Plant Archives Vol. 20, Supplement 2, 2020 pp. 176-181 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

STUDY OF THE ECOLOGICAL IMPACTS OF AIR POLLUTANTS EMITTED FROM BRICK MANUFACTURING IN AL-SINAIYA, QADISIYAH GOVERNORATE, IRAQ

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Abstract

Environmental pollution is one of the most important problems in the world. It has recently increased with the advancement of industries and the increasing population density. In this study, the field of brick factories is located in the industrial Al-Sinaiyah area lies within the, 15 km northwest of Qadisiyah; the area enjoys a moderate weather, and medium amounts of rain, with little heights temperature. The environmental assessment process included measuring gaseous pollutants, as well as pollutants heavy metals, where samples were taken of the surrounding air, soil, and plants in that region, where the region was divided into 3 stations with 3 replicates in within one as control station. The samples were taken within four months starting (December 2018 - March, May and July 2019). The apparatus for total suspended particles was accustomed collect 10 air sampler (filter) loaded with suspended particles ,where the analysis of their results and calculations showed that the entire suspended particles exceeded the nationally and internationally allowed limits. Due to the quantity of factories within the area, and therefore the density of emissions of every factory. Another excuse for that result was the massive amounts of dust within the air caused by vehicles movement since the soil is shaken thanks to the manufacture activity. Heavy elements analysis using the Atomic absorption spectrometer technique shows that the concentration of trace elements (Cu, Cr, Cd, Pb, Ni), for all sample collections. With regard air sampler in the study area was contaminated with heavy elements by Bricks kiln where mean concentrations of cadmium (Cd) and nickel (Ni) elements higher than the national and global limit, except lead (Pb), chromium(Cr) and copper (Cu) element, which, less than the national but higher than global limits in all station and months.
Keywords : Ecological impact, air pollutants, brick factory.

Introduction

Bricks are widely used as complementary materials in the construction sector. The bricks were used in ancient Babylonian and Ur civilizations in central and southern Iraq, while the civilizations and urban activity in the north relied on rocks as building material. In the fifties of the last century, the brick industry flourished throughout central and southern Iraq as the cities grew and developed. The lack of rock from building materials and the availability of dirt, manpower, gas and transport in central and southern Iraq disapproved the brick industry (Al-Hasnawi and Al-Obaidi, 2014). brick manufacturing, have a negative impact on the natural and human atmosphere as a result of pollution caused by gasses, smoke, and mist produced from brick factories, as well as raw materials, dyes, and oils that go directly to the factory-based environment. Brick factories are industrial contaminants that have a great impact, whether they are gaseous, fluid, or solid, through the toxins they emit (Al-Mudhafar, 2014). Contamination of soils with heavy metals or micronutrients in phototoxic concentrations not only adversely affects plants, but also poses risks to human health (Hashim *et al.*, 2018). The effect of brick factories directly on the environment surrounding the factories, especially the vegetation near these factories, as it leads to soil degradation and thus affects crop productivity in that region (Akinshipe and Kornelius, 2017). If it turns out that the extent of the influence of emissions from brick factories varies from one place to another and is also affected by weather factors in that region, which lead to dispersal of pollutants and their transport to remote locations (Abass *et al.*, 2016). The city of Al-Sinaiya in the north of Al-Qadisiyah Governorate is one of the most important Iraqi brick factories. The presence of these factories has a negative impact on the surrounding environment, random urbanization and population growth. The brick industry is an important source of pollutants, with pollutant emissions from these industries estimated at millions of tons annually. Air quality monitoring for the city of Al-Sinaiya is vital and very important for human health and on the environment in general. This study aimed to investigate the effects of brick factory emissions on the surrounding environment, measuring the concentration of heavy metal of air samples in study area and Monitor and analyses total suspended matter (T.P.M).

Material and Methods

Description of the study area

Al-Saniyah is located to the north of Al-Diwaniyah district, which is affiliated with Al-Qadisiyah city Area (15 km north Al-Qadisiyah Governorate), the Al-Saniyah area is the main road between the cities of Hilla and Qadisiyah Figure (1). Were taken three stations with three sub-stations were chosen for sampling. The distance between each station was between 500-2000 m, while control station about 3500m. The distance between each sub-station is about (200-300 m). Three replicates for each station of air, soil, and plant samples were taken. The period of the study was seven months, from (23\12\2018 to 11\7\2019), with a sampling for every two months.

