction is the name given to the process where plant roots uptake metal contaminants from the soil and translocate them to their above soil tissues. A plant used for phytoremediation needs to be heavy-metal tolerant, grow rapidly with a high biomass yield per hectare, have high metal-accumulating ability in the foliar parts, have a profuse root system, and a high bioaccumulation factor (Chaney, 1997). Phytoextraction is, no doubt, a publicly appealing (green) remediation technology.

2.9.3.2. Phytostabilization

Phytostabilization, also referred to as in-place inactivation, is primarily concerned with the use of certain plants to immobilize soil sediment and sludge's. Contaminant are absorbed and accumulated by roots, adsorbed onto the roots, or precipitated in the rhizosphere. This reduces or even prevents the mobility of the contaminants preventing migration into the groundwater or air and also reduces the bioavailability of the contaminant thus preventing spread through the food chain. Plants for use in Phytostabilization should be able to (i) decrease the amount of water percolating through the soil matrix, which may result in the formation of a hazardous leachate, (ii) act as barrier to prevent direct contact with the contaminated soil, and (iii) prevent soil erosion and the distribution of the toxic metal to other areas(Raskin, and Ensley, 2000).

2.9.3.3. Phytofiltration

Phytofiltration is the use of plant roots (rhizofiltration) or seedlings (blastofiltration), is similar in concept to Phytoextraction, but is used to absorb or adsorb pollutants, mainly metals, from groundwater and aqueous-waste streams rather than the remediation of polluted soils (Garbisu, and Alkorta, 2001) .

Plants are hydroponically grown in clean water rather than soil, until a large root system has developed. Once a large root system is in place, the water supply is substituted for a polluted water supply to acclimatize the plant. After the plants become acclimatized, they are planted in the polluted area where the roots uptake the polluted water and the contaminants along with it. As the roots become saturated, they are harvested and disposed of safely.

2.10. Hydrogen sulfide (H_2S)

The naturally occurring Hydrogen sulfide (H_2S) is colorless gas with a foul odor such as rotten eggs. The H_2S is regularly generated as sulfurous composites in organic substance, like manure, are decayed via bacteria in anaerobic (without oxygen) environments. In addition, hydrogen sulfide is present in groundwater, natural gas, as well as volcanic gases. Gas and oil operations, Sour crude oil refineries, pulp and paper mills, animal breading and sewage treatment plants are common artificial sources of hydrogen sulfide.

The H_2S is a tremendously irritating and poisonous gas. For protecting workers from lethal exposures, initial detection and recognition of gas is critical. Workers working in regions that have the probability to encompass H_2S ought to learn to identify the symptoms and signs of exposure to hydrogen sulfide. In confined areas, instrumentation has to be present for continuously monitoring the atmosphere for oxygen deficiencies, hydrogen sulfide and other gases.

OSHA has regulated hydrogen sulfide tolerable exposure limit of 20 ppm. Furthermore, highest exposure hydrogen sulfide limit of 50 ppm for less than 10 minutes was identified. Breathing the level of (500 to 1000) ppm will result in unconsciousness rapidly and death via the paralysis of respiratory system and suffocation.

Table 2.1. Effects of Air Pollutants from Al-Dura refinery in the Surrounding Area South Baghdad (Rasheed et al., 2016).

Site	Season		Mean ± SE
	1	2	
	December 2014	March 2015	
Control	0.42 ± 0.007	0.35 ± 0.004	0.385 ± 0.015 C
1 (0.5 Km distance)	0.991 ± 0.036	0.950 ± 0.172	0.97 ± 0.009 B
2 (1 Km distance)	1.045 ± 0.110	1.028 ± 0.089	1.036 ± 0.004 B
3 (2 Km distance)	1.153 ± 0.083	1.141 ± 0.066	1.147 ± 0.002 A
Mean ± SE	0.902 ± 0.08 A	0.867 ± 0.09 A	

Concentrations of H_2S (ppm) (Mean ± SE) in the air of study sites for the two seasons. H_2S concentrations the results in table 2.1 show that there was no significant difference in the mean concentrations of H_2S between the two seasons. Whilst, they show significant differences in the concentrations of H_2S from all three sites when compared with the control site, the concentration of H_2S in site 3 was (1.147 ± 0.002) ppm, higher than all other sites. The higher interaction value with a significant difference was recorded during season 1 at site 3, while the lowest value was in season 2 at the control site. Noted that the H_2S did not have a limit for air quality because it’s a dangerous gas and it's not supposed to be existed in the ambient air (Lafta et al., 2014).

When Hydrogen sulfide is breathed or it comes in contact with the skin, eyes, nose or throat, can impact the body. In addition, hydrogen sulfide impacts the body when it is swallowed. Headache, dizziness and upset stomach can be resulted from breathing low level of Hydrogen sulfide. Loss of consciousness and death might be caused by the exposure to higher concentrations hydrogen sulfide.

2.11. Hydrogen Sulfide and Human Health

At elevated level, hydrogen sulfide is exceedingly poisonous. Via breathing of polluted air or ingestion of polluted water, exposure can occur. The exposure to low concentration over a long time can result in fatigue, headaches and eye irritation. The air inhalation of high concentration of H_2S might cause instant death. As H_2S is heavier compared to the air, it might amass in low-lying or enclosed spaces.

More than 80% of people have the ability to smell H_2S at levels between 0.5 to 30 ppbv (parts per billion by volume), in accordance to a federal database of information on hazardous substances, The level at which classic irritation symptoms starts to appear in more than 80 percent of the population is called the irritant threshold. This value starts at 25 parts per million by volume and is greatly beyond human detection levels.

Hydrogen sulfide at concentration more than 150 ppmv cannot be detected by human, as it disables the sense of smell via paralyzing the olfactory nerve. Several health impacts from hydrogen sulfide exposure, like the olfactory nerve damage, are possibly reversible. Nonetheless, the incapability to perceive odors, which called anosmia, the damage to the respiratory system and impairment to the brain or eyes is regularly long-lasting.

Lung damage, respiratory failure and unconsciousness can suddenly result from human exposure to elevated concentration about 100 ppmv. At extremely high concentrations, more than 800 ppmv, complete failure of the nervous-system and rapid death.

Moderate level between (1 to 10) ppmv of hydrogen sulfide exposure for Short-term will effect nausea, dizziness, breathing issues, eye, nose, and throat irritation, headaches, appetite loss, and sleeping disorder. Irritated breathing passages and pulmonary edema might be resulted from prolonged exposure to hydrogen sulfide (fluid buildup in the lungs). Individuals inhibiting nearby sources of hydrogen sulfide like paper mills, geothermal features, refineries and meat-packing plants have an escalated danger of cough, headache, eye irritation, nasal blockage, and impaired neurological function.

Long-lasting hydrogen sulfide exposure even to very low concentrations might give the rise to health impacts (Von Essen and Auvermann., 2005). Exposure to concentrations lower than the irritant threshold for a long time period might cause neuropsychological symptoms like such as depression, memory loss, anxiety, sleep disturbance, numbness, balance loss, and exhaustion, and physiological symptoms eye or respiratory irritation (Legator et al., 2001).

3. MATERIALS AND METHODS

In this research is detriment the concentration of heavy metal in soil near refinery in Erbil and Sulaimania city and also measuring the concentration of H_2S gas in Erbil nonstandard refinery.

3.1. Area of the study

This study was taken place in the two refineries located in Erbil city and Sulaimania city in northern Iraq showed in the maps below.

Figure 3.1. Location of refinery in Erbil city.

