

Determination of some oxides, methane and some aromatic compounds in air via monitoring station in Babylon province during 2011

قياس تراكيز بعض الأكاسيد والميثان وبعض المركبات الأروماتية في الهواء في محطة الرصد الجوي لمحافظة بابل خلال عام 2011

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Abstract

The air pollution by any biological agent, physical or chemical may alter the natural characteristics of the atmosphere and harm happens to humans, animals and plants. Therefore, this study came for the purpose of conducting measurements of certain air pollutants that may cause concern to public health or have global effects.

Air pollution by aromatic compounds, carbon oxides, nitrogen oxides, sulfur oxides and methane were investigated monthly during 2011 by weather station of Babylon university within the province of Babylon by using the following devices: Fluorescence SO₂ Analyzer, Chemiluminescence NO_x Analyzer, Photometric O₃ Analyzer, Gas Filter CO₂ Analyzer, Synspec alpha 115 VOCs Analyzer GC and Synspec alpha 115 Methane Analyzer. The correlation coefficient was used to determine the relationship between pollutants and meteorological measuring. The results showed that the concentrations of SO₂, NO, NO₂, CO₂, O₃ and CH₄ were (0.31 - 27.17), (20.27 - 63.60), (49.13 - 136.26), (346.25 - 1648.75), (39.88- 75.70) and (1.31-3.08) ppm respectively and the concentrations of (aromatic compounds) *O*-xylene, *P*-xylene, benzene, ethyle benzene and toluene were (0.03 -0.23), (0.00 - 0.11), (0.16 -0.33), (0.21-0.51) and (0.19 - 0.49) ppb respectively on weather station during 2011. The results indicated that a high positive correlation between O₃ with air temperature and negative correlation with relative humidity. Also positive correlation between *O*-Xylene with air temperature and negative correlation with relative humidity.

الخلاصة

ان تلوث الهواء الناتج عن طريق أي عامل سواء كان بيولوجي أو فيزيائي أو كيميائي قد يغير الخصائص الطبيعية للغلاف الجوي ويحدث ضررا للإنسان والحيوان والنبات. لذلك جاءت هذه الدراسة لغرض إجراء قياسات لبعض ملوثات الهواء التي قد تسبب قلقا على الصحة العامة أو لها تأثيرات عالمية.

تم دراسة تلوث الهواء بالمركبات الأروماتية وأكاسيد الكربون وأكاسيد النيتروجين وأكاسيد الكبريت والميثان من خلال فحصه يوميا داخل محطة الرصد الجوي في جامعة بابل خلال العام 2011 باستخدام الأجهزة التالية: المحلل لـ SO₂ فلورسنس والمحلل لـ أكاسيد النيتروجين Chemiluminescence والمحلل لـ O₃ الفوتومترية وفلتر الغاز المحلل لـ CO₂ والمحلل للمركبات العضوية المتطايرة Synspec ألفا 115 (GC) والمحلل للميثان Synspec ألفا 115. كذلك استخدم معامل الارتباط لتحديد العلاقة بين الملوثات وقياسات الأرصاد الجوية.

أظهرت النتائج أن تركيز SO₂ و NO و NO₂ و CO₂ و O₃ و CH₄ كانت (0.31- 27.17) و (20.27- 63.60) و (49.13- 136.26) و (346.25- 1648.75) و (39.88- 75.70) و (1.31- 3.08) جزء في المليون على التوالي وتراكيز (المركبات الأروماتية) *O*-زيلين و *P*-زيلين و البنزين واثيل البنزين و التولوين كانت (0.03- 0.23) و (0.00- 0.11) و (0.16- 0.33) و (0.21- 0.51) و (0.19- 0.49) جزء في البليون على التوالي في محطة رصد الهواء خلال عام 2011. وأشارت النتائج إلى أن

وجود علاقة إيجابية عالية بين O_3 مع درجة حرارة الهواء وارتباط سلبي مع الرطوبة النسبية. أيضا علاقة إيجابية بين O-الزيلين مع درجة حرارة الهواء وارتباط سلبي مع الرطوبة النسبية.

Introduction

Air pollution is an essential detector of health, many epidemiological search and studies have detected a clear correlation between health problems and air pollution which ranges from simple to complex health problems such as asthma and other diseases, most of these studies investigated the concentration of particulate matter , ozone, nitric oxide (NO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and other air pollutants [1].

