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# Ambient Air Quality in the Industrial Area of Khor Al-Zubayr, Southern Iraq

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## Abstract:

The objective of this study is to determine the levels of gaseous pollutants, as indicators of ambient air quality, emitted from the industrial area of Khor Al-Zubayr, Southern Iraq. Several polluting-induced industries, such as petrochemical complex, gas liquefier plant, steel and iron complex, fertilizers factory, and gas-fueled power station, are located on the study area. Gaseous pollutants such as HCs, NOx, SOx, HCHO, $O_3$, and $CO_2$ measured using the portable detection instrument of Drager Chip-Measurement System, Germany, whereas portable instrument of RK1 Gas Monitoring Eagle II, USA, detected the pollutants of $CH_4$, $H_2S$, and CO. Fieldwork carried out during 2012 at six selected stations in the study area. The results have showed that there a spatial variability in gaseous concentrations throughout the selected stations. The measured concentrations of CO, $CO_2$, NOx, SOx, $H_2S$, HCs, $CH_4$, and HCHO ranged from10.11 to 35.63, 100.01 to 400.01, 0.21 to 3.12, 0.92 to 9.59, 1.12 to 5.28, 10.51 to 28.21, 9.21 to 20.52, and 0.11 to 1.25 ppm, respectively; while $O_3$ concentrations ranged from 0.01 to 0.24ppb. By comparison, the recorded levels differ with the previous studies results. These levels lies within the recommended guidelines and in other cases exceed it. Generally, air quality in the study area is safe. Some gaseous pollutants concentrations, however, may represents potentially hazard on the public health. Therefore, the need for more rigorous longitudinal monitoring with repeated measures across seasons and spaces to air pollution is necessary.

**Keywords:**

Air quality, Atmospheric pollution, Gaseous pollutants, KhorAl-Zubayr.

**الخلاصة:**

تهدف هذه الدراسة إلى تحديد مستويات الملوثات الغازية المنبعثة من المنطقة الصناعية لخور الزبير، كمؤشر على نوعية الهواء الجوي. تشتهر منطقة الدراسة بتوطن العديد من الصناعات المسببة للتلوث فيها، وخاصة النفطية والكيماوية، مثل معمل البتروكيماويات، معمل الغاز السائل، معمل الحديد والصلب، معمل الأسمدة الكيماوية، محطة الكهرباء الغازية. أجري قياس الملوثات الهيدروكربونات، أكاسيد النتروجين، أكاسيد الكبريت، الفورمالدهايد، الأوزون، وثنائي أكسيد الكربون بجهاز كاشف الغازات المحمول نوع Drager CMS، ألماني المنشأ، فيما قيست الملوثات غاز الميثان، كبريتيد الهيدروجين، وأحادي أكسيد الكربون بجهاز من نوع RK1 Gas Monitoring Eagle II، أمريكي المنشأ. أجريت القياسات حقلياً خلال العام 2012 في ست محطات مختارة عبر منطقة الدراسة. وأظهرت النتائج أن تراكيز الغازات كانت متباينة مكانياً عبر محطات القياس، إذ كانت تراكيز أحادي أكسيد الكربون تتراوح بين 10.11 – 35.63 جزء بالمليون، ثنائي أكسيد الكربون 100.01 – 400.01 جزء بالمليون، أكاسيد النتروجين 0.21 – 3.12 جزء بالمليون، أكاسيد الكبريت 0.92 – 9.59جزء بالمليون، الأوزون 0.01 – 0.24 جزء بالبليون، كبريتيد الهيدروجين 1.12 – 5.28 جزء بالمليون، الهيدروكربونات 10.51 – 28.21 جزء بالمليون، الميثان 9.21 – 20.52 جزء بالمليون، الفورمالدهايد 0.11 – 1.25 جزء بالمليون. وبحسب المقارنة، فإن المستويات المسجلة تتباين عما مسجل في الدراسات السابقة. كما أن هذه المستويات تقع أحياناً ضمن المحددات البيئية الموصى بها لكنها في أحيان أخرى تتجاوزها. ويمكن القول أن نوعية الهواء في منطقة الدراسة آمنة عموماً، لكن هناك بعض الملوثات الغازية قد تمثل خطراً محتملاً على الصحة العامة. لذلك، فإن الحاجة ماسة لمزيد من الرصد الفصلي والمكاني الدقيق والمتكرر لتلوث الهواء في هذه المنطقة.