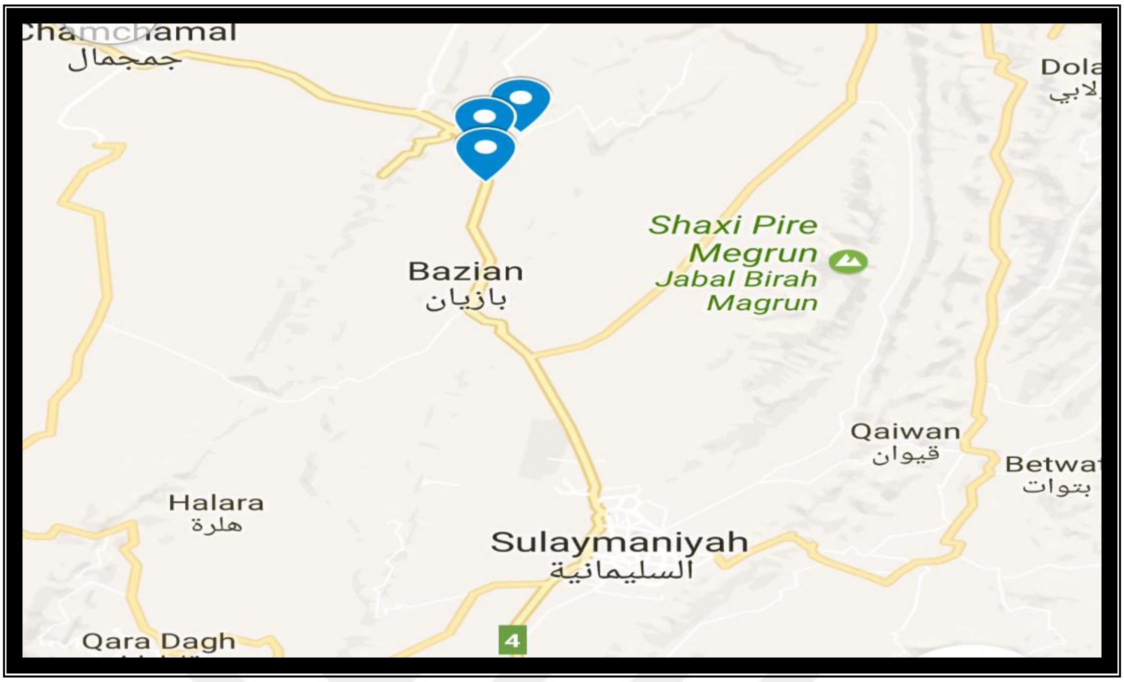

Figure 3.2. Location of the refinery in Sulaimania city.

The investigation conducted in three steps comprising sampling process at the field, soil analyses in the laboratory and data analyzed at office works. This study was carried out in the cities of Erbil and Sulaimania northern Iraq. As indicated in Figure3.1 and 3.2, Erbil positioned between (35°59′59.63″N and 43°54′23.71″E) and Sulaimania is between (35°40′52.06″N and 45°1′2.67 ″E).These positions are the origins of contamination. The data measurement on the H_2S include field measurement of the concentration of H_2S by ppm in Erbil city northern Iraq which located between (35°59′59.63″N and 43°54′23.71″E). In both cities the samples were taken from (0.4, 4, 8) km away from pollution sources as shown in figure 3.1 and 3.2.

Erbil:	0.4 km	36°0′19.20″N	and	43°54′35.13″E
	4 km	36°2′15.69″N	and	43°55′57.56″E
	8 km	36°4′19.26″N	and	43°56′46.19″E

Figure 3.3. Location of take data in Erbil city.

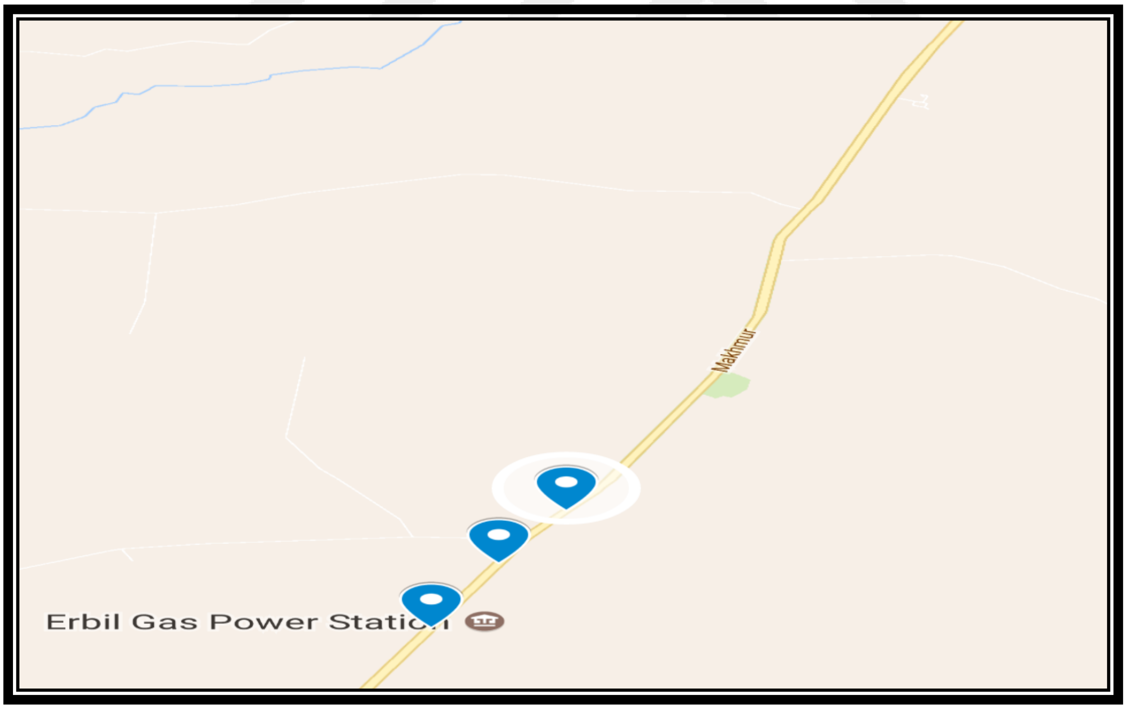

Figure 3.4. Three sites take soil sample in Erbil city.

Sulaimania:	0.4 km	35°40′31.57″N	and 45°1′14.21 ″E
	4 km	35°39′35.43″N	and 45°1′39.04″E
	8 km	35°38′38.16″N	and 45°1′37.97″E

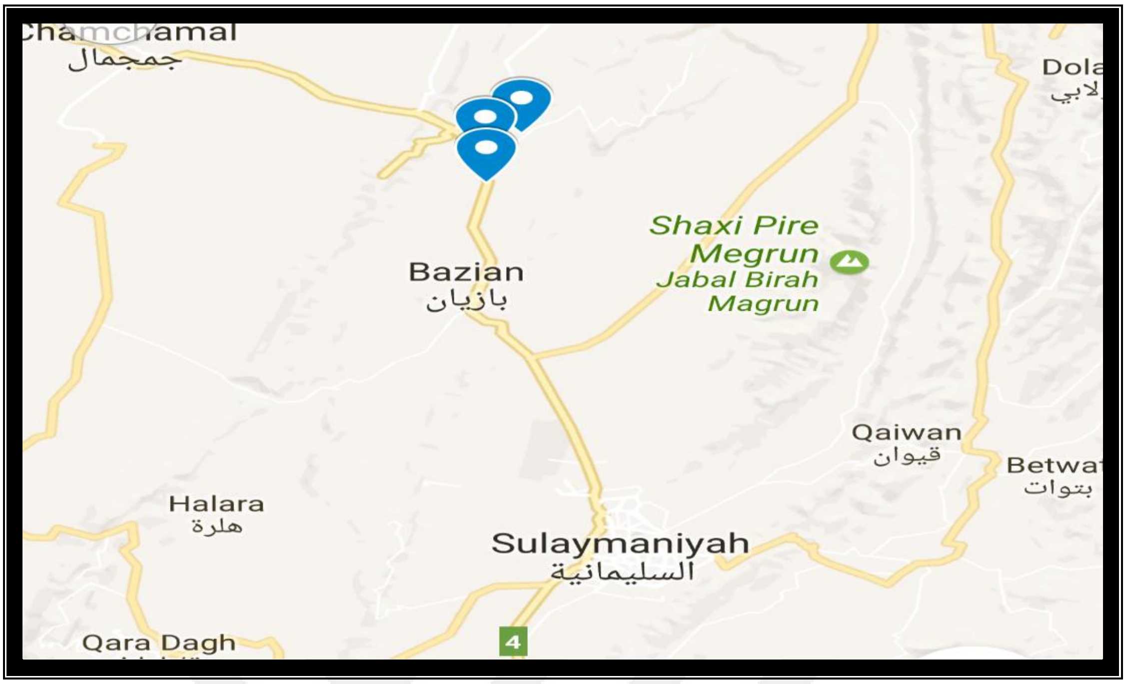

Figure 3.5. location of take data in Sulaimania city.