There are many gases can be consider as air pollutant, such as SO_2 which is nonflammable, colorless gas that has a powerful odor which can be recognized by human, humans emission of this gas are responsible for one third of the sulfur compound found in the atmosphere. SO_2 is very soluble in water and forming sulfuric acid and causing an acid rain [2]. There are a mixture of nitrogen oxides in the air, particularly two of these oxides are important from toxicological point of view, which are nitric oxide and nitrogen dioxide, NO has a sweet sharp smell while NO_2 has a strong harsh odor at room temperature, nitrogen oxides are used for rocket fuel and production of explosives [3]. Another air pollutant is carbon dioxide CO_2 which is a colorless, tasteless, with no smell gas, it is produced naturally as a result of breathing , it is known to effect the cycle of heat from and to atmosphere [4]. While ozone is found in the atmosphere which protect Earth from the ultraviolet rays, normally found in the lower part of the stratosphere [5]. Also methane CH_4 is rising concern for environment climate change as it consider a potential agent of global warming and it need an urgent attention [6]. On the other hand xylene is flammable, colored or without color with strong sweet smell and it evaporate fast into the air, in general there are three forms of xylene, which are meta-xylene (*M-xylene*) , ortho-xylene (*O-xylene*) and para-xylene (*P-xylene*), that differ between each other in the site of the methyl groups on their benzene ring [7]. Toluene enter the air during the process of production , transportation of petrol which contain about 5-8% toluene [8]. Another important air pollutant is benzene which is an organic compound results for different sources of emission into the air, benzene has no color and the odor similar to the gasoline [9]. At last but not less ethyl benzene which is liquid at room temperature, ethyl benzene present in a mixture with xylene in gasoline or as solvent, and it can enter the urban air from the combustion of gasoline in the cars [10]. This study is a simple effort to build a data base for the air pollutant that found in the Hillah city and make it in the reach for the new researchers that interested with air pollution.

Materials and Methods

In this study, the aromatic compounds, carbon oxides, nitrogen oxides, sulfur oxides, methane, toluene, benzene, and ethyl benzene were investigated on 2011 by weather station of Directorate of Environmental Protection and Improvement in the Middle Region Euphrates in Babylon University within Babylon province (Map 1), the measurement of these air pollutants concentration were conducted daily in the period of 8.30-12.00 A.M. at the height of 3 M by using the following devices and instruments :

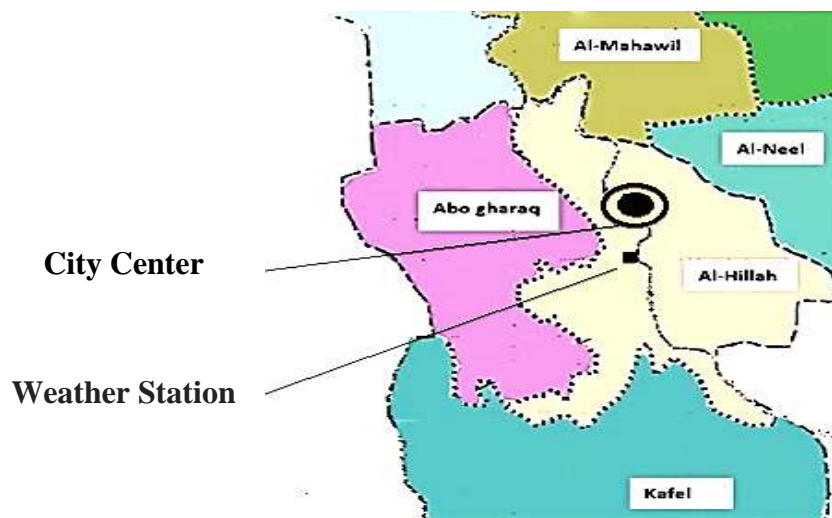
- 1-Fluorescence SO_2 Analyzer- Model 100E - UK, for measuring SO_2 concentration.
- 2-Chemiluminescence NO_x Analyzer- Model 200E –UK, for measuring NO and NO_2 concentrations.
- 3-Photometric O_3 Analyzer Model 400E –UK, for measuring Ozone concentration.
- 4-Gas Filter CO_2 Analyser- Model 360E –UK, for measuring CO_2 concentration.
- 5-Synspec alpha 115 VOCs (volatile Organic Compound) Analyser GC –UK, for measuring *O-Xylene*, *P-Xylene*, Benzen, Ethyle Benzen and Toluene concentrations.