## Introduction:

Atmospheric pollution defines as that "the presence of contaminants or pollutant substances in the air that interfere with human health or welfare, or produce other harmful environmental effects" (Vallero, 2008). Furthermore, atmospheric pollution is taken to be "the presence in the atmosphere of substances or energy in such quantities and of such duration as to be liable to cause harm to human, plant, or animal life; or damage to human-made materials and structures;

or changes in the weather and climate; or interference with the comfortable enjoyment of life or property or other human activity" (Gittins, 1999).

Air pollutant is any smoke, soot, fly ash, dust, dirt, fume, non-naturally occurring gas, odor, toxin, or radioactive substance occurring within an environment (Koren, 2005). Not all pollutants are a result of human activity. Natural pollutants are those which are found in nature or are emitted from natural sources. For example, volcanic activity produces sulfur dioxide, and particulate pollution may derive from forest fires or windblown dust. Anthropogenic pollutants are those which are produced by humans or controlled processes. For example, sulfur dioxide is produced by fossil fuel combustion and particulate matter comes from diesel engines. Air pollutants are classified as primary or secondary. Primary pollutants are those which are emitted directly into the atmosphere from an identifiable source. Examples include carbon monoxide and sulfur dioxide. Secondary pollutants are those which are produced in the atmosphere by chemical and physical processes from primary pollutants and natural constituents. For example, ozone is produced by hydrocarbons and oxides of nitrogen (both of which may be produced by car emissions) and sunlight (Christoforou, 2004).

Atmospheric pollution can have a devastating effect on human and animal health; damages vegetation; causes the destruction of building materials, fabrics and decoration; and brings about climatic change (Gittins1999).

A recent report of the Department of Health's Committee on the Medical Effects of Air Pollution contains estimates of the number of deaths and hospital admissions due in part to poor air quality. The suggestion that up to 24000 deaths a year are brought forward by air pollution should act as a spur to encourage creative approaches to air quality problems (Megainey, 1999).

However, to well understand the atmospheric pollution of a given area, should have assessed an ambient air quality in that area. Air quality is the levels of

pollution and lengths of exposure at which specific adverse effects to health and welfare may occur; recommend regulations reflect these levels. Therefore, air quality assessment is the collection, handling, evaluation, analysis, and presentation of data required to understand the air pollution problem of a given area and its causes (Koren, 2005).

The study area (Khor Al-Zubayr) is located in Basra, Southeast Iraq as shown in Figure1. Khor Al-Zubayr considers as an industrial area because of several existing industries. In general, considerably varied temperatures, elevated solar radiation, low quantity of rainfalls, and high relative humidity characterize the climate of the study area.

The importance of present study lies in necessary of assessing air quality in the industrial area atmosphere of Khor Al-Zubayr, because the study area have many of human activities that resulted in excessive gaseous emissions and air pollutants. Gaseous emissions from industrial sources includes those which released by petrochemical complex, gas liquefier plant, steel and iron complex, fertilizers factory, and gas-fueled power station, as well as burned natural gas flames. Therefore, constant environmental assessing and monitoring of ambient air quality at the study area in the terms of recommended exposure levels of air pollutant concentrations is urgent action.

## Materials and Methods:

Six sampling stations were chosen in the study area. The distances between these stations are almost equal. The sampling station No.1 is in vicinity of petrochemical complex northward, while the sampling station No.6 move away fertilizers factory southward figure(1).