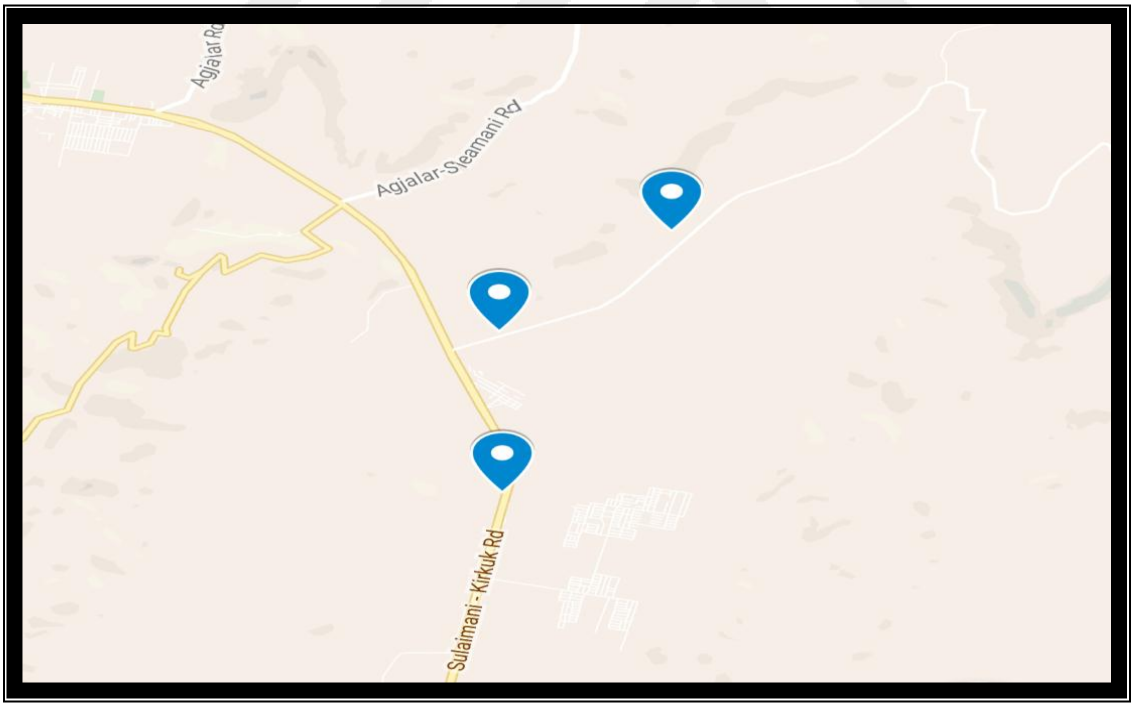

Figure 3.6. Three sites take sample soil in Sulaimania city.

The investigated positions are industrial field having particularly oil refineries. Soil samples were collected in three different locations (0.4 km, 4 km away and 8 km away from the contaminations sources). Sixty surface soil samples 0-25 cm depth from different distances away from the contamination sources were taken in Erbil and Sulaimania. GPS readings for all locations of the sampling were recorded. Figure 3.1, 3.2, 3.3, and 3.4 displays the interpolation maps for the points of the soil sampling.

After taking the sample, they were stored in plastic bags. The samples, then, taken to the laboratory of soil science and plant nutrition department at faculty of agriculture in German university at Kalar.

After the drying, the samples were crumpled by wooden hammer and passed through 2 mm sieve. Then take 2g of soil and add 3 to 4 ml of concentrated HNO_3.then heated up to 100 ^{0}C after heating let solution one hour after diluting with 25ml distil water we filter it finally put 5 ml in to ICP-OES Spector (Arcos Germany) levels of significance were determined.

Figure 3.7. ICP-OES heavy metal concentration determination tool.

The investigation pursues to measure the amount and concentration of hydrogen sulfide gas in atmosphere surrounding the refineries in Erbil. The study handles the experimental data gathering of H_2S gas that can be poisonous and injurious to the surroundings.

The refinery positioned in Perdawd village on Erbil-Makhmur road. The refinery is 29 km south west of Erbil city, and its coordination is (43˚ 54’ 23.71” E longitude) and (35˚ 59’ 59.63” N latitude). The below map demonstrated the site of the refinery and several other position that H_2S data were collected from in two time when the refinery in operation and non-operations.

Tool

Gas analyzer tester

Model: testo -350

Brand name: gas analyzer

Utilization

Measurement concentration of H_2S

Figure 3.8. indicates the H_2S Measurement tool.

3.2. Methods

This section involves the description of Hydrogen sulfide data collection gas from various points. The data was taken from several points which are the sources of hydrogen sulfide gas emission in non-standard the refinery in Erbil city.

The process of hydrogen sulfide data collection was conducted in Erbil refinery by going 20 meters away every time from the refinery. Then, the distance was escalated to (40, 80 and160) m correspondingly. This process was repeated twice, once during the operation of the refinery and the other time after the refinery is turned off.

4. RESULTS AND DISCUSSION

4.1. Descriptive statistics of general results.

In this investigation, the analysis for 60 soil samples that taken from various points from the contamination source were conducted. This is for determining the contents of some heavy metals such as (Ni, As, Cr, Cd, Hg, Co, Zn) in the soil. Table 4.1 indicates the means of heavy metal contents.

Table 4.1. Displays the descriptive statistics of heavy metal contents in the soil samples.

Metals	No	Minimum	Maximum	Mean	Std. Deviation
Ni	60	60.17	640.29	196.74	50 by bergmann&WHO&FAW
As	60	2.70	10.13	5.80	20 by bergmann&WHO&FAW
Cr	60	0.12	4.01	0.78	100 by bergman&WHO&FAW
Co	60	11.21	63.81	27.14	50 by bergmann &WHO&FAW
Hg	60	4.50	110.74	19.66	2 by bergmann
Zn	60	18.74	1973.52	107.13	300 by WHO&FAW
Cd	60	48.01	403.24	136.12	3 by bergmann&WHO&FAW

It can be seen from the table 1 that the in the soil samples the level of, Ni, Zn, Cd, Co, As, Cr, Hg were (196.74, 107.13, 136.12, 27.14, 5.80, 0.78 and 19.66) ppm correspondingly. It is also revealed that the distance highly affects the contents of heavy metal. Furthermore, the mean values Ni, Cd and Hg were greater in comparison to the tolerable values reported by (Bergmann, (1992), WHO, FAW) for these elements as (50, 3, 2) ppm correspondingly.

The concentrations heavy metal declined by increasing space between soil sampling location and the pollution source. Thus, high contamination level was observed in 0.4 km from the contamination source and lower levels of contamination were monitored in 4 km and 8 km respectively. Therefore, it can be stated that the level of contamination by heavy metals is negatively correlated with the distance from the pollution source.

Table 4.2. Displays the mean value of heavy metal contents acquired in various distances from to pollution sources.

Distance (Km)	**Ni**	**Zn**	**Cr**	**Cd**	**Co**	**Hg**	**As**
0.4	120.16	370.25	0.63	156.20	22.73	21.42	5.72
4	221.13	124.54	0.42	117.23	16.19	18.55	5.27
8	340.14	42.25	0.30	125.48	32.84	40.18	6.32

This table illustrates the concentration of heavy metals in three different points (0.4, 4, and 8) km away from the contamination sources). According to Kashem and Singh, (1998) there are adverse relationship between the concentrations of total Zn the distance from the nearby regions of tannery and textile dying industries. Additionally, similar statement have been made by Blom, (1986), Loska et al., (2004), Li and Huang, (2007), they declared that contents of heavy metal escalated in the soil around industrial regions. In accordance to the results of the descriptive statistical analysis, the concentrations Zn, Ni, Cd, Co, As, Cr and Hg of soil samples taken from 0.4km away contamination source were (370.25, 120.16, 156.20, 22.73, 5.72, 0.630, and 21.42) ppm correspondingly Table 4.1.

Table 4.3. Demonstrated that the concentration of Ni, Cd, Zn, Co, As, Cr and Hg 0.4 km away from pollution source were (120.16, 156.20, 370.25, 22.73, 5.72, 0.63 and 21.42) ppm correspondingly.

Metals	**No**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Ni	20	61.30	278.33	120.16	50 by bergman&WHO&FAW
As	20	4.06	7.18	5.72	20 by bergman&WHO&FAW
Cr	20	0.12	4.01	0.63	100 by bergman&WHO&FAW
Co	20	11.21	37.17	22.73	50 by bergman&WHO&FAW
Hg	20	4.76	49.13	21.42	2 by bergman
Zn	20	34.20	1972.52	370.25	300 by WHO&FAW
Cd	20	48.04	403.24	156.20	3 by bergman&WHO&FAW

Table 4.3. Points out the results of descriptive statistical analysis of heavy metal contents in soil samples taken at 4.0 km distance away from continuation sources

Metals	No	Minimum	Maximum	Mean	Std. Deviation	
Ni	20	74.16	630.59	221.13	50	by bergman&WHO&FAW
As	20	2.70	9.36	5.27	20	by bergman&WHO&FAW
Cr	20	0.90	1.93	0.42	100	by bergman&WHO&FAW
Co	20	12.56	36.79	16.19	50	by bergman&WHO&FAW
Hg	20	4.50	35.52	18.54	2	by bergman
Zn	20	22.80	112.75	124.54	300	by WHO&FAW
Cd	20	53.66	260.30	117.23	3	by bergman&WHO&FAW

It is clear that the means of heavy metals in the samples taken from 4 km away from contamination source were (221.13, 117.23, 124.54, 16.19, 5.27, 0.42 and 18.54) ppm for Ni, Cd, Zn, Co, As, Cr and Hg respectively.