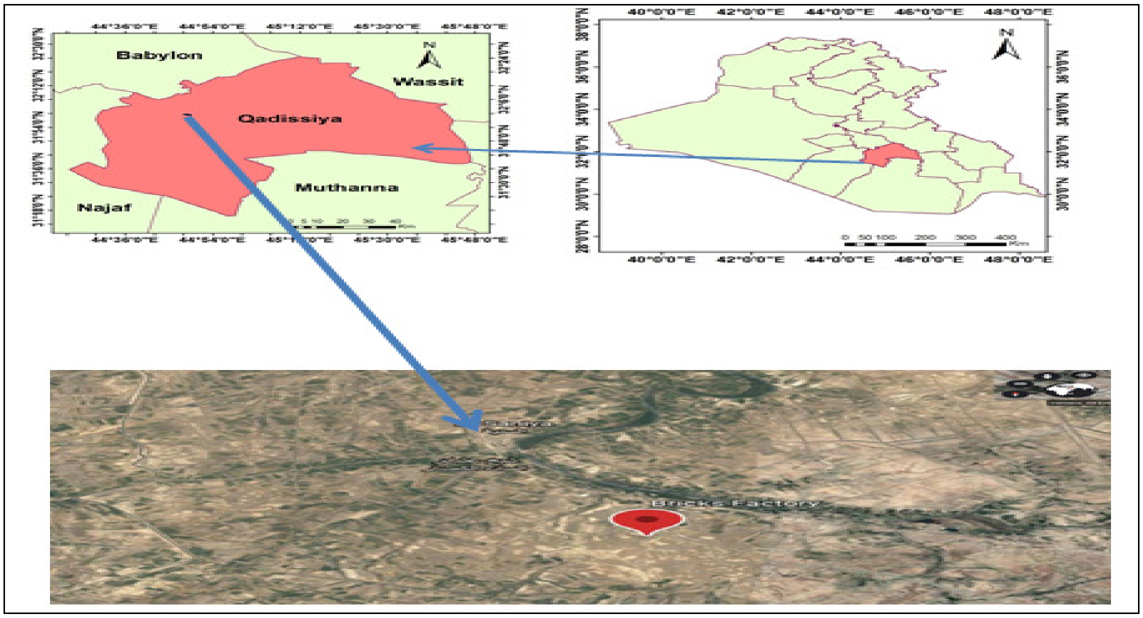

Fig. 1: Location of study area

Samples Collection

3 locations (S1, S2 and S3)were identified with 3 replicates (P1,P2 and P3) for each location at distances between one location to another (500 m, 1000 m, 2000 m) respectively and between repeaters (200-300 m) with one station control far from the factories (3500 m) against the direction of the wind as a reference area with taking a point GPS for each, collected for four periods of Dec\ 2018, March 2019, May \ 2019 and July \ 2019) for brick factories.

Air sampling

The study determines the locations chosen by the GPS device, and the gases emitted from the brick factories, Figure (2). The samples are collected by using Low Volume Sampler (Sniffer) shows the location of air sampling in the study area. where the sniffer/CF-995B-4/230 (230 VAC) is used after fixation to an electrical source, and the height (1.5 meters) is the breathing level Then the filter paper is put in its designated place inside the machine and run for half an hour at a rate of (50 L / min). After the measurement is completed, the filter paper is carried to a Petri dish and stored in a dark, dry place and transferred to the laboratory for examination (Neustadter *et al*., 1975).

Fig. 2 : Location of Brick factories in Al-Sinaiyah in Al-Qadisiyah governorate (Google earth, 2019).

Laboratory Works

(A) Total Suspended Particles

The concentration of the total suspended particles was determined by the air intake device (Sniffer), as the study included detection of the TSP concentration for the selected sites of (10) stations, the air samples were taken from them at ideal times. Measurements were taken at a height of 1.5 meters and the prescribed duration was 30 minutes for each observation. The steps for collecting samples (method of work) can be illustrated by the following points (Neustadter *et al.,* 1975).

1- Place the filter paper inside (the oven) for 15 minutes at a temperature of 105 ° C to get rid of moisture.