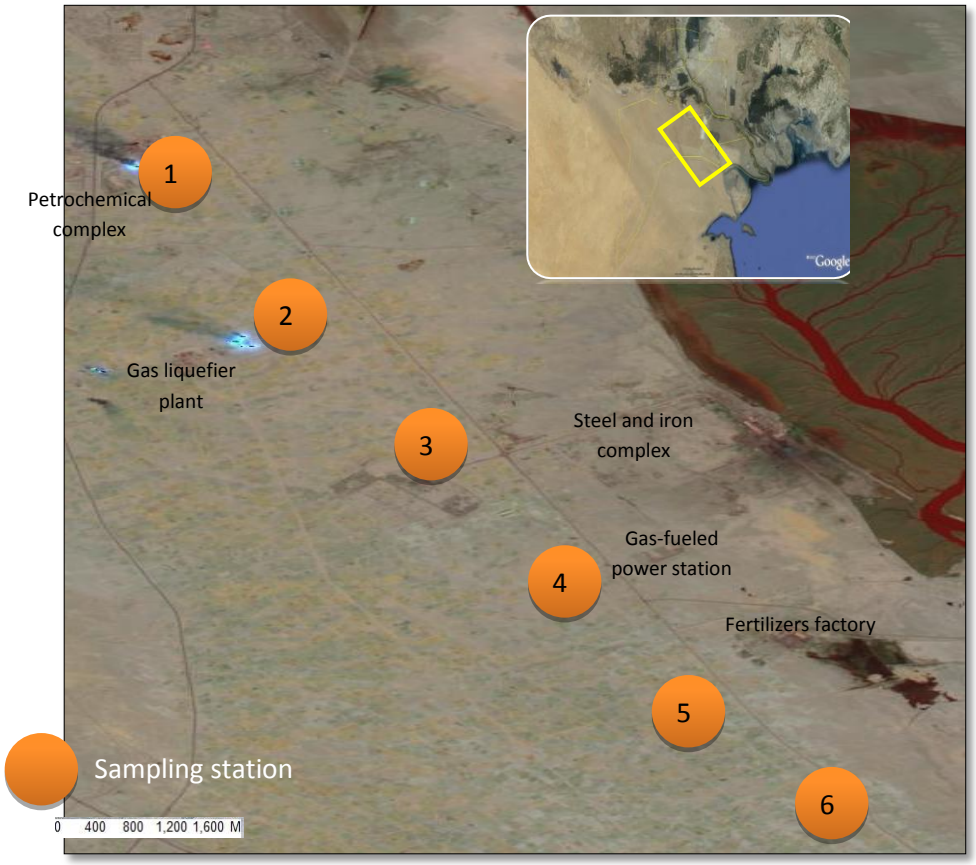



**Fig. (1) Map of the study area (Khor Al-Zubayr, Basra, Southern Iraq) and sampling locations.**

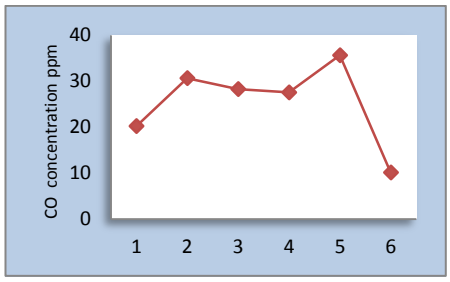
The selected stations were in order to monitor the ambient air quality and gaseous emissions released from the nearby industrial plants. A variety of gaseous pollutants such as carbon monoxide (CO), carbon dioxide ($CO_2$), sulfate oxides (SOx), nitrogen oxides (NOx), ozone ($O_3$), petroleum hydrocarbons (HCs), methane ($CH_4$), hydrogen sulfide ($H_2S$), and formaldehyde (HCHO), measured in this work. Concentrations of HCs, NOx, SOx, HCHO, $O_3$, and $CO_2$ measured using the portable detection instrument of Drager Chip-Measurement System, Germany, whereas the portable instrument of RK1 Gas Monitoring Eagle II, USA, detected the pollutants of $CH_4$, $H_2S$, and CO. Fieldwork carried out during 2012. The procedure of measuring was as described by Douabul et al (2013).