Table 4.4. The descriptive statistical analyses results belong heavy metal contents of soil Sample taken from 8 km distance away pollutant sources

Metals	**No**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Ni	20	60.17	640.29	340.14	50 by bergman&WHO&FAW
As	20	5.10	10.13	6.32	20 by bergman&WHO&FAW
Cr	20	0.14	0.65	0.30	100 by bergman&WHO&FAW
Co	20	13.27	63.81	32.84	50 by bergman&WHO&FAW
Hg	20	6.30	110.74	40.18	2 by bergman
Zn	20	18.74	85.16	42.25	300 by WHO&FAW
Cd	20	51.10	356.73	125.48	3 by bergman&WHO&FAW

It can be observed in table (4.1, 4.3, 4.4, 4.5) that mean values of Ni, Cd and Hg means were greater in compared to the tolerable values stated by (Bergmann ,1992, WHO, FAW) for these metals (50, 3, 2) ppm correspondingly. The highest values of Zn acquired in the 0.4 km away from the contamination sources were higher compared to the tolerable values expressed by (FAW, WHO) for this elements as 370.25 ppm.

4.2. Sulaimania city

The means of Cd, Cr, Hg, Zn, in Sulaimania city decreased when the distances between the pollution source and measuring points was increased from 0.4 km to 4 km. The lowest means of Cd, Co, Cr and Zn were (148.19, 22.23, 0.46 and 60.00) ppm respectively at 8 km away from the contamination sources.

Table 4.5. Displays the relation of heavy metal concentrations and the distance in Sulaimania city.

Distance (Km)	Descriptive	**Ni**	**As**	**Cd**	**Cr**	**Hg**	**Co**	**Zn**
0.4	No.	10	10	10	10	10	10	10
	Minimum	95.73	4.56	73.12	1.30	11.30	17.04	65.30
	Maximum	278.30	7.18	403.24	3.60	49.13	37.17	1973.52
	Mean	220.12	5.15	200.28	2.90	22.45	26.77	530.35
	Std. Deviation	50	20	3	100	2	50	300
4	No.	10	10	10	10	10	10	10
	Minimum	85.10	3.87	64.12	0.23	4.50	14.53	22.80
	Maximum	630.59	9.36	260.30	1.73	31.12	36.79	106.04
	Mean	330.54	4.43	152.35	1.01	28.01	23.78	61.33
	Std. Deviation	50	20	3	100	2	50	300
8	No.	10	10	10	10	10	10	10
	Minimum	108.37	6.03	78.10	0.18	17.00	19.15	29.47
	Maximum	640.29	10.13	356.73	0.65	110.74	63.81	85.16
	Mean	313.17	7.55	148.19	0.46	27.99	22.23	60.00
	Std. Deviation	50	20	3	100	2	50	300

4.3. Erbil city

In accordance to the Table 4.7 the mean value of the contents of heavy metal were generally declined whereas the space between the contamination sources escalated. In addition, the maximum contents of Cd, Cr, and Zn of soil samples were 97.16, ppm, 3.01, ppb and 88.53, ppm respectively at the 0.4 km away from pollution source.

Table 4.6. Illustrates the relations between the metal concentrations and distance in Erbil city.

Distance Km	Descriptive	**Ni**	**As**	**Cd**	**Cr**	**Hg**	**Co**	**Zn**
0.4	No.	10	10	10	10	10	10	10
	Minimum	61.30	4.00	48.03	0.12	4.70	11.21	34.20
	Maximum	185.12	5.03	110.16	4.01	25.78	19.84	340.11
	Mean	103.32	4.10	97.16	3.01	13.54	12.43	88.53
	Std. Deviation	50	20	3	100	2	50	300
4	No.	10	10	10	10	10	10	10
	Minimum	74.16	2.70	53.66	0.40	5.14	12.56	46.16
	Maximum	127.17	8.16	225.18	1.90	53.30	28.39	112.75
	Mean	101.00	3.79	95.45	0.77	19.81	20.31	63.50
	Std. Deviation	50	20	3	100	2	50	300
8	No.	10	10	10	10	10	10	10
	Minimum	60.17	5.10	51.10	0.14	6.30	13.27	18.74
	Maximum	206.59	9.12	301.00	0.53	94.18	54.01	71.65
	Mean	98.95	7.76	92.76	0.33	44.80	25.00	40.90
	Std. Deviation	50	20	3	100	2	50	300

This investigation revealed that in comparison to samples taken from 0.4 km way from pollution source, the sample in the 4 km and 8 km demonstrated a decline in the content of Ni, Cd, As, Cr, Hg, Co and Zn. It was believed that factors like topography and climate conditions, lithogeny reasons and mineral deposits might affect the differently on the content of heavy metals. Figure 3.1, 3.2, indicates the differences in topographical positions of sampling glaciations.

In accordance to the stud’s outcomes, concentrations of Ni, Hg, Cd and Zn in 0.4 km sampling positions were higher than the limited values reported by (Bergmann 1992, WHO, FAW) in all sampling positions. Thus, oil industries, iron industry and oil field have high level of Ni, As, Cd, Cr, Hg, Co and Zn. Khwedim, (2013) declared that the contaminated soil by heavy metals might be affected by intensive industrial activity and accumulated great amounts of contaminants in northern Iraq. It was expressed that the discharge of Cd, , Ni, and Hg in to the environment were as a result mining, oil industry activity, metal refining, fossil fuels combustion (Sherene, 2010).

4.4. Measuring of hydrogen Sulfide gas from refinery in Erbil city

Table 4.7. Concentration of H_2S from non-standard refinery in Erbil city when the refinery in operations (ppm)

Distance/m	Concentration (H_2S)
0	12.5
20	11.9
40	11.3
60	10.7
80	10.1
100	9.4
120	8.6
160	7.8
200	7.1
240	6.5
280	5.8
320	5.1
400	4.2
480	3.3
560	2.5
640	1.8
800	1.0
960	0.4
1120	0.1
1280	0
1440	0
1600	0

* The data was taken data from 12 of September 2016 while the temperature was between 25-28 and the wind speed was 2.2 m/s at 1-2 pm.

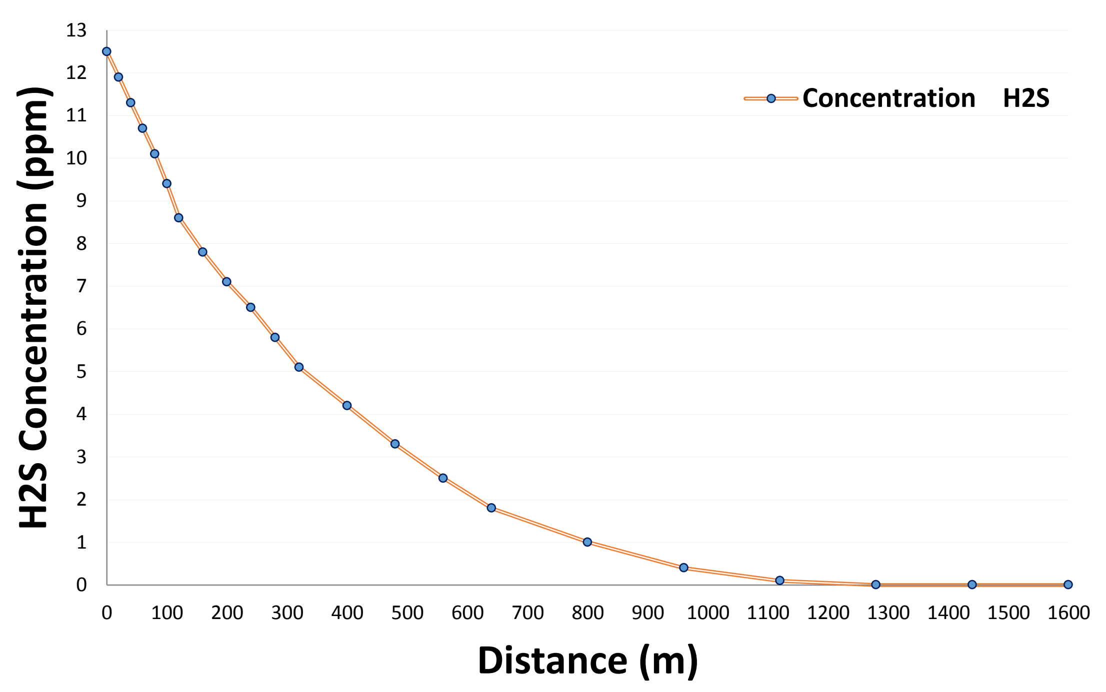

Figure 4.1. Concentration of H_2S from non-refinery in Erbil city when the refinery in operations

Firstly, the concentration of hydrogen sulfide gas in air around the refinery was measured when refinery is in the operational mode. In addition, the measurements were also taken according to wind directions. It can be seen from the table 4.8 that level of hydrogen sulfide from (0, 20, 40, 60 and 80) m away from the refinery were (12.5, 11.9, 11.3, 10.7and 10.3) ppm respectively.