6-Synspec alpha 115 Methane Analyser M/TNMHC –UK, for measuring CH₄ concentrations.

In the station there is a system of meteorological measuring, the measuring of air temperature by (Metone, Model 592), relative humidity by (Metone, Model 594), wind speed and direction by Wind sonic (Crill windsonis).

Correlation coefficient between aromatic compounds, carbon dioxide, nitrogen oxides, sulfur oxides and methane with wind speed, air temperature °C and relative humidity % respectively was used to determine the relationship between two properties according to the following equation :

$$\text{Correl}(X, Y) = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2 \sum (y - \bar{y})^2}}$$



Map 1: Location of study area and weather station

Results and Discussion

Air pollution has a different effects human health practically on children, in this order a guideline must be done and this must determine on the basics of the available data and researches[1]. In this study, the concentration of several factors of air pollution were measured, as shown in Table(1). It was study the correlation between every air pollutants with the wind speed, air temperature and relative humidity.

Transportation is the main origin of air pollution, it is responsible for 80% of the entire air pollutants, among these pollutants is SO₂, which is a chemical irritant that effects the mucous lining of respiratory tract and it is responsible for the acid rain, it is valued that 50% of this gas emission from coal burning , and 25 to 30% of its emission to air from oil burning [11]. As shown in the Fig. 1 all the concentrations of the SO₂ exceeded the acceptable limit which is 0.5 ppm [2], except in February the concentration of SO₂ was within the limits, the statistic studies show that there are a week positive correlation between SO₂ and air temperature and low correlation with relative humidity% (R.H.%) and very low correlation with wind speed, as shown from Fig.1 the lowest SO₂ concentration at January and the highest concentration at October, the concentration of SO₂ was low during the cold season and start to increase in the worm season and start to decline at December.

Nitrogen oxides are formed in the atmosphere both naturally and due to human activities from burning fossil fuel, in the atmosphere the N₂ is react with O₂ and form NO , which then react again with O₂ to form NO₂, which is not a component of fuel but result from a catalytic reaction of heat with the atmospheric N₂ and O₂. The main source of the NO_x emissions is automobiles and power

plants, the increase in the vehicles increase the concentrations of NO_x in the air [12]. As shown in Fig. 2 there was a fluctuation in the concentration of NO, the lowest concentration of NO was observed in July which was 20.27 ppm and the highest concentration was observed in October 63.6 ppm, there is no known limit for NO in ambient air, the correlation studies show there is a moderate negative correlation between NO and air temperature and wind speed and week positive correlation with R.H.%.

Fig.3 show the concentration of NO_2 there was a fluctuation in the concentration of NO_2 , the lowest concentration was 49.13 ppm in January and the highest concentration was 136.26 ppm in October, as shown in Table 1 there was a week negative correlation between NO_2 and wind speed and R.H.%, while there was a week positive correlation between NO_2 and air temperature .the WHO limit for this gas is 0.21 ppm [13]. And all the reading in this study exceeded this limit by far, and the increase in the NO_2 concentration can cause lung injury, asthma and chronic obstructive pulmonary diseases [14].

The emission of CO_2 is the final by-product of burning all matters, along with NO_x and CO. CO_2 cause greenhouse effect, which led to global warming, were the billions of tons of CO_2 that form anthropogenic activities cover the planet like a blanket (Small and Kazimi,1995). Also CO_2 is responsible for forming acid rain [14]. The WHO stipulated limit for CO_2 is 20,000 ppm [15], all the concentrations of CO_2 in this study was within the limit. The Fig.4: illustrates the concentration of CO_2 , the lowest concentration of CO_2 was noted in July 346.25 ppm and the highest concentration was 1648.75 ppm in February, all the concentration were in the range of 350-400 ppm except for February which show elevated concentration due to the fact that there was a nearby brick factory which then closed after that month. As shown from Table 1, there was a very week negative correlation between CO_2 and wind speed, week negative correlation with air temperature and strong positive correlation with R.H.%.