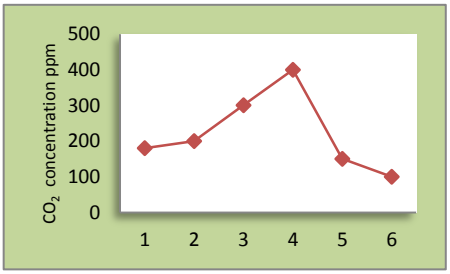
## Results and Discussion:

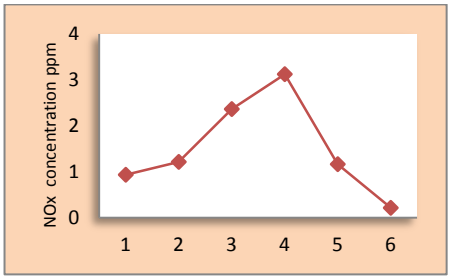
The concentrations of gaseous pollutants measured in the six stations listed in table (1) and shown in figure( 2).

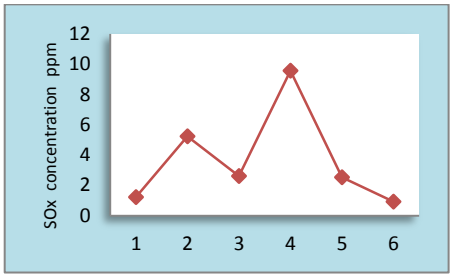
**Table (1) Concentrations of the selected gaseous pollutants in ambient air of KhorAl-Zubayr during 2012.**

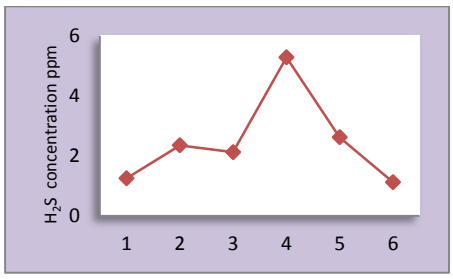
| Sampling station | CO (ppm) | $CO_2$ (ppm) | NOx (ppm) | SOx (ppm) | $H_2S$ (ppm) | HCs (ppm) | $CH_4$ (ppm) | HCOH (ppm) | $O_3$ (ppb) |
|---|---|---|---|---|---|---|---|---|---|
| **1** | 20.21 | 180.32 | 0.93 | 1.22 | 1.25 | 12.23 | 10.25 | 0.22 | 0.02 |
| **2** | 30.65 | 200.03 | 1.21 | 5.23 | 2.35 | 25.36 | 12.43 | 0.92 | 0.03 |
| **3** | 28.27 | 300.64 | 2.36 | 2.61 | 2.12 | 22.13 | 12.26 | 0.72 | 0.02 |
| **4** | 27.54 | 400.01 | 3.12 | 9.56 | 5.28 | 28.21 | 20.52 | 1.25 | 0.24 |
| **5** | 35.63 | 150.21 | 1.16 | 2.53 | 2.62 | 15.43 | 12.22 | 0.63 | 0.21 |
| **6** | 10.11 | 100.01 | 0.21 | 0.92 | 1.12 | 10.51 | 9.21 | 0.11 | 0.01 |
| **Mean** | 25.40 | 221.87 | 1.49 | 3.67 | 2.45 | 18.97 | 12.81 | 0.64 | 0.08 |

