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The impact of Waste from oil exploration on air pollution in Al-Roumila North oil field-Governorate of Basra – Iraq

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Abstract The province of Basra in Iraq is of great importance to the submerged oil fields, the most important of which is the Rumailia North, which represents the seventh largest oil well around the world. Explorations of new wells as well as the development of productive wells have caused thousands and millions of tons of drilling waste. The burning of natural gas associated with oil, instead of take advantage of it, has thrown millions tons of pollutants into the air. The present study, which was conducted in the spring of 2017 (March), measured the concentration of atmospheric pollutants in this field.

The practical measurements of several points within the northern Rumaila field showed that clear concentrations of carbon monoxide and high levels of carbon dioxide are emitted into the air by the combustion of natural gas rather than the use of it. As ozone concentrations, partially burned or partially burnt hydrocarbons, as well as various nitrogen oxides, are at dangerous limits if added to the high solar radiation intensity, they are well suited to form photochemical smog, which is very hazardous to public health in Basra Governorate. The measured concentration of SO_2 and H_2S show the risk of vapors of sulfuric acids. The results of the study confirms the great responsibility on the Iraqi government and the local government in Basra additional to oil companies working to reduce pollution in this province in general and in the field of Rumaila North in particular.

Keywords Waste, oil exploration, air pollution

Introduction

Environmental pollution is gaining increasing attention worldwide, as environmental problems are caused by very high rates of wasteful use of fossil fuels such as oil and its derivatives used for the purpose of saving energy or operating cars and trucks of various kinds [1, 2, 3]. The economic development of most of the world depends directly on the fossil energy, which is causing pollution of the environment, whether air, water, and soil [4]. Pollution negatively affects the surrounding environment and its components, and affects even the performance of individuals, so we must point out the impact of excessive use of oil derivatives on the environment and sustainable development [5, 6, 7].

Pollution is defined as a physical or chemical change in the environment, which affects the quality of human life due to a defect in the environment that makes it unable to get rid of pollutants, especially the organic ones [8, 9]. This occurs when the rate of pollution raise on the potential of the environment to eliminate these pollutants, as is the case today, resulting from the excessive use of fossil fuels beyond natural processes and overcoming the ability of the environment to contain and dispose of them [10, 11]. This process has great effects on the environmental cycle and causes its decay [12].

The oil resources are non-renewable resources, the available quantity of this material is less than the quantities extracted from them, and in other words, they are enforceable [13, 14]. The demand for oil and its derivatives

exceeded the perception, however large the reservoir of the resources fate is gone [15, 16]. The oil consists of a mixture of carbon and hydrogen (hydrocarbons) [17]. Oil occupies a distinct position among energy types, as coal for an example, because of its characteristic features, as well as the growing demand in recent years [18, 19]. This feature is embodied in being liquid and not only used as energy but enters into many and multiple fields, such as petrochemical process [20]. Studies indicate that the quantities of oil consumption are doubling every decade [21, 22]. There is a global fear of depletion of oil in the future and there is no alternative that has its full specifications [23, 24, 25].

The negative effects of pollution on humans are large and result in extensive damage [26]. The licensing of fossil fuels and the lack of awareness of environmental damage has increased pollution [27, 28]. The addition of improved materials for combustion, as in the case of gasoline cars, the addition of lead chemicals without concern to its harmful effects when they spread in the atmosphere after the combustion has caused serious problems for growth, breathing, and urinary tract especially on children [29, 30, 31]. The cars' engines exhaust emit a lot of toxic substances, such as the first carbon monoxide, sulfur dioxide, and carbon dioxide and other [32, 33, 34]. When some of these toxic substances such as carbon monoxide are mixed with the blood it lead to poor oxygen absorption capacity, this results in poor thinking and nausea and affects the embryos in their mothers' womb [35, 36].