Ozone is colorless gas that has a highly reactive capability with sharp odor, it's usually mistaken between ozone layer which found in the stratosphere 15-20 Km above the earth surface, and the ozone gas which found in atmosphere, which consider a major health concern, the ozone dose not released from any source directly, but its form the reaction between organic volatile compounds from motor vehicles, refineries, petrochemicals. Deferent health effects such as : lung disease, asthma and also has adversative damages on building and plants, the limit for ozone is 0.10 ppm (1 hour), and 0.08 (4 hour) [16]. As revealed in Fig. 5, the highest concentration of ozone was in 72.56 ppm August, and the lowest was 38.2 ppm in December, all the concentrations were exceeded the limit by far, there was a moderate positive correlation between the ozone gas and wind speed, and very strong positive correlation between ozone and air temperature, as well as, there was a negative correlation between ozone and R.H.%.

Methane emissions symbolize a danger to our climate, reducing the methane emission is life-threatening to reduce the overall emission of greenhouse gases [17].It worth mention that the burning of natural gas as well as from shale gas is low in the production of CO_2 , but it exert a large amount of CH_4 which is more effective in the greenhouse effect, since it is trap heat in the atmosphere and effect and influent greenhouse gas footprint GHGs [18]. Fig.6 displays the concentrations of methane through the study period, the highest concentration for CH_4 was 3.08 ppm in November and the lowest concentration was 1.31 in April. There was a week positive correlation between CH_4 and wind speed, while the was very week negative correlation between CH_4 and air temperature, and there was a very week positive correlation between CH_4 and R. H.%.

Xylene characterized the three isomers of dimethyl benzene, which are ortho-, meta- and para- form of molecule. Xylene isomers are unlimited importance in petrochemical production, *O*-xylene is chiefly used for the manufacturing of *O*-dicarboxylic anhydride, which is vital raw material used in plasticizer, unsaturated polyester, alkyl resins, dyes, medicine and agriculture [19]. Most people start to smell Xylene in air at 0.08-3.7 ppm [20]. Fig.7 show the concentrations of *O*-

xylene, the highest concentration was 0.23 ppm in September and the lowest concentration was 0.03ppm in January, there was a week positive correlation between *O*-xylene and both air temperature and wind speed, and strong negative correlation between *O*-xylene and R.H.%.

The most common aromatic compounds result from the vehicles in urban places are benzene, toluene, xylene and ethyl benzene (BTEX). It been found that motor vehicle emissions impact ambient levels of (BTEX) [21]. Humans can be exposed to xylene from different sources such as : gasoline, varnish, shellac, rust preventives and cigarette smoke [20]. *P*-xylene is used mainly in the production of terephthalate, which is the main raw material used to manufacturing resin and films. *P*-xylene is also used to produce dimethyl terephthalate [22]. Fig. 8 show the concentrations of *P*-xylene, the concentration of *P*-xylene was zero in August, October and December and the highest concentration was 0.11 ppm in March. There was a moderate positive correlation between *P*-xylene and wind speed, while there was a low negative correlation between *P*-xylene and air temperature and very low negative correlation between *P*-xylene and R.H.%.

Under the representative ambient conditions, some liquid benzene will evaporate and occur as gas in the ambient air, benzene is listed as a carcinogenic agent to humans. Benzene is considered a "non-threshold toxicant", that mean at any concentration when the benzene in the air it will have effects on organisms [23]. Fig.9 illustrates the concentrations of benzene, the highest concentration was 0.8 ppm in April and the lowest concentration was 0.16 ppm in January. There was a week negative correlation between benzene and air temperature, while there was a weak positive correlation between benzene and both of wind speed and R. H.%

Ethyl benzene is an essential in the petrochemical manufacturing as intermediate in the production of styrene, that used for making polystyrene [24]. Ethyl benzene found in crude oil and as component of xylene mixture that used in gasoline , costumers can be exposed to ethyl benzene during refueling with concentration of 0.01 ppm [10]. EPA has set a life time exposure to 0.7 ppm [7]. Fig.9 exemplifys the concentrations of Ethyl benzene, the highest concentration was 0.51 ppm in February and the lowest concentration was 0.21 ppm in April all the concentrations were within the limits. There was a week negative correlation between Ethyl benzene and both wind speed and air temperature, while there was a moderate positive correlation between Ethyl benzene and each of wind speed and R. H.%.