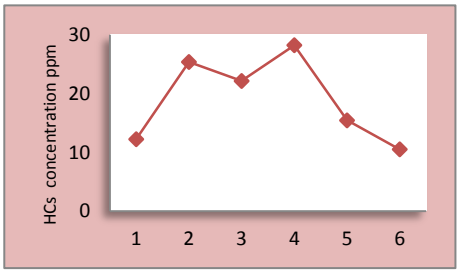


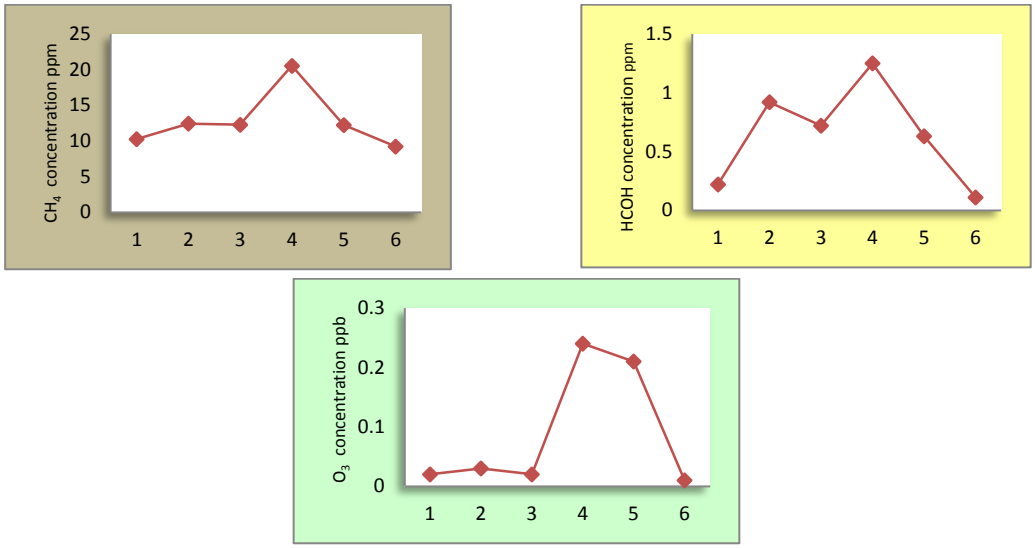



**Fig. (2) Graphic representation of air pollutant concentrations in KhorAl-Zubayr during 2012 Based on Table (1)**

The results indicate that there is a spatial variation in the recorded concentrations of all the monitored gaseous pollutants. They progressively increased starting from the sampling station No.1 until No.5, and then significantly decreased at station No.6. This may primarily attributed to the direct effect of gaseous emissions released from the industrial plants near the stations No.1 to 5, whereas station No.6 is relatively distant from the source of industrial pollution. In general, station No.4 records the higher concentrations when compared to the other studied stations. This is due to the location of sampling station No.4 existing between the steel and iron complex, gas-fueled power plant, and fertilizers factory. The emissions releasing from those three industrial facilities accumulate in the surrounding micro-atmosphere, and this act as increase in the gaseous concentration.

During the study period, concentration of CO ranged from 10.11 to 35.63ppm, with mean concentration of 25.40ppm. The concentration of $CO_2$ ranged from 100.01 to 400.01ppm, with mean concentration at 221.87ppm. The concentration of NOx ranged from 0.21 to 3.12ppm, with mean concentration of 1.49ppm. The concentration of SOx ranged from 0.92 to 9.59ppm, with mean

concentration of 3.67ppm. The concentration of $H_2S$ ranged from 1.12 to 5.28ppm, with mean concentration of 24.5ppm. The concentration of HCs ranged from 10.51 to 28.21ppm, with mean concentration of 18.97ppm. The concentration of $CH_4$ ranged from 9.21 to 20.52ppm, with mean concentration of 12.81ppm. The concentration of HCOH ranged from 0.11 to 1.25ppm, with mean concentration of 0.64ppm. Moreover, the concentration of $O_3$ ranged from 0.01 to 0.24ppb, with mean concentration of 0.08ppb.

