eISSN: 2789-858X

SCIENTIFIC JOURNAL FOR THE FACULTY OF SCIENCE - SIRTE UNIVERSITY

DOI: 10.37375/issn.2789-858X - Indexed by Crossref, USA

VOLUME 3 ISSUE 1 APRIL 2023

Bi-Annual, Peer- Reviewed, Indexed, and Open Accessed e-Journal

SJFSSU

معامل التأثير العربي = 1.02

Legal Deposit Number@NationaL Library (Benghazi): 990/2021

Sjsfsu@su.edu.ly
journal.su.edu.ly/index.php/JSFSU

Scientific Journal for the Faculty of Science-Sirte University

Journal home page: http://journal.su.edu.ly/index.php/JSFSU/index

DOI: 10.37375/issn.2789-858X

Air Pollution: Selected Fuel Stations in Benghazi City, Libya

Adel M. Najar*[1], Mohmed A. I Amajbary, Abduslam H. A. Awarfaly, Tahani Aeyad[2], Mona H. A. Bnhmad[3], Naima Aeyad[4], Aliaa M. M. Khalifa[5]

[1] *School of Basic Science, Chemistry Department, Libyan Academy for Postgraduate Studies Benghazi, Libya.*

[2,3,5] *Chemistry Department, Art and science Faculty, Al-Marj, Benghazi University, Libya.*

[4] *Higher Institute of Science and Technology, Al-Marj, Libya.*

DOI: https://doi.org/10.37375/sjfssu.v3i1.299

ARTICLEINFO:

Received: 16 December 2022.

Accepted: 05 March 2023.

Published: 17 April 2023.

Keywords:

Fuel Stations, air pollution, Filling Station, Benzene, Xylene, VOCs, CO_2

A B S T R A C T

This study aims to measure the amount of pollutants that might be present in the air of Benghazi city. Twelve refueling stations from different regions of Benghazi City in Libya were selected. The ambient air quality at all stations was investigated. Also, the evaporation of fuels from loosely closed underground tanks has been investigated for two fuel stations. Drager X-am7000 and MiniRAE-3000 Instruments were used to measure the concentration of CH_4, H_2S, CO, O_2, xylene, and benzene as pollutants in the atmosphere. The pollutant concentrations were within the range of the FEPA air quality standard in most stations; however, the measurement of these pollutants during tank refueling showed a high percentage in the surrounding area of the fuel tanks. Therefore, this study can contribute to understanding the air pollutants exposure and its effects on human health.

1 Introduction

At the local, national, and global levels, air pollution is seen as a serious issue today. Many nations have put restrictions on the amount of pollutants that can be released into the air. Many epidemiological studies have authenticated decrements in lung function and several additional health problems associated with long-time air pollution exposure (Aprajita et al., 2011). Many persuasive pieces of evidence exist for an association between air pollution and cardiovascular disease (Novikova et al., 2014). Air pollution consists of heavy metal or particles in the atmosphere that pose severe health and ecological threats. One of the main polluting compounds is benzene, a volatile chemical substance that with other substances constitutes gasoline. The health effect of vocational exposure to petroleum vapour and air pollution associated with vehicular sources have been thoroughly investigated among petrol-filing workers (Zamanian et al., 2018) (Spengler et al., 2011)(Qafisheh et al., 2021)(Rahimi Moghadam et al., 2019). It is well recognized that vehicular emitted air pollution has a pernicious effect on health outcomes such as morbidity, mortality, and hospital admission. Furthermore, the economic costs could be great (Kingham et al., 2013). In addition to the spread of diseases among workers and neighbours, environmental problems can be caused by the activity of gas stations. For instance, the potential leakage of fuel and oil to the ground and groundwater, also distortion of the aesthetic face of the areas surrounding the gas station, especially when it is located in a crowded residential neighbourhood (Hazrati et al., 2016).