Toluene which is a non-polar gas has low loss rate indoor which means that it transported indoors and persists [24],it is estimated the concentration of toluene is much higher in the urban area than in the rural area, the pure toluene can be detected at concentration of 1 mg/m³ by its odor, toluene can affect the humans nerve system, as well as, cause developmental decrements and congenital anomalies in humans [25]. Fig.11 represents the concentrations of toluene, the highest concentration was 0.49 ppm in February and the lowest concentration was 0.19 ppm in April. There was a week negative correlation between toluene and air temperature, while there was a weak positive correlation between Toluene and R. H.%, also there was a strong positive correlation between toluene and wind speed.

Table (1): Correlation coefficient of aromatic compounds and some gases with wind speed, air temperature and R/Hum. %

Air pollutants	W/Speed [m/s]	Air Temp [°C]	R/Hum [%]
SO ₂	-0.0254	0.120	-0.161
NO	-0.449	-0.503	0.336
NO ₂	-0.145	0.241	-0.289
CO ₂	-0.0197	-0.371	0.397
O ₃	0.432	0.977	-0.859
CH ₄	-0.101	-0.036	0.003
<i>O</i> -Xylene	0.141	0.653	-0.704
<i>P</i> -Xylene	0.346	-0.121	-0.072
Benzene	0.259	-0.187	0.131
Ethyle Benzene	-0.044	-0.149	0.329
Toluene	0.098	-0.129	0.138

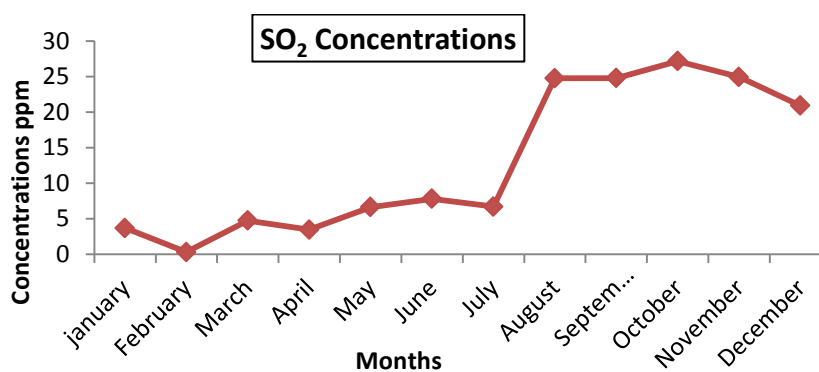


Fig. 1: Concentrations of SO₂ at the weather station during 2011.

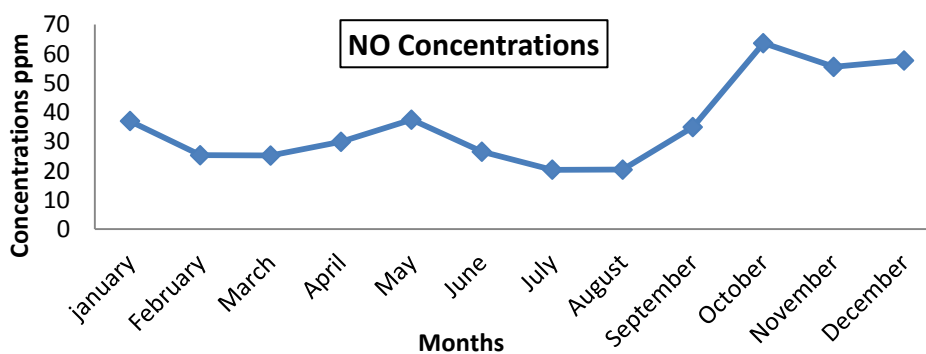


Fig.2: Concentrations of NO at weather station during 2011.