Table 4.8. Concentration of H_2S from refinery in Erbil city when the refinery in turned off (ppm)

Distance/m	Concentration (H_2S)
0	0.9
20	0.8
40	0.6
60	0.3
80	0.1
100	0
120	0
160	0
200	0
240	0
280	0
320	0
400	0
480	0

* The data was taken data from 12 of September 2016 while the temperature was between (25-26) and the wind speed was 2.4 m/s at 2-4 pm.

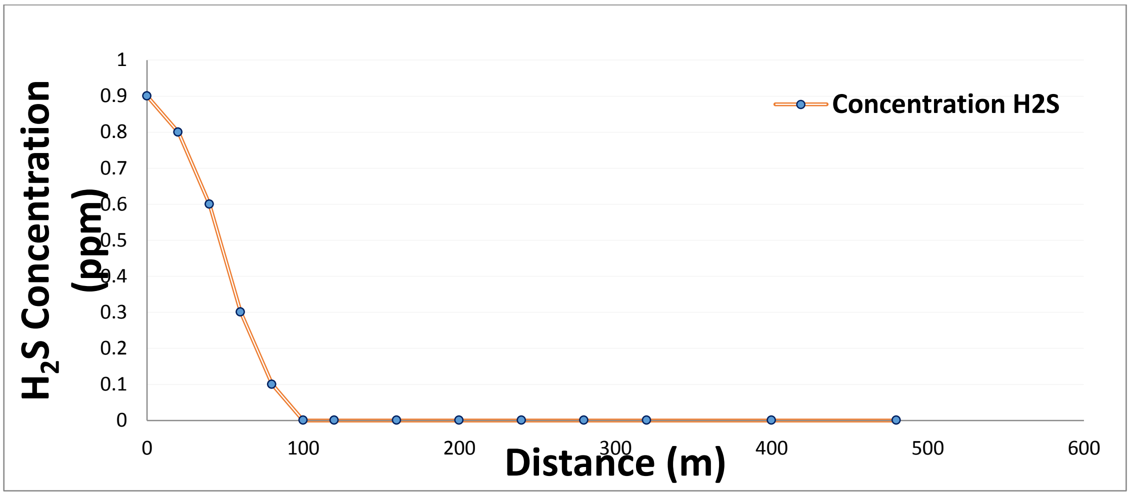

Figure 4.2 Concentration of H_2S from refinery in Erbil city when the refinery in turned off

Then data of hydrogen sulfide concentration in air around the refinery were recorded while refinery is turned off. It was unveiled that the levels of hydrogen sulfide were 0.9ppm in 0, mater (0.8, 0.6, 0.3, and 0.1) ppm in the distance (20, 40, 60, and 80) m away from the distillation tower respectively.

Comparison between these two data indicates that the hydrogen sulfide concentration from refinery significantly higher when the refinery was operating compared the state when the refinery was off by comparison the concentration of H_2S in table 4.8 and4.9 with table.2.1 in literature review for standard refinery in Iraq, the concentration in non-standard refinery is more than standard refinery because in non-standard is non-safety formations.

And by comparison this concentrations of H_2S gas in non-standard refinery in Erbil city north of Iraq with concentrations of H_2S gas in standard refinery in Aldoura refinery in medal of Iraq, in table 2.1 in literature review the result is show that the concentrations of H_2S gas in non-standard refinery in Erbil is higher than concentrations of H_2S gas in standard refinery in Aldoura refinery in medal of Iraq show table. 2.1 And 4.8.

4.5. Effect of distance

The investigation revealed that the distance between the contamination source and data collection point significantly affects the concentration of hydrogen sulfide. In addition, it indicated that distance negatively impact hydrogen sulfide concentration in the refinery. It infers that the farther the distance from the refinery the lower the hydrogen sulfide concentration vice versa. This is shown in tables 4.8, and 4.9

4.6. Effect of wind

Table 4.9. Displays Wind speed (m/s)

Day	Wind speed
1	1.8
2	1.6
3	1.5
4	2
5	1.6
6	1.4
7	1.6
8	2.2
9	2.4
10	2.6
11	1.4
12	1.3
13	1.8
14	1.9
15	1.2
16	2.6
17	2.6
18	3.0
19	1.5
20	2.8
21	2.2
22	1.8
23	1.2
24	1.6
25	1.7
26	1.8
27	1.7
28	1.5
29	1.6

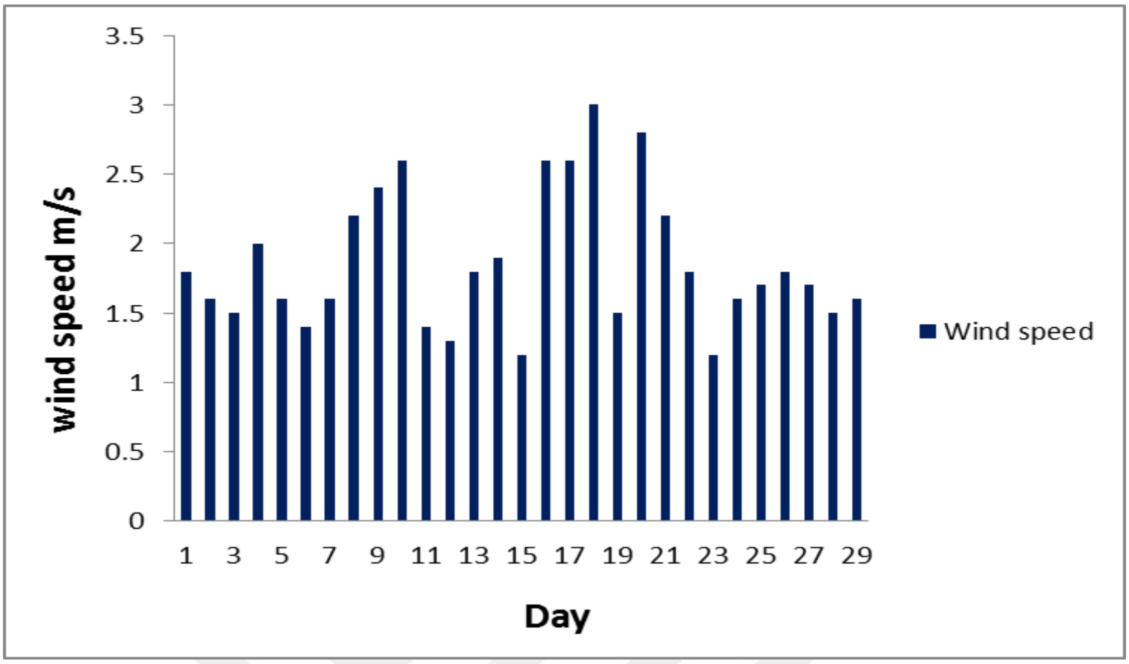

Figure 4.3. Indicates the data for wind speed which was acquired in September 2016.

The impacts of the wind speed on the concentration of hydrogen sulfide displayed in Table 4.10 and figure 4.3. It was found that the diffusion of H_2S gas in air increased when the wind speed increased show table below.

Hydrogen sulfide level from refinery in Erbil city was measured on 18-9-2016 when the wind speed was (3.0 m/s).

Table 4.10. Concentration of H_2S in distillation tower wind speed 3.0m/sec.

Distance/m	Concentration (H_2S)
0	12.7
20	12.5
40	12.1
60	11.7
80	11.1
100	10.8
120	10.4
160	9.8
200	9.1
240	8.5
280	8.1
320	7.3
400	6.2
480	5.3
560	4.5
640	3.8
800	3.0
960	2.4
1120	1.1
1280	0.7
1440	0.1
1600	0
1760	0
1920	0

* The data was taken data from 18 of September 2016 while the temperature was between (25-26) and the wind speed was 3.0 m/s at 1-4 pm.