2- After drying, the filter is weighed with a sensitive and pollutant-free (1W) weight.

3- The filter is placed in a glass dish (Petri dish) and stored until placed in the air intake device.

4- The filter paper is placed in the device and we operate the device for a while. 30 minutes and here the volume of the air drawn in the units (M3) is recorded when the device starts up (1V) and after 6 minutes (2V).

5- After switching off the device, the cellulose filter containing pollutants is transferred to a glass dish (Petry Dish) and the filter is weighed with pollutants (2W) after drying, as previously indicated for the drying method. It is preferable to install some information on the container for the weight of the filter, which is empty, then weigh with Pollutants also have the volume of air drawn. The concentrations of suspended particles are found by

Applying the below equation (Schilling, 1997) :

$$TSP.Coc = \frac{W2 - W1}{Vt} \times 10^6 \qquad ...(2.1)$$

Where:

TSP: concentration measured in unit microgram / m^3 ($\mu g/m^3$)

W2: weight of the filter after running the equipment (grams).

W1: weight of the filter before the running (grams)

Vt: volume of air drawn with (m3)

10^6: convert gram to a microgram.

The volume of air drawn Vt is calculated according to the equation:

$$Vt. = Q.T \qquad ...(2-2)$$

Q: Rate flow (M^3/Min)

T: sampling time of total size per minute.

(B) Air Samples Analysis

The filter is taken to the stage of heavy metals measurement in the filter contaminated with brick factory air. According to (Perry and Young, 1977), heavy metals were determined as follows:

a. Dissolve filters containing P.M with a mixture of (2:5) volume of acid perochloric ($HClO_4$) and nitric acid (HNO_3).

b. Leave the sample overnight.

c. Transfer the mixture to a volumetric detergent with nitric acid, then with distilled water and then with deionized.

d. Complete the volume to (50) ml with deionized water

e. After (d) the solution is ready to detect heavy elements by the flame atomic absorption spectrum device.

f. A non-pollutant blank standard reference solution is prepared in the same conditions treat the model for the purpose of correcting the results.

The heavy elements examined were Cr, Cd, Cu, Ni, Pb and Ni by atomic absorption spectroscopy (A.A.S) in the Ministry of Health and Environment Department of the Environment in Al-Qadisiyah Service Laboratory.

The concentrations of heavy metal air sample are found by

$$\text{Metal Conc. } (\mu g/m^3) = C * Vi / VT \qquad ...(2.3)$$

Where:

C: concentration of the element in the sample at (ppm) unit.

Vi: the size of the sample in ml unit.

VT: the total volume of air drawn size in cubic meters

Statistical Analysis:

The Statistical Analysis System- SAS (2012) program was used to detect the effect of difference factors (Station and Month) in study parameters. Least significant difference –LSD test was used to significant

Compare between means in this study.

Results and Discussion

Total suspended particles and trace elements are toxic and in high concentrations can be harmful for living organism-animals as well as on vegetation. Therefore the reduction of air pollution to some acceptable levels is an important environmental issue (Dimov *et al*., 2004). The main input for many elements in the atmosphere is related to particle emission processes. Regarding trace metals (Pb, Cd, Zn, etc.), anthropogenic sources play a more significant role than natural sources, such as continental dust, salt spray, and biogenetic particles (Silvia *et al*., 2004; Katja *et al*., 1998). Particulate heavy metals can have severe toxic and carcinogenic effect for humans when inhaled in higher concentration (Kabata *et al*., 2001). Heavy elements are released from the chimneys of the brick factory and carry them with black smoke that pollutes the surrounding air, soil, and plants in that surrounding area of the worker, and the airborne pollutants may reach long distances(Al-Shammari, 2014).