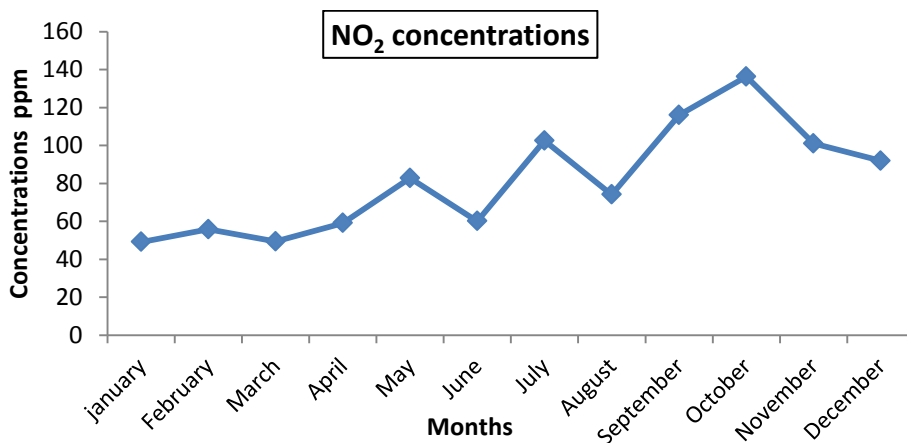


Fig.3: Concentrations of NO₂ at the weather station during 2011.

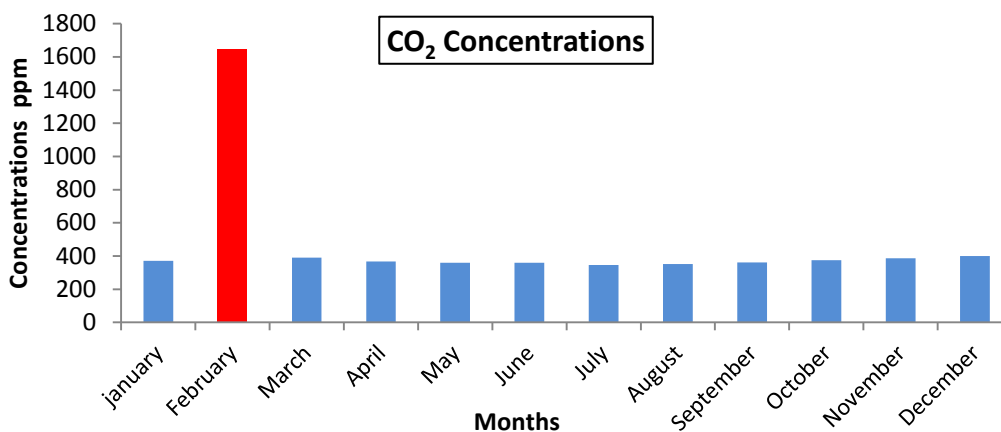


Fig. 4: Concentrations of CO₂ at the weather station during 2011.

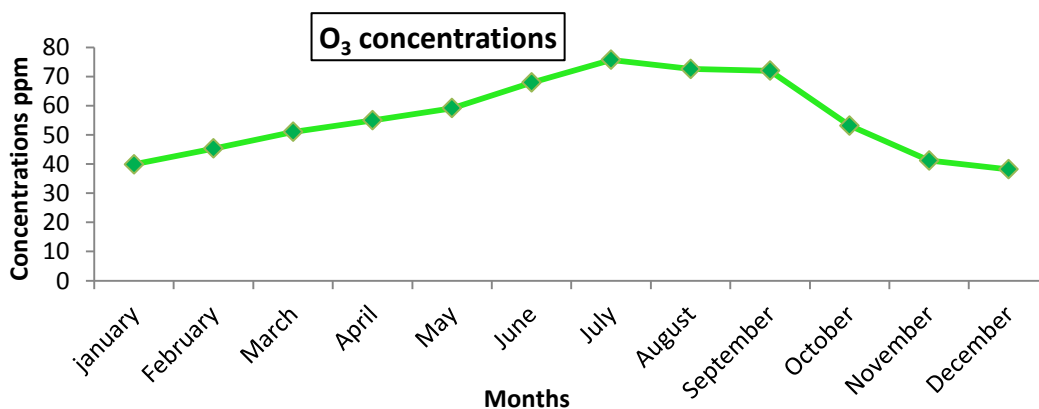


Fig. 5: Concentrations of O₃ at the weather station during 2011.

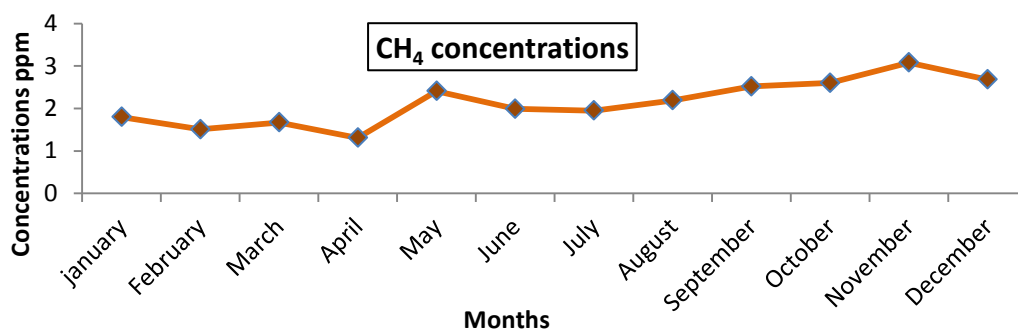


Fig. 6: Concentrations of CH₄ at the weather station during 2011.