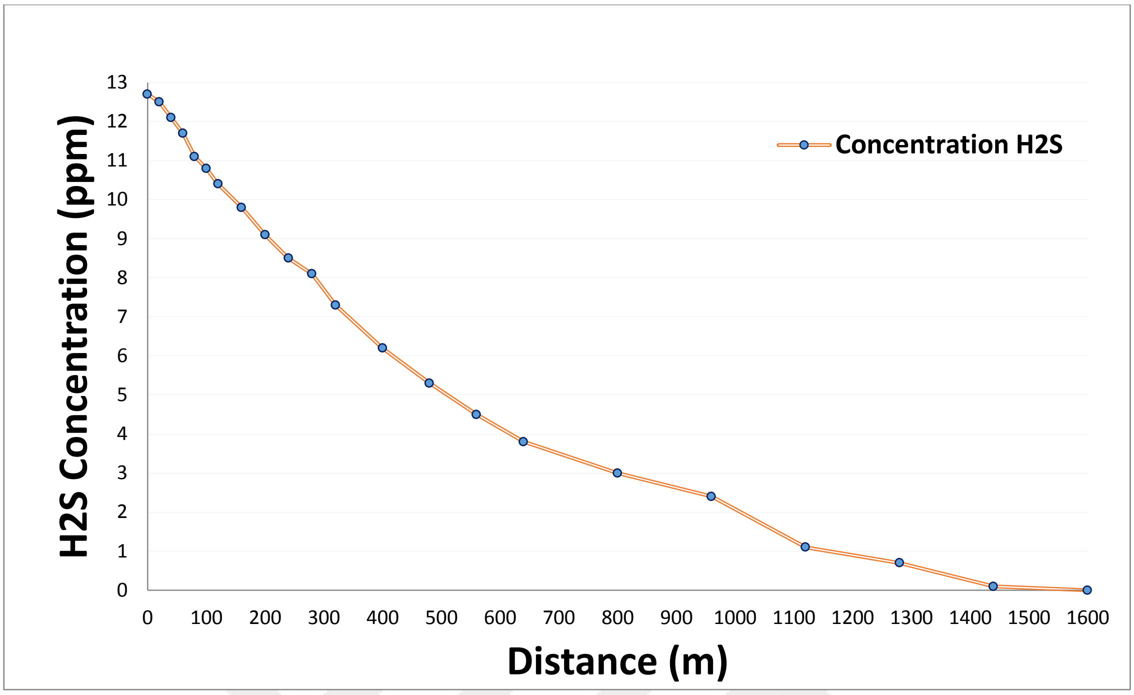

Figure 4.4. Concentration of H_2S from refinery in Erbil city when the wind speed is 3.0m/sec

4.7. Effect of temperature

The hydrogen sulfide diffusion is highly impacted by the air temperature. It was revealed that the diffusion of hydrogen sulfide increased when the temperature increased as the kinetic energy increased.

5. CONCLUSION

At the end of the investigation and analyzing the data, the following conclusion has been made:

1. The heavy metals concentration is decreased with increasing the distance from source of pollutant.
2. Concentration of Ni, Cd, Hg, in most cases is higher than standard when we compared this concentrations of heavy metals with acceptable concentration.
3. In 0.4 km in Sulaimania concentration of Zn is higher than permissible (acceptable) level.
4. In (0.4, 4) km mean concentration of Ni, Cd, Hg in Sulaimania city is higher than Erbil city.
5. In 8 km just mean concentration of Hg in Erbil city is higher than Sulaimania city.
6. Waste water, industrial, refineries, cars are the main source of pollution. Also in some place the concentration of certain type of heavy metals are high naturally without human effect.
7. In some places people say that now differ from years before because they cannot planting some types of plant.
8. During soil pollution by heavy metals this must be treated by some process that we focus on it.
9. Several toxic gases such as H_2S are discharged to the atmosphere by refineries. In addition, these poisonous gases have dangerous effect on the human health and environment.
10. The rate of hydrogen sulfide diffusion from refinery is higher than the standard rate.
11. Distance is another factor that impacts the level of H_2S. Furthermore, the concentration of hydrogen sulfide reduced by increasing the distance from the refinery and data collection points.
12. Wind is also impacts H_2S diffusion. There are a positive correlation between the wind speed and the concentration of H_2S.

13. Temperature is also impacts H_2S diffusion.
14. The diffusion of H_2S is highly impacted by the temperature. Increasing the temperature, the Kinetic Energy increased and the rate of gas diffusion also escalated. Most of refineries and industrial was near to population in Iraq.

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APPENDIX INDEX
EXTENDED TURKISH SUMMARY
GENİŞLETİLMİŞ TÜRKÇE ÖZET

IRAK'TAKİ ERBİL DOLLABAKRA MEVKİSİNDE YER ALAN PETROL VE DOĞALGAZ ALANLARINDA İNSANLARI ETKİLEYEN ZARARLI GAZLAR

Bayar Sabah MAJED
Yüksek Lisans Tezi, Kimya Mühendisliği Bölümü
Tez Danışmanı : Prof. Dr. Nahit AKTAŞ
Haziran 2017, 62 sayfa

Bu çalışmada petrol işleme tesislerindeki işlemler sırasında ortaya çıkan, havayı ve toprağı kirleten zehirli ürünler olan ağır metaller ve hidrojen sülfür araştırılmıştır. Erbil ve Süleymaniye şehirlerinde havadan ve topraktan alınan örnekler incelenmiştir. Toprakta özellikle bazı ağır metallerin (Ni, As, Cr, Co, Hg, Zn, Cd) yoğunlukları ölçülmüştür.

Numuneler, Erbil ve Süleymaniye şehirlerine sırasıyla 0.4, 4 ve 8 kilometre uzaklıklardan ve 0 ile 25 santimetre arasında değişen farklı derinliklerden alınmıştır. Alınan bu numuneler hazırlanıp ICP-OES-SPECTRO cihazı ile incelenmiştir.

Ayrıca hidrojen sülfür gazı ölçümleri Erbil şehri yakınlarındaki standart dışı bir rafineriye rüzgar yönünde değişik uzaklıklardan sabit sıcaklıklarda (25-28 ^{0}C) yapılmış ve sonuçlar standart dâhilindeki diğer rafinerilere ait değerlerle karşılaştırılmıştır.

Son olarak, hangi ölçümlerin yüksek değerler olarak değerlendirilebileceğini anlamak için eldeki veriler standart değerler ile kıyaslanmıştır.

Anahtar kelimeler: Ayçiçeği, FAW, Hümik asit, Verim ve verim öğeleri, WHO.

1. GİRİŞ

Bu çalışmada Erbil ve Süleymaniye şehirlerindeki iki petrol rafinerisi bölgesinde topraktaki ağır metaller ile, Erbil şehrindeki bir rafineride rafineri kapalı ve işler durumda iken ortam havasındaki hidrojen sülfür gazı araştırılmıştır.

Petrokimya ve kimya endüstrilerinde faaliyet gösteren tesisler ile petrol rafinerileri hava, su ve toprak kirliliğine neden olarak doğaya ciddi miktarda zarar vermektedirler Ezejiofor ve ark., (2013). Saadoun ve ark. (2008)'e göre, çok sayıda petrol rafinerisine sahip olması nedeniyle Irak en yüksek kimyasal kirlenme riskine sahip ülkeler arasındadır. Irak'ta petrol rafinerilerinin çoğu büyük şehirlerin yakınlarında yer almakta, hatta bazı durumlarda şehrin içinde bulunmaktadır. Dolayısıyla bu şehirlerde yaşayanlar doğrudan veya dolaylı olarak risk altındadırlar. Çoğu zehirli olan zararlı maddelerin atmosfere yayılmasını önlemeye dair tedbirler alınmış olmasına rağmen, bu zararlıların istemli veya istemsiz olarak doğaya atılmasının önüne geçilememiştir (Pezeshki ve ark., 2001).

Hava insan yapımı ya da doğal yollarla kirlenebilir. İnsandan kaynaklı kirliliğin başlıca sebepleri enerji üretim santralleri, araçlar ve üretim faaliyetleridir. Hava kirliliğinin anahtar öğeleri ise genellikle muazzam miktarlarda tüketilebilir petrolün işlendiği petrol rafinerileri ya da enerji tesisleri gibi işletmelerdir. Bu endüstriler yüksek duman çıkışları nedeniyle diğerlerine göre çok daha yüksek miktarlarda zehirli gaz ve katı parçacık salınımından sorumludur. Bu tip tesisler şehirlerin ya da yerleşkelerin sınırları içinde oldukları zaman daha da tehlikeli hale gelirler Afaj ve ark., (2008). Irak'taki Erbil ve Süleymaniye şehirlerinin rafinerileri buna örnek olarak gösterilebilir. Her yıl petrol rafinerilerinden doğaya salınan zararlıların miktarının milyonlarca ton olduğu düşünülürse bu endüstrinin hava ve toprak kirliliğinin önemli bir sebebi olduğu söylenebilir (Afaj ve ark, 2008).