Temporal and Spatial Variance for Total Suspended particles (TSP)

Total suspended particles are a common pollutant that is released from brick factories. The results of the stations during the months (Mar, May, July) exceeded the limitations of the World Health Organization (WHO, 1996), whose value was (150 $\mu g/m^3$), as well as with the Iraqi limits (2012), whose value was (350 $\mu g/m^3$), except for December It was within the acceptable limits, figure (3). The results showed that the air of the study area contained high concentration of total suspended particles in the air, where the (TSP) show values higher than Iraq Standards and World International limits in most stations during study also the results showed the concentration where higher the outside of factory, this is due to industrial processes in the area and climate and unstable of the wind direction in the region. Remarked that dry season has higher TSP levels than those during wet seasons, and statistical analyses also showed a positive correlation between TSP and air temperature and wind speed. This pollution is attributed to the industrial activity in the region With bricks, projectile chimneys and fuel combustion products, we must not neglect the effect The spread of soil dust in the area is fragmented by industrial processes and movement Heavy vehicles and quarries, especially when the strong wind blows their load Sediments, and heavy vehicle exhaust may have another effect in increasing its atmospheric concentrations It uses diesel fuel (Enas, 2019; Al-Shammari, 2014; Al-Nuzal *et al.*, 2018). The variation in season by season of the value of particulate matter depends on the prevailing direction of the wind. Particulate high value can reach quickly into the respiratory system.

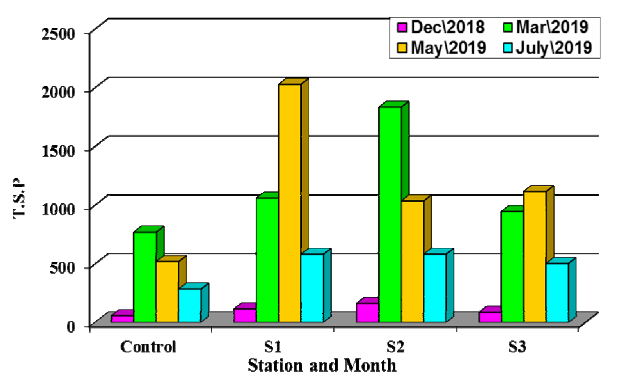

Figure 3: Mean values of Total suspended particulate (μg/m$_3$) from different sites during four months in bricks factory

Temporal and spatial variation of heavy elements in air samples

1. **Cadmium (Cd)**

This study found the highest value of cadmium in the first station during the month of July and the lowest value in the reference station as in the figure (4). The S1, S2 and S3 station, as in the figure, was higher than the WHO determinants that were identified with less than (0.05 μg/m^3) and also above the Iraqi determinants limits which is less than (1 μg/m^3) except for the reference station and the S3 was at Iraqi determinants. The data all exceeded the permissible limit, due to the smoke density of the factories of bricks and the resulting from burning fuel (crude oil) containing high concentrations of heavy vehicles, as well as used vehicles for uprooting and loading the soil and bricks in the study area.

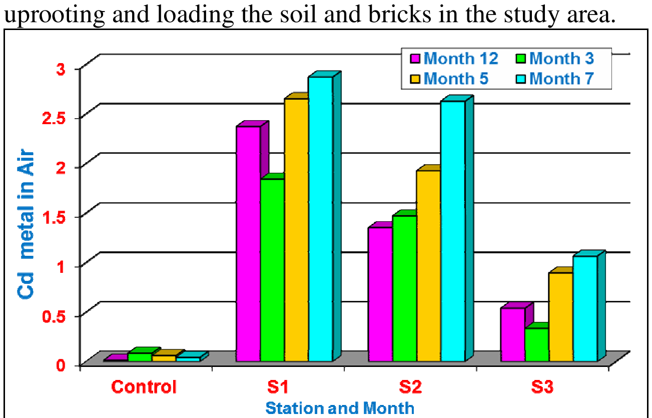

Figure (4). Mean of ambient air Cd μg/m³ in different stations at four months within Bricks Factories

2. **Chromium (Cr)**

Airborne chromium and its results came chromium and as in Figure (5) there is a clear variation between seasons where it was high in hot seasons and medium in cold. As all stations except the control station have exceeded the also given that all stations studied as shown in the figure (5) exceeded the limits allowed by the World Health Organization (1996) and specified by less than (0.02 μg/m^3), but on the contrary, all were within the limits allowed by the Iraqi determinants, which were Less than (5 μg/m^3) which can also affect the surrounding environment. It is clear that the presence of chromium in the air in high concentrations was as a result of emissions from brick factories in the region, due to the poor quality of fuel used in brick kilns factories in the region, due to the poor quality of fuel used in brick kilns.