The Earth's atmosphere consists of a mixture of several gases, the most important of which are oxygen and nitrogen gases, as well as other gases such as carbon dioxide and some inert gases such as helium, neonates and argons, which are found in small percentages [37, 38]. Air pollution causes harmful effects that disrupt this ecological balance [39]. As the quantities of excess perception of the exhausts of the use of oil derivatives, as well as other natural phenomenon such as volcanoes, wars, and daily activities increased the amount of pollutants in the atmosphere that began to form a halo surround the surface of the globe caused imbalance and affected the change in rainfall sites and emerged a lot of new phenomena that were the cause due to the presence of air pollution [40, 41, 42].These pollutants in the atmosphere are derived from the combustion of different fuels, especially oil and its derivatives and chemicals involved in industrial processes [43].

Iraq has been exposed to 40 years of war, drought and destruction of infrastructure, making the environmental problems of this country very large and very dangerous [44, 45]. As an example of this threat, one can mention that after 2003, Iraq imported more than 1,300,000 cars, according to the General Director of Traffic, most of them for personal use and not for development purposes [46, 47]. These old cars that are over 10 years old represented more than 70% of the imported cars [48, 49]. This large number of uncontrolled emission cars caused an imbalance in the environmental balance [50]. Most of the natural pollution filters have been lost in Iraq [51]. These are the trees that were burned for fuel, the marshes that dried up for political reasons, the lands were polluted and desolate because of the poor use of the peasants because they left their villages and headed for the difficulty of living in the countryside [52, 53]. This huge number of cars added to the balance of contaminants heavy burden as old cars exhausting a lot of toxic substances polluted the air, which far outweighs the pollutants caused by modern cars [54, 55].

Also, a large number of motorcycles, which exceeded (300,000) motorcycle according to statistics of the General Traffic Manager have entered Iraq [56, 57]. Besides, electricity generators that entered the service because of the lack of electricity, and the power cutting for long hours [58, 59]. These generators fueled either to be gasoline or diesel that added a lot of pollutants in the atmosphere [60]. The estimated number of generators that actually work on a daily basis is around 500,000 for powering shops, houses, government departments, in addition to other life facilities [61, 62]. Table 1 lists the numbers of the civil and governmental vehicles and trucks for the period 1970-2003 [63].

The waste resulting from the discovery of oil and its removal and treatment is considered of the most important topics that occupy place among the concerns of local, regional and international bodies [64, 65]. As these wastes constitute an environmental and health hazard in their various areas of presence, whether during production, collection, transport or treatment [66, 67].

Table 1: The governmental and personal cars and trucks in Iraq for the period from 1970 to 2003

Years	Governmental sector	Personal sector	Total
1970	9502	100036	109538
1975	38014	164420	202434
1980	80902	382244	463146
1985	80392	738532	818934
1990	48696	992623	1041319
1995	35258	1039946	1075204
2000	34888	1067040	1101928
2003	29064	1097769	1126833

Studies conducted by national and international organizations have shown that the annual cost of all aspects of air quality degradation may reach to 2% of GDP in developed countries, and more than 5% in developing countries [68, 69]. These include costs of deaths, chronic diseases, hospital treatment and low productivity of workers and farmers in addition to consequence intelligence and low vision due to air pollution [70, 71].

Air pollutants affect human health in varying degrees, depending on their concentrations, dosages, exposure times, general health, age, sex, and other factors [72]. Hydrocarbons, for example, cause respiratory disturbances and increase the risk of leukemia [73, 74]. The ozone gas affects the eyes and lungs and heart functions [75]. Sulfur and nitrogen oxides cause shortness of breath, chronic pulmonary disease, and impaired body immunity [76]. Carbon monoxide limits the human blood ability to transport oxygen, and thus may cause damage to brain cells or suffocation, as well [77]. CO2 affects the blood circulation and nervous system [78]. Lead leads to kidney disease, which affects the nervous system and the brain and leads to increased mental retardation, convulsions, episodes of behavioral changes, etc. [79, 80].