Karbon monoksit (CO), sülfür dioksit (SO_2), Karbondioksit (CO_2) azot dioksit (NO_2), Hidrojen sülfür (H_2S), Amonyak (NH_3), Toz, Ozon (O_3) Parçacıklı Madde (PM1-PM10) ve Peroksiasetil Nitrat (PAN) doğayı kirleten en yaygın maddelerdir. Bu maddeler şehirde yaşayanları, insan sağlığını, flora ve faunayı, hidrosferi ve toprağın verimliliğini olumsuz şekilde etkilemektedir Naranyan, (2011), Weli ve Ayode, (2014), Weli, (2014), Okoroafor ve Ikebude, (2015), (FMEnv, 2015)

1.1. Verilerin doğası ve kaynakları

Bu araştırma için gerekli veriler, Hidrojen Sülfür (H_2S), Hg, Ni, As, Cr, Cd, Co ve Zn gibi bazı hava kalitesi parametrelerini içermelidir. Ayrıca rüzgar hızı ve yönü, sıcaklık ve bağıl nem gibi bazı iklim koşulları dahil edilmelidir. Bu parametreler, endüstriyel, konut, rekreasyonel, ticari, kurumsal ve tarımsal depolama alanları gibi çeşitli araziler yoluyla kaydedilmelidir.

Birincil ve ikincil kaynaklar verisi dahil edilmelidir. Birincil veriler, kalite kriterleri kirleticilerinin havasını sahadaki doğrudan hava hava kalitesi ölçüm cihazlarıyla kaydettirerek elde edilmelidir. Bununla birlikte, ikincil verileri elde etmek için kitaplar ve dergiler gibi mevcut literatürler kullanılmaktadır. Ayrıca karşılaştırma için DSÖ tarafından verilen deşarj sınırları ve iklim ile ilgili meteorolojik bilgiler mevcuttu.

1.2. Çalışmanın kapsamı

Soruşturma, Süleymaniye ve Erbil metropollerinde ve çevrelerindeki çeşitli arazi kullanımlarıyla hava ve toprak kalitesindeki farklılıklara odaklanıyor. Ayrıca hidrojen sülfid H2S ve birkaç ağır metal gibi sonraki hava, toprak kalitesi parametrelerinin seviyesini inceler.

1.2.1. Hava kalitesi

Çevremizdeki hava durumu hava kalitesi olarak gösterilebilir. Temiz, temiz ve kirlenmemiş havaya İyi hava kalitesi denir. Yeryüzündeki ve tüm ekosistemlerdeki nazik dengeyi korumak için temiz hava hayati önem taşır. Kötü hava kalitesi, havadaki doğal elementlerin yapısını değiştirerek ve yerinden oynatarak insan sağlığını, bitki örtüsünü, bitki örtüsünü, bitki örtüsünü, vahşi hayatı, su gövdesini ve atmosferi tehdit eden düzeyde çevre kirleticilerin varlığını ortaya koydu (% 78.00) Oksijen (% 21.00), Argon (% 0.03), Karbon dioksit (% 0.3) ve Su (% 0-4) (Narayanan 2011), (Kaushik ve Kaushik, 2008).

1.2.2. Normal toprak kalitesi

Doğal olarak, ağır metaller topraklarda bulunur. Bununla birlikte, kirlilik, tarım, fabrikasyon, atık yakımı, fosil yakıtların yanması ve yol trafiği gibi yerli kökenlerden kaynaklanmaktadır Asgari, (2011), Suciu ve diğerleri, (2008). Teorik olarak, her ton standart topraklar (0.2 kg) Krom, (0.08 kg) Nikel, (0.1) 6 kg Kurşun, (0.0005) kg Cıva ve (0.0002) kg Kadmiyum içerir. Bu nedenle, ağır metal içeriğinin arttırılması için belirli bir kaynak atamak son derece karmaşıktır. Ağır metallerin yerçekimi (yoğunluğu) normalde 5g / cm3'ü aşıyor. Bazı ağır metal seviyelerinin varlığı, tüm yaşam biçimlerinin hayatta kalması için hayati önem taşımaktadır. Bu ağır metaller, eser element olarak tanımlanır. Öte yandan, standart konsantrasyonun ötesinde var olduğunda, bunlar kontaminant olarak kabul edilir. Bu durumda, ağır metaller ekolojik çevre için büyük potansiyel bir tehlike oluşturmaktadır. Bunun nedeni, çevreye boşaltılmaları nedeniyle biyolojik olarak parçalanamamalarıdır. (Li ve ark., 2010).

2. KAYNAK BİLDİRİŞLERİ

Irağın kuzeyindeki topraklarda Ni, Zn, Cd, Co, Pb, As, Cr ve Hg konsantrasyonları sırasıyla 2.92 ppm, 179.39 ppm, 116.44 ppm, 30.30 ppm, 20.71 ppm, 15.40 ppm, 6.40 ppm, 0.83 ppm, 0.53 ppm, 0.46 ppm, 0.22 ppm ve 18.23 ppm olarak bulunmuştur.

Irağın kuzeyinde topraklarda bulunan bazı ağır metaller ve bunların konsantrasyonları Tablo-1'de verilmiştir.

Tablo 4.1 Irağın kuzeyindeki topraklarda bulunan bazı ağır metaller ve miktarları

Agir metal	Konsantrasyon
Ni	196.74 ppm
Zn	107.13 ppm
Cd	136.12 ppm
Co	27.14 ppm
As	5.80 ppm
Cr	0.78 ppm
Hg	19.66 ppm

Toprak numunelerinin kaynaktan 0.4, 4 ve 8 kilometre uzaklıklarda içerdiği ağır metal oranları derinlik arttıkça azalmaktadır. Bu numunelerde Ni, Cd ve Hg oranları, sırasıyla Bergmann (1992) tarafından 50 ppm, 3 ppm ve 2 ppm olarak belirtilen kabul edilebilir sınırların üzerinde çıkmıştır. Ayrıca Zn için tespit edilen en yüksek değerler de bu ağır metal için belirlenmiş olan 100 ppm sınırının üzerine çıkmıştır. Numuneler farklı mesafe ve derinliklerden alındığından Ni, As, Cd, Cr, Hg, Co ve Zn oranları numuneler arasında değişiklik göstermektedir. Her bir noktada Bergman (1992)'nin belirttiği şekilde insan ya da doğa kaynaklı etmenlerin oranları etkilediği düşünülmektedir.

Beklendiği üzere kaynaktan uzaklaştıkça toprak numunelerindeki ağır metal oranı azalma göstermiştir. Cd için kaynaktan uzaklaştıkça tespit edilen azalma miktarı istatistiki açıdan anlamlı bulunmuştur ($p<0.05$).

Doğal yollarla oluşan hidrojen sülfür gazı renksiz ve yumurta çürüğü kokusundadır. Hidrojen sülfür ayrıca gübre gibi organik bazı maddelerin içerisinde anaerobik bakterilerin faaliyetleri sonucunda ortaya çıkabilmektedir.

OSHA, kabul edilebilir hidrojen sülfür seviyesini 20 ppm olarak belirlemiştir. Ayrıca milyonda 50 parçacık hidrojen sülfüre kabul edilebilir maruz kalma süresini 10 dakika olarak tespit etmiştir. 500-1000 ppm hidrojen sülfüre maruz kalmanın hızlı bir şekilde bilinç kaybına ve ardından solunum sistemi felci nedeniyle ölüme yol açtığı da tespit edilmiştir. Hidrojen sülfür için hava kalitesine dair bir oran belirlenmemiştir, zira zehirli bir gaz olarak kabul edildiğinde ortam havasında hiç bulunmaması gerektiği kabul edilmektedir (Lafta ve ark., 2014).

3. MATERYAL VE YÖNTEM

İncelenen mekanlar endüstriyel alanlar olup özellikle petrol rafinerileridir. Toprak numuneleri bu kaynaklara 0.4, 4, ve 8 kilometre mesafelerden alınmıştır. Erbil ve Süleymaniye'de yer alan bu tesislerden belirtilen bu uzaklıklarda 0 ila 25 santimetre arasında değişen derinliklerden toplamda 60 numune alınmıştır. Kurutulan numuneler ahşap bir çekiçle ufalanarak 2 mm'lik elekten geçirilmiştir. Bu elenmiş numunelerden 2 gramına 3 ila 4 ml konsantre HNO_3 eklenerek 100 ^{0}C'ye kadar ısıtılmış, bir saat kadar bekletildikten sonra ise 25 ml distile su ile sulandırılarak, elde edilen numunenin 5 ml'si ICP-OES SPECTRO (Across, Almanya) cihazına yerleştirilerek ölçümler yapılmıştır.

Bahsi geçen toprak numunelerinin yanı sıra ERBİL standart dışı rafinerisinin yakınlarından da H_2S gazı ölçümleri yapılmıştır. Bu ölçümlerin her birinde ilk ölçüm rafineriye 20 metre alınmış, ardından 40, 80 ve 160 metreden ilave ölçümler alınmıştır. Bu ölçümler, birisi rafineri çalışmaya başlamadan önce, diğeri de rafineri günlük faaliyetini sonlandırdıktan sonra alınmıştır.