Table (2) shows a comparison between the results in the present work and those in the previous studies. The comparison demonstrate that there is significant variability in the registered values between this study and those which for others. This may refers to the differences in the adopted measuring durations, instruments, and procedures. The careful examination, however, indicates that the present concentrations are relatively less than those that recorded in the previous studies. Nonetheless, some concentrations such as CO, NOx, SOx, and HCs are of concern.

**Table (2) Comparison between the results (mean concentration) of present work and those of previous studies.**

| CO (ppm) | $CO_2$ (ppm) | NOx (ppm) | SOx (ppm) | $H_2S$ (ppm) | HCs (ppm) | $CH_4$ (ppm) | HCOH (ppm) | $O_3$ (ppb) | Ref. |
|---|---|---|---|---|---|---|---|---|---|
| 12.5 | - | - | 1 | - | 3 | - | - | - | Al-Asadi, 1998 |
| 52.5 | 0.19 | - | 22.5 | 4 | 15 | - | - | - | Al-Mayahi, 2005 |
| 10 | 0.04 | - | 10 | 2.5 | 10 | - | - | - | Al-Saad, 2005 |
| - | 174 | - | - | - | - | 40.5 | - | - | Al-Imarah et al, 2007 |
| 27.3 | 270 | 2.51 | 0.57 | 11 | 22.0 | - | - | 0.16 | Al-Hassen, 2011 |
| 7.37 | 280 | 0.35 | 0.36 | - | - | - | - | - | Qassim, 2011 |
| 11 | 255 | 0.9 | 0.65 | - | 0.8 | - | - | - | Douabul et al, 2013 |
| 25.40 | 221.87 | 1.49 | 3.67 | 2.45 | 18.97 | 12.81 | 0.64 | 0.08 | **The present study** |

From a viewpoint of public health, table (3) shows a comparison between pollutants concentrations in this study and the recommended concentrations of air pollutants by WHO (2005; 2010), EPA (2011), and MoE (2012).

**Table (3). Comparison between the results (minimum and maximum concentration) in the present study and the recommended guidelines.**

| CO (ppm) | $CO_2$ (ppm) | NOx (ppm) | SOx (ppm) | $H_2S$ (ppm) | HCs (ppm) | $CH_4$ (ppm) | HCOH (ppm) | $O_3$ (ppb) | Ref. |
|---|---|---|---|---|---|---|---|---|---|
| 9-35 | 5000-30000 | 0.015-0.100 | - | - | - | - | 0.1-0.2 | 0.050 | WHO, 2005; 2010 |
| 9-35 | 10000 | 0.53 | 0.03-0.50 | - | - | - | - | 0.075-0.12 | EPA, 2011 |
| 10-35 | - | 0.04-0.05 | 0.018-0.1 | 4.5-9 | 18 | 18 | 0.2 | 0.06 | MoE, 2012 |
| **10.11-35.63** | **100.01-400.01** | **0.21-3.12** | **0.92-9.59** | **1.12-5.28** | **10.51-28.21** | **9.21-20.52** | **0.11-1.25** | **0.01-0.24** | **The present study** |

Within the guide
Exceed the guide

The comparative analysis reveals that the present minimum and maximum concentrations of CO, NOx, and SOx were higher than the recommended exposure of levels for all the guidelines of WHO, EPA, MoE. The minimum concentrations of $H_2S$, HCs, $CH_4$, HCOH, and $O_3$ were within the guidelines, whereas the maximum concentrations of mentioned pollutants exceeded the recommended concentrations. The minimum and maximum concentrations of $CO_2$, however, were less than the guidelines.

## Conclusion:

It is obvious that the recorded concentrations of gaseous pollutants in this study are spatially varied. This may due to the direct and indirect impact of emissions released from industrial plants, depending on the locations of monitored sampling stations.

Generally, air quality of the study area is safe. Some gaseous pollutants concentrations, however, may represents a potentially hazard on the public health. Therefore, the need for more rigorous longitudinal monitoring with repeated measures across seasons and spaces to air pollution is necessary.

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