Given the complexity of factors influencing air quality and generally high uncertainty of the results of emission estimation and mathematical modelling, the most credible information about air pollution is estimated by direct measurement results. These are achieved by using reference measurement methods or methods recognized as equivalent to the reference (Parliament et al., 2008). The convenience of air quality monitoring stations for the performance of specific tasks can be assessed using various methods, depending mainly on the type of station (which is strongly dependent on its location), size

Corresponding author: E-mail: *adle.njar@uob.edu.ly*

or specificity of the monitored area, and measurement range (Chan & Hwang, 1996) (Li et al., 2021). Essentially, in urban-industrial areas, there are three main types of monitoring stations: urban traffic stations, background stations and industrial stations. The measurement data acquired from these usually authorize the estimation of the average exposure to air pollution in the city, the impact of road transport and the impact of industry respectively. These impacts overlap each other depending on: the location of the station, the wind direction and the period assessed, which may reflect different types of emission sources in addition to the local and inflow background (Cyrys et al., 2012)(Oleniacz & Gorzelnik, 2021). The variability assessment of the pollutant concentration results in the air at various types of monitoring stations has been carried out, among other things, in research works (Kim et al., 2005)(Sówka et al., 2019). In some cases, it was achieved using cluster analysis or other statistical methods. Several applications of cluster analysis were described in (Govender & Sivakumar, 2020)(He et al., 2018).Moreover, the similarity assessment of air quality monitoring stations based on PM 2.5 concentrations enabled the detection of redundant stations while in diurnal concentration profiles of PM10 and black carbon were conducted. (Žibert & Pražnikar, 2012), Statistical significance tests were also conducted in air quality studies. For instance, in (Almeida-Silva et al., 2016), the Wilcoxon signed-rank test allowed for assessment of the statistical significance of the differences between indoor and outdoor PM10 concentrations(Battista et al., 2016). Used probability distribution, Poincaré sections, Skewness, Kurtosis, and cross-correlation of the different pollutants to estimate the level of air pollution in the city of Rome and the correlation of human activity sources with the pollutant release. Statistical analysis of spatiotemporal heterogeneity of the distribution of air quality index (using the Kruskal–Wallis rank-sum test method and the Wilcoxon signed-rank test) was also performed for urban zones by(Zhao et al., 2018). On the other hand, (Nikolopoulos et al., 2021)used statistical and entropy methods to investigate a 17-year PM10 time series that was recorded from air quality stations in Athens to delineate existing stochastic and self-organization trends**.**

This study aimed to estimate the harmful environmental effects that could result from the activities of gas stations in the city of Benghazi-Libya. The focus was placed on the air quality near to these stations and the concentrations of some volatile organic compounds (VOCs) were determined. In general, the pollutant concentrations of these compounds were within the authorized percentage range.

2 Materials and Methods

In this paper, twelve different filling stations were studied. All stations were located in Benghazi city in Libya. However, the stations were located in different places within the city. The measurements of ambient air quality at all stations were measured once at one point which was in the center of each filling station. These one-point measurements aimed to investigate the concentrations of products of combustion and the volatile organic compounds that the workers and citizens are exposed to during working hours. The equipment used in the air quality monitoring and measurements are X-am 7000 and MiniRAE3000. The X-am 7000 particle gas Monitor was used in measuring the concentrations of the particulate matter. Each of the filling stations was visited, and the ambient air quality was measured at one point of the filling station. Moreover, some measurements have been taken during the supplying of the stations with fuel. Seven different air pollutants were measured, and their data was collected from each filling station. These pollutants include the suspended particulate matter (PM1, PM2.5, and TSP), CO, dinitrogen tetroxide (N_2O_4), sulphur dioxide (SO_2), hydrogen sulphide (H_2S), methane (CH_4), and volatile organic compounds. The data collected from each filling station were compared to the FEPA air quality standard (*Air Quality Guidelines for Europe*, 2000)(Garzón et al., 2015)(Colman Lerner et al., 2012) to determine whether the pollutant concentrations are within the permissible range.