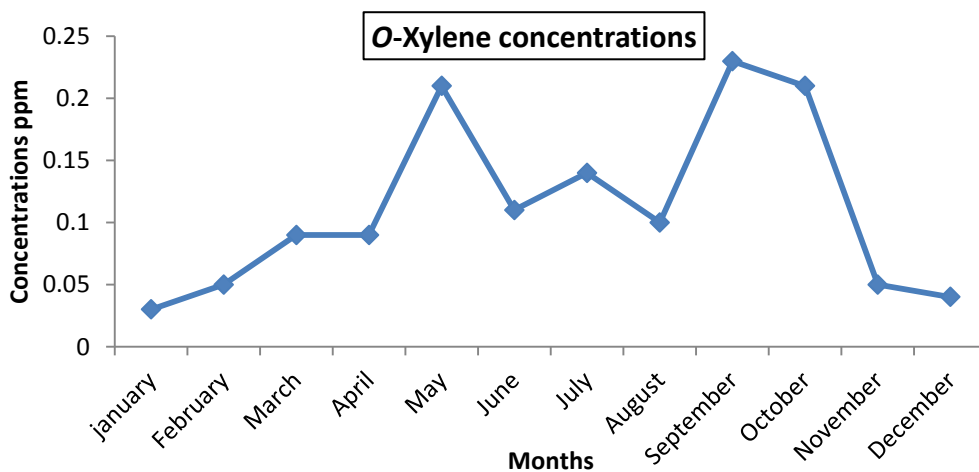


Fig. 7: Concentrations of O-Xylene at the weather station during 2011.

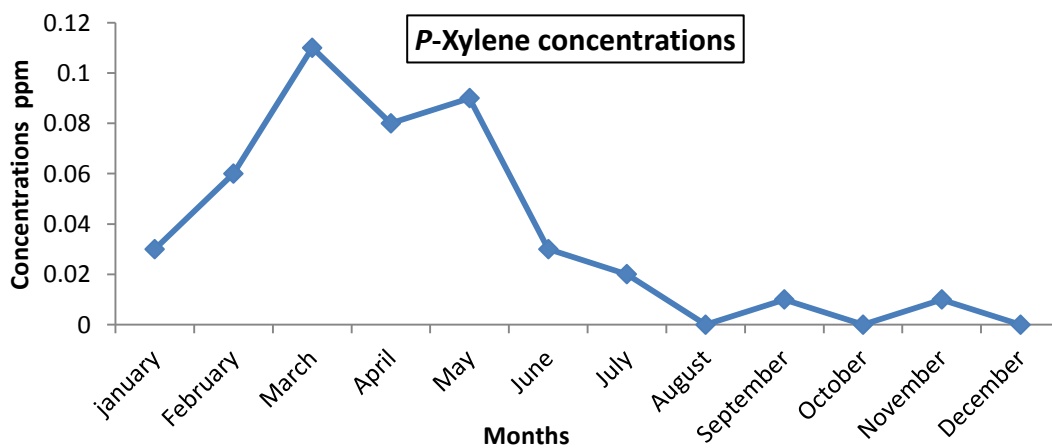


Fig.8: Concentrations of P-Xylene at the weather station during 2011.