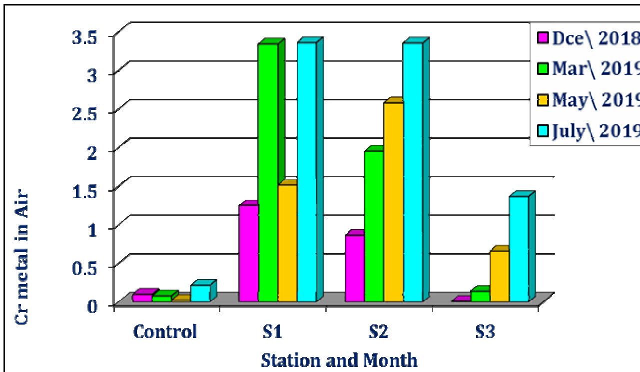

Figure (5). Mean of ambient air Cr μg/m3 in different stations at four months within Bricks Factories

3. **Copper (Cu)**

For the copper level in the air, as usual, the first station recorded the highest values of copper concentration over the months, reaching the highest value during the month of July and May at the station (2.611 ± 0.12 μg/m^3 and 2.662 ± 0.32 μg/m^3) and the lowest recorded concentration where it was (0.082 ± 0.00 μg/m^3) at the station Reference, Figure (6). Where all stations exceeded the limits set by the WHO, where it was less than (0.25μg/m^3) except for the reference station, it was an approach to the global determinants. As for the Iraqi determinants, all stations were within their determinants that were less than (5μg/m^3). Exposure to copper can cause irritation of the nose, mouth and eyes and it causes headaches, stomachaches, dizziness, vomiting and diarrhea. Intentionally high uptakes of copper may cause liver and kidney damage and even death. Industrial exposure to copper fumes, dusts, or mists may cause changes in nasal mucous membranes .Chronic copper poisoning results in Wilson's disease, characterized by hepatic cirrhosis, brain damage and renal disease (NIOSH, 1997). The results show that the copper concentrations are higher than the global and Iraqi subject determinants (Nagi, 2018). Also, compared to previous studies, it is clear that the absolute emissions of brick ovens are a major part in polluting the environment close to the factories, especially on human health and plant cover (Enas, 2019).

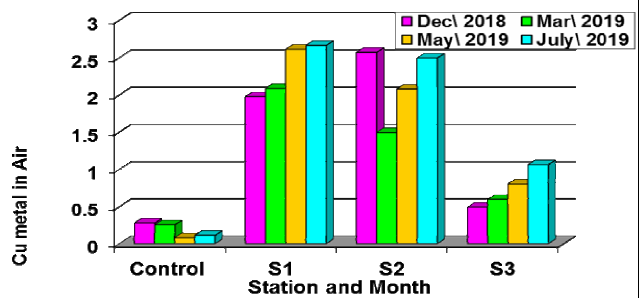

Figure (6). Mean of ambient air Cu µg/m³ in different stations at four months within Bricks Factories

4. **Nickel (Ni)**

Airborne nickel, the results showed their highest value in the S1 station during the July (2.835 ± 0.09 µg/m^3) and the lowest value appearing in the March in the reference station (0.009 ± 0.00 µg/m^3), as shown in Figure (7). as all stations including the reference exceeded the limits set by the World Health Organization which was less than (0.2 µg/m^3) and also all stations The boundaries exceeded the Iraqi determinants that were less than (1 µg/m^3) the reference station equipment and data for the December during all stations and the march in the S3 station only was within the Iraqi limits for the concentration of nickel emitted from the brick factories. In the study area, nickel element quantities are released into the atmosphere by the burning (crude oil) containing different concentrations of nickel, The most serious harmful health effects from exposure to nickel, such as chronic bronchitis, reduced lung function, and cancer of the lung and nasal sinus(ASTDR, 2005). This is due to the poor quality of the crude oil used in brick kilns, as well as the non-use of treatment units to reduce plant emissions (Faith & Atkisson, 2002).