There is a wide range of mitigation options and strategies to reduce air pollution, different from a country to another depending on social and economic well-being [81, 82]. But options like setting air quality standards [83], and setting up networks to monitor air pollutants [84], raise awareness among citizens and decision makers [85], and allocate sufficient funds [86], can be adopted in most developing countries like Iraq [87]. Some countries have taken steps and developed systems designed to solve the problem of air pollution, such as switching to alternative fuels [88, 89], and the imposition of vehicle tests on the roads by mobile devices for emission analysis, air quality control [90, 91].

Burning fuel to produce electricity, run factories and cars is the main cause of air pollution [92]. To reduce this problem, The Iraqi Government should eliminate subsidies on fuel prices, introduce appropriate tax structures, and support Renewable energy technologies such as water, solar, and wind power, and stimulate citizens and sectors across the energy consumption economy [93-96]. Mandatory building laws that take into account energy-efficient designs should also be developed [97, 98]. In the industry sector, the use of waste recovery technologies and automated process controls should be expanded, especially in energy-intensive industries such as cement, steel, and glass plants, as a key part of the "cleaner production" concept [99-102]. In the transport sector, more fuel-efficient technologies, such as electric vehicles and hybrids, which operate on gasoline and electricity, urban traffic management to reduce fuel consumption, rigorous annual exhaust emission checks, public transport promotion of cleaner fuel and most efficient engines [103-108].

Methodology

The studied Area Location

Iraq -according to geological studies- contains about 530 geological structures that give strong indications of the existence of huge oil reservoirs. From these reservoirs, only 115 have been excavated, of which 71 have been proven to contain huge oil reserves spread over many fields. The discovered Iraqi fields are 71 fields and only 27 fields, including 10 giant ones, have been used (Fig.1). Currently oil and gas fields are concentrated in the provinces of Basra and Kirkuk. The bulk of Iraq's oil reserves are concentrated in the south, namely Basra province, where there are 15 fields, 10 of which are productive fields and five are still awaiting development and production. These fields contain oil reserves estimated at more than 65 billion barrels, or about 59% of the total Iraqi oil reserves.

The oil reserves of the provinces of Basra, Maysan and DhiQar combined about 80 billion barrels, or 71% of the total Iraqi reserves. One of the most prominent fields in southern Iraq is the northern Rumaila field, the giant of the Iraqi fields and extends from the west of the city of Basra heading south to enter the southern part of the State of Kuwait, and its most senior is in Iraq. It is the ninth largest oil field in the world and its best oil types. Its exploitation dates back to November 1970. In the 1970s, its wells were less than twenty and now have more than 663 productive wells.

These large numbers of wells produce a large amount of waste that pollutes the soil and air of the area (Fig. 2). Therefore, in our study, air pollution in this area resulted from the drilling and excavation residuals.

Measuring devices

Since the studied area is wide and the concentrations vary from one point to another, measuring devices for regular pollutants such as CO, CO2, HC, NOx have been used. For this purpose portable devices for mobility were used. Table 1 represents the specifications and details of the measuring instruments.