4. BULGULAR VE TARTIŞMA

4.1. Genel sonuçlaren açiklanmasi.

Bu çalışmada kirliliğe neden olan tesislere değişik mesafe ve derinliklerdeki noktalardan alınan 60 numune incelenerek Ni, As, Cr, Cd, Hg, Co, Zn gibi ağır metal içerikleri araştırılmıştır. Numunelerin ağır metal içerikleri Tablo-1'de verilmiştir. Bu tablodan anlaşılacağı üzere Ni, Zn, Cd, Co, As, Cr ve Hg için numune konsantrasyonları sırasıyla 196.74, 107.13, 136.12, 27.14, 5.80, 0.78 ve 19.66 ppm olarak tespit edilmiştir. Ayrıca mesafe arttıkça ağır metal içeriğinin azaldığı görülmüştür. Bu veriler incelendiğinde Ni, Cd ve Hg içeriklerinin Bergman (1992, WHO, FAW) tarafından sırasıyla 50, 3 ve 2 ppm olarak belirtilen kabul edilebilir sınırların üzerinde oldukları tespit edilmiştir. Ayrıca Zn için bulunan en yüksek numune içeriğinin de bu madde için WHO ve FAW tarafından 100 ppm olarak belirlenen kabul edilebilir sınır değerin üzerinde olduğu anlaşılmıştır.

4.2. Süleymaniye şehri

Süleymaniye şehrinde kaynaktan uzaklık 0.4 kilometreden 4 kilometreye çıkarıldığında Cd, Cr, Hg ve Zn değerlerinin azaldığı görülmüştür. En düşük Cd, Co, Cr ve Zen değerleri sırasıyla 148.19, 22.23, 0.46 ve 60 ppm olup kirlilik kaynağından 8 kilometre uzakta tespit edilmişlerdir.

4.3. Erbil şehri

Tablo 7'de belirtildi üzere kirlilik kaynağına olan mesafenin artışıyla birlikte ağır metal içeriği medyan değerleri düşüş göstermiştir. Ayrıca kaynakta 0.4 kilometre uzaklıkta Cd, Cr ve Zn için tespit edilen azami içerik değerleri 97.16, 3.01, 88.53 ppm olmuştur.

4.4. Erbil şehrindeki rafineride hidrojen sülfür gazı ölçümü

Tablo 4.8’de Erbil şehrindeki standart dışı rafineriye ait H_2S gazı konsantrasyonları ppm cinsinden verilmiştir. İlk olarak rafineri çalışma halindeyken etrafındaki hidrojen sülfür gazı konsantrasyonu ölçülmüştür. Ayrıca ölçümler yapılırken rüzgarın yönü de dikkate alınmıştır. Tablo 4.1 ve Şekil 4.1’de görülebileceği üzere hidrojen sülfürün 0, 20, 40, 60 ve 80 metre mesafedeki yoğunlukları sırasıyla 12.5, 11.9, 11.3, 10.7 ve 10.3 ppm olarak tespit edilmiştir.

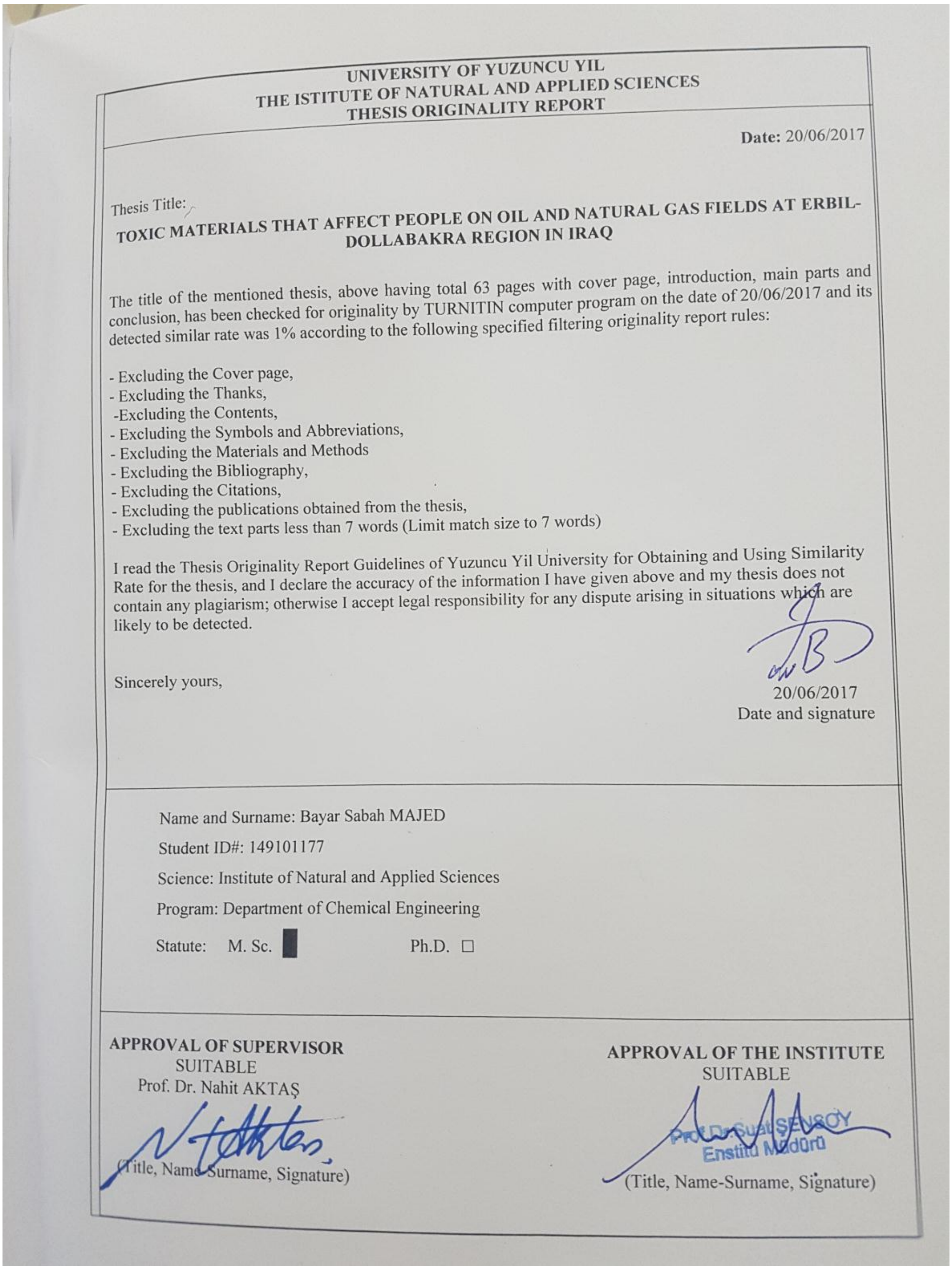
5. SONUÇ

Verilerin toplanıp incelenmesinin ardından aşağıdaki sonuçlara varılmıştır.

1. Kaynağa olan mesafe arttıkça ağır metal yoğunlukları azalmaktadır.
2. Çoğu numunede Ni, Cd, Hg ve Zn yoğunlukları FAW ve WHO tarafından belirtilen kabul edilebilir sınırların üzerinde çıkmıştır.
3. 0.4 ve 4 kilometre mesafelerde Süleymaniye şehrinde tespit edilen Ni, Cd ve Hg yoğunluk değerleri Erbil şehrindekilere göre daha yüksektir.
4. Erbil şehrinde kaynağa 8 kilometre mesafede medyan Hg içeriği değeri Süleymaniye şehrindekine göre daha yüksektir.
5. 0.4 kilometrede Süleymaniye şehri Zn içeriği oranı Erbil'dekine göre daha yüksektir.
6. Rafinerilerden H_2S de dâhil olmak üzere pek çok zehirli gaz etrafa salınmaktadır. Bu gazların insan ve çevreye olumsuz etkileri olduğu bilinmektedir.
7. Ölçüm yapılan rafineriden kaynaklanan hidrojen sülfür gazı salınımı standart oranın üzerindedir.
8. Mesafe H_2S gazı yayılmasına etken eden bir faktördür. Ölçüm alınan noktaların rafineriye olan mesafesi arttıkça hidrojen sülfür gazı yoğunluğu azalmaktadır.
9. Rüzgar da H_2S yayılmasına etken etmektedir. Rüzgar hızı ile H_2S yayılma hızı arasında pozitif korelasyon vardır.
10. H_2S yayılma hızı sıcaklıktan oldukça etkilenmektedir. Artan sıcaklıklar gazın kinetik enerjisini artırarak yayılma hızını yükseltmektedir.

CURRICULUM VITAE

Bayar sabah MAJED was born in ERBIL/IRAQ he finished the primary and secondary school in ERBIL .and he graduated from pharmacy college in HAWLER medical univercity.



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