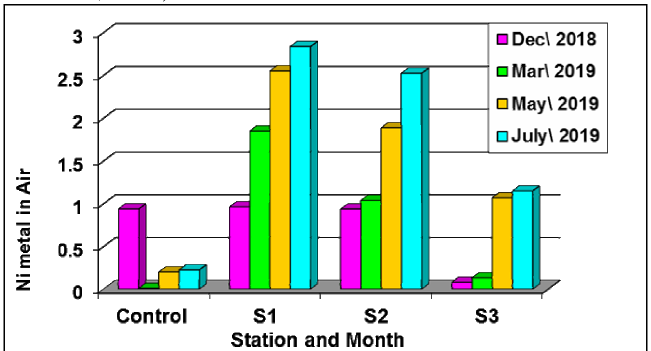

Figure (7). Mean of ambient air Ni µg/m³ in different stations at four months within Bricks Factories

5. **Lead (Pb)**

In this study, it was found that the concentration of lead in the air was its highest value in the July in the S1 station, where its value was (2.679 ± 0.08 µg/m^3) and the lowest values were recorded during the S3 station during December and the value was (0.026 ± 0.01 µg/m^3), Where as a shown in Figure (8). Accordingly, most of the stations exceeded the limits allowed by the World Health Organization (WHO, 1996) and its value is less than (0.5 µg/m^3), but the reference station during the two months December and May and the month of December of the third station was within the boundaries of the organization, and for that all the stations were within the Iraqi determinants which were less than (5 µg/m^3). The higher lead concentrations are due to the proximity of the source to its starting point, as the farther away from the source the lower the lead concentrations in the air. According to the level of exposure, lead can adversely affect the nervous system, kidney function, immune system, reproductive and developmental systems and the cardiovascular system (Mohamed, 2016). Lead is one of the main products of combustion of crude oil and this is due to the chemical nature of his inference with previous studies as move away from the source of combustion, the less concentration in the air, this study has proven.

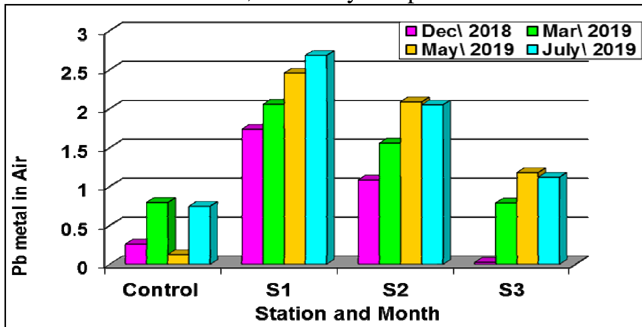

Figure (8). Mean of ambient air Pb µg/m³ in different stations at four months within Bricks Factories

Conclusion

1- Total particulate matter (T.S.P): The concentration of pollutants in the total particulate matter increased during the summer (high temperatures and low relative humidity) compared to the winter season, and the speed of the winds affected the process of transporting the pollutants as well as soil abstraction during the summer.

2- There are clear and high pollution in the heavy elements in the entire environmental object studied air sample and the appearance of high pollution in the air of the study area because the high concentration of heavy elements and the total suspended particulate resulting from by the factories smoke.

3- In general, pollutants may reach cities, residential complexes, and other Installations where we notice higher concentrations of pollutants in the summer compared to winter the high concentrations of pollutants (heavy elements) outside the factories area air sampler (filter).

4- The wind movement disperses and transports the pollutants as it is noticed that the pollutants are heading with the permanent wind line, as the absence of terrain and high structure affected of Distraction of pollutants, and dispersal of pollutants may decrease when there are little or no currents wind.

Recommendation

1. There is a need for continuously measuring air pollution parameters in order to determine the concentration of pollutants which results from the Bricks factory and other sources.
2. Replaces the fuel used in the burning process of black oil, preferably use natural gas or gas oil (Kerosene) or used electric kilns for clay bricks.
3. Utilization suitable treatment units to remove contaminants from Chimneys before they are released, such as water filters and carbon filters that have proven effective in reducing factory pollutant emissions ,and the

chimney height must be increased to the dimensions of the pollutants from the breathing range because the chimneys used are irregular as they less than 3 meters.

4. Afforesting the perimeter of each plant is no less than two aspirations of evergreen trees and paving the roads leading to the factories, to reduce the dust suspended in the air to a minimum of movement within the factories and vehicles
5. Avoid the establishment of housing complexes for workers near the factories in order to avoid catastrophic events harmful to humans, especially which some workers are children and women.

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