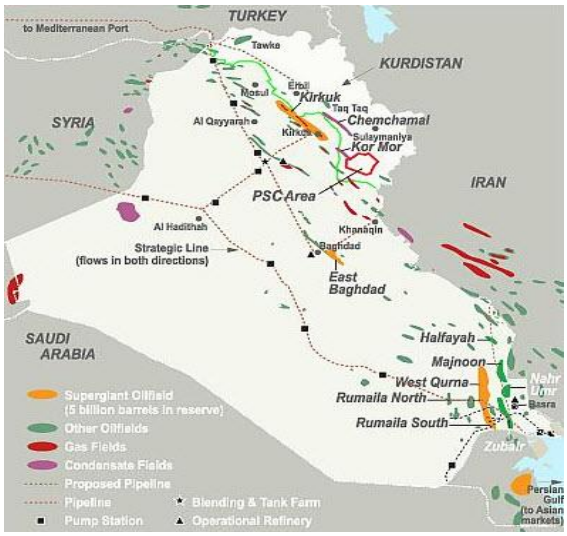

Figure 1: Distribution of oil wells in Iraq

Figure 2: Waste of oil wells and pollution resulting from oil industry

Table 1: measuring instruments specifications

No.	Device name	The measured pollutant	Made in	Range	Uncertainty
1	G460	CO, CO_2, H_2S, NOx, SO_2,O_3	Germany	0-55 ppm	0.14
2	G460	Ozone, VOC	Germany	0-500 ppm	0.12
3	AEROCET	PM1, PM2.5, PM7, PM10, TSP	USA	5-250 ppm	0.2
4	Sound level meter	Sound level	Japan	0-120 dB	0.23

All the measuring instruments were calibrated at the Central Organization for Standardization and Quality Control, Baghdad-Iraq.

Results and Discussion

Fig. 3 shows the average solar radiation intensity distribution with tests daytime; the tests were conducted in March 2017. The curve declares the high solar intensity in the testing period. Iraq, in general, characterized by its high solar radiation intensity as it is located near the red belt. Some reductions in solar radiation intensity appear in 2 to 6 PM because of the smoke clouds in the area resulted from burning natural gases from oil wells.

Fig. 4 shows the average air temperature distribution with daytime. March in Basra Governorate characterized by its mild degrees as the figure indicates, although of the high solar intensity.

Fig. 5 shows the average wind velocity distribution with daytime. The wind speed in the study area and during the testing period was low to light speed. This wind speed caused partial transmission of air pollutants to surrounding areas during the month of March in which the study was conducted.