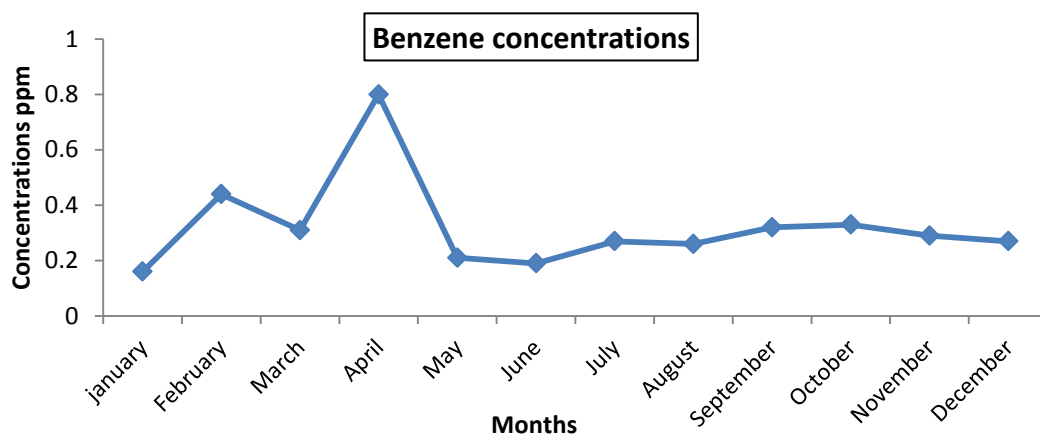


Fig. 9: Concentrations of Benzene at the weather station during 2011.

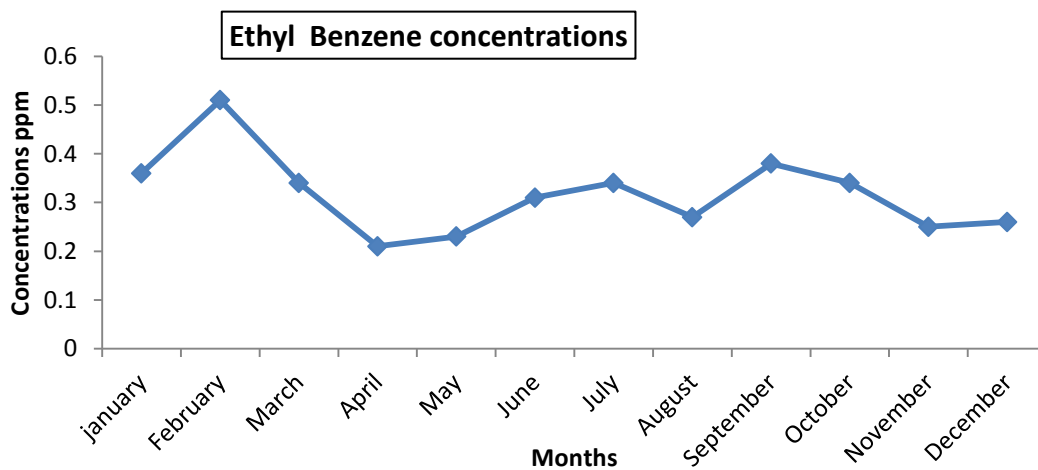


Fig. 10: Concentrations of Ethyl Benzene at the weather station during 2011.

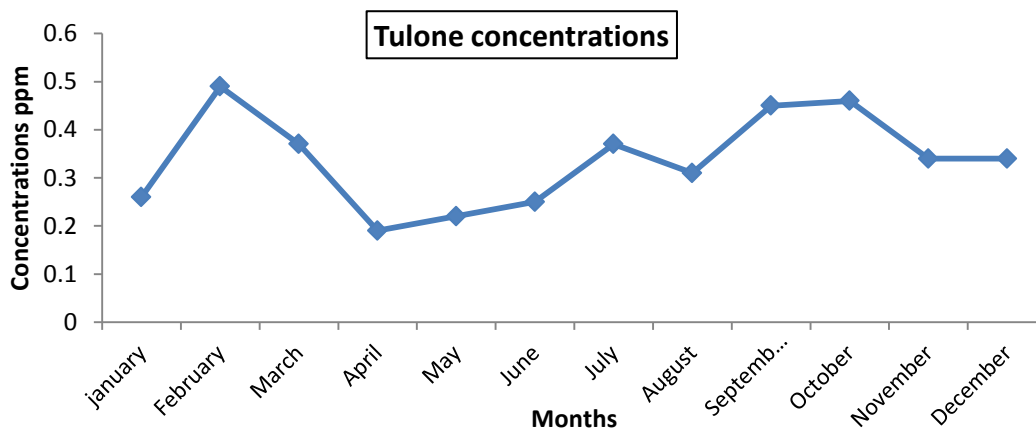


Fig.11: Concentrations of Toluene at the weather station during 2011.

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