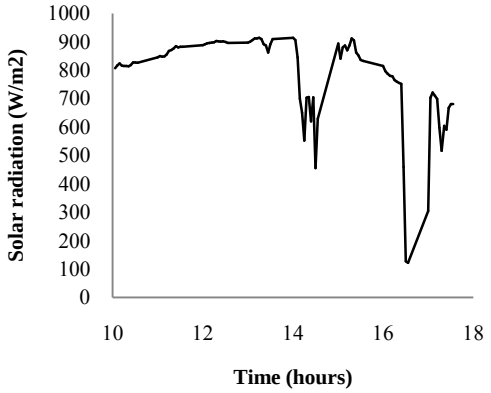

Figure 3: Solar radiation intensity during the tests period

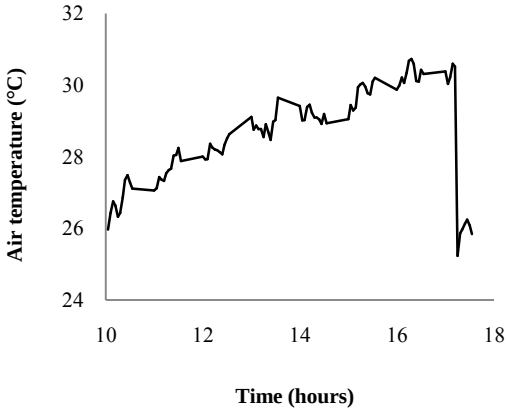

Figure 4: Air temperature during the tests period

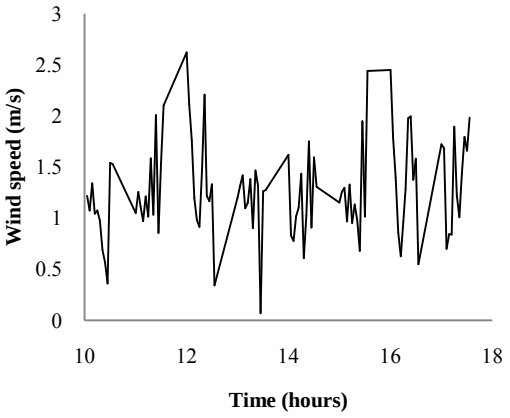

Figure 5: Wind speed during the tests period

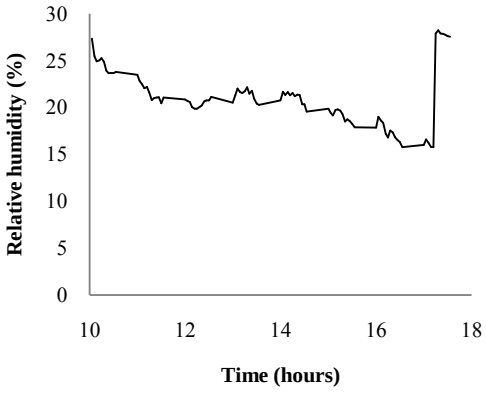

Figure 6: Relative humidity during the tests period

Fig. 6 shows the relative humidity variations with daytime during the tests period. Although Basra is known as a relatively high humidity area most days of the year, the period of study was characterized by low relative humidity. The high humidity in this area generates a significant risk to the public health of those in the region. As the presence of water vapor in the air accompanied by high solar radiation makes the interaction with sulfur, hydrocarbons, and nitrogen oxides compounds emitted confirmed.

Fig. 7 shows the emitted CO, O_3, and CH_4 variations with daytime during the testing period. The measurements show clear quantities of carbon monoxide and ozone pollutants and larger amounts of methane, which is a major component of natural gas. Carbon monoxide is produced by the incomplete combustion of hydrocarbons, in this case natural gas associated with oil. Ozone gas is a by-product of the interaction of non-burnt hydrocarbons with nitrogen oxides. Ozone is a basic compound causing the clouds of chemical and availability in this area facilitates the formation of these clouds and thus poses a danger to the health of peoples living in this area. The figure shows low levels of methane and escalates as time progresses to peak at 06:00 pm. Methane can be added to unburned or partially burnt hydrocarbons that makes the hydrocarbon concentrations very high and higher than the accepted air quality levels.

Fig. 8 shows the NO, NO_2, and NOx average levels distribution during the tests period. The measurements show low levels for all measured pollutants, with a maximum value not6 exceeded of 0.35 ppm. However, these small quantities with high solar radiation and suitable relative humidity accompanied with the availability of ozone and hydrocarbons constitute a dangerous gathering of the composition of the photochemical smog.

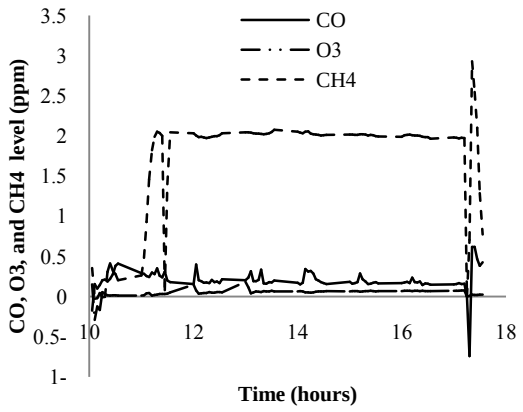

Figure 7: CO, O_3, and CH_4 concentrations in air during tests period

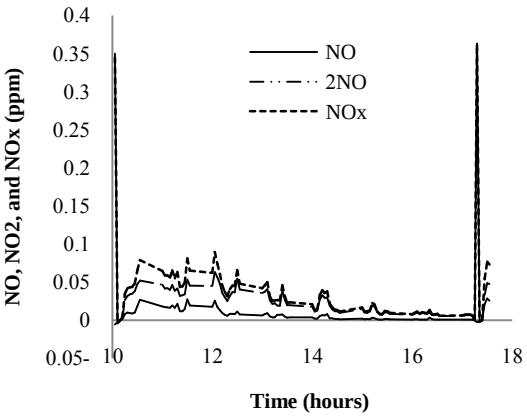

Figure 8: NO, NO_2, and NOx concentrations in air during tests period

Fig. 9 shows the SO_2 and H_2S average levels distribution through the testing period. These concentrations are high at the beginning of the morning and then decrease to very low levels and then jump at the evening. The presence of concentrations of sulfur compounds in the air in conditions of high temperature and solar radiation with the availability of water vapor due to high humidity as is the atmosphere of the province of Basra most days of the year makes the region likely to be fumes sulfuric acids, which cause respiratory ulcers at any concentration.

Fig. 10 shows the CO_2 concentrations during the testing period. The concentrations of carbon dioxide are high compared to other measured pollutants because it is a natural result of burning millions of cubic feet of natural gas associated with oil without benefiting from it. It is known that this gas is the main cause of global warming, so reducing its rates is required. The best way to get rid of this pollutant is through vegetation, but unfortunately this province, which was devastated by wars for four decades, lost most of its vegetation and also increased the salinity of its water. The Iraqi government should direct oil companies working to reduce the burning of natural gas associated with oil. The remnants of drilling contaminants and the development of wells and being mixed with traces of Iraqi oil can be a reason to increase concentrations of hydrocarbons and sulfur associated with Iraqi oil. The increase in vegetation in the province of Basra has become a necessity and inevitable imposed by the huge amount of air pollution and to improve the quality of air. It is also necessary to impose instructions and laws to maintain the safety of workers in these areas and the need to wear masks and special clothing to prevent contact with these pollutants to their skin or respiratory system.

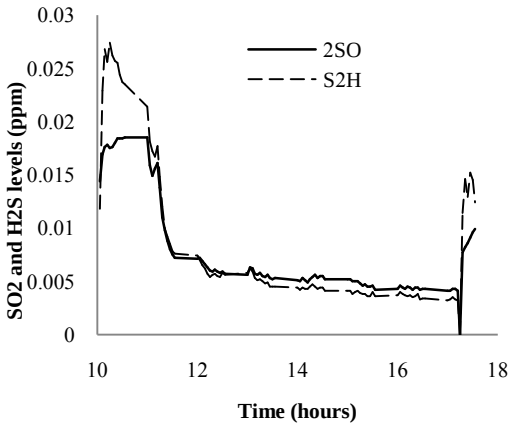

Figure 9: SO_2 and H_2S concentrations in air during tests period

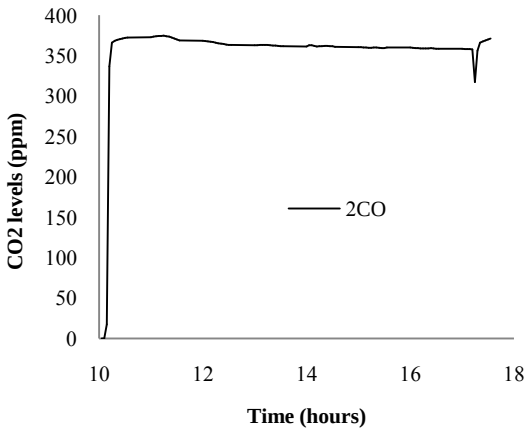

Figure 10: CO_2 concentrations in air during tests period

Conclusions

The province of Basra in Iraq has special economic interest as it contains 70% of the country's oil reserves. The northern Rumailiya field is one of the most important oil fields in the world and it extends to a large area in this province. In this study, measurements were made for the concentration of many pollutants at different points of the field during the month of March 2017. The results showed that the concentrations of carbon monoxide and ozone are low compared to the concentration of methane. The presence of ozone concentrations means an important interaction between methane and nitrogen oxides to produce ozone. The availability of these three components with high-intensity solar radiation, as described in the study, can cause photochemical smog affecting the areas where it is formed. It is known if there is a movement of wind that may cause the transfer of these clouds to population areas, which causes a danger to public health and properties. This study showed clear concentrations of sulfuric components such as SO_2 and H_2S and the risk of these compounds in the possibility of turning into sulfuric acids, which are very dangerous to health. This study beats the alarm, indicating the depth and intensity of environmental pollution that controls the studied area and the competent authorities to work hard in controlling the pollution resulting from the burning of natural gas associated with oil extracted or because of the waste of exploration and development of oil wells.

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