3 Results and Discussions

Pollutant concentration measurements of the VOCs were determined three times. The average of these readings has been calculated. The concentrations of CO measured in our study in the (E) and (D) stations were slightly, but not significantly, higher than those of other stations at 34.67 and 35 ppm respectively, as shown in table-1 and figure-1.

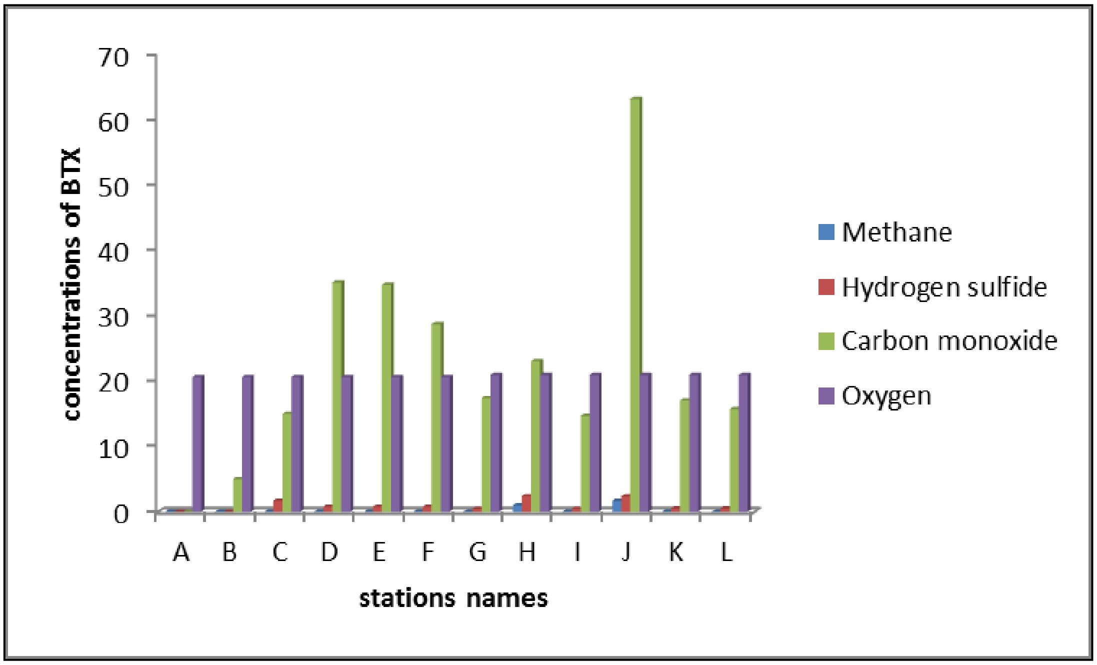

Figure 1: Concentration of VOCs

Table 1: Concentrations of methane, hydrogen sulfide, carbon monoxide and oxygen (VOCs)

Name of station	Methane CH_4 LEL%	Hydrogen Sulfide H_2S ppm	Carbon monoxide CO ppm	Oxygen O_2 Vol%
A	0	0	0	20.6
B	0	0	5	20.6
C	0	1.7	14.97	20.6
D	0	0.8	35	20.6
E	0	0.8	34.67	20.6
F	0	0.8	28.67	20.6
G	0	0.5	17.33	20.9
H	1	2.4	23	20.9
I	0	0.53	14.67	20.9
J	1.67	2.37	63	20.9
K	0	0.55	17	20.9
L	0	0.56	15.67	20.9

Average concentrations of toluene, benzene, and xylene (BTX) were measured. Their concentrations were significantly raised, the values obtained were 1544, and 2068 mg/m^3 for benzene and xylene respectively in (E) station, and 1306 mg/m^3 for toluene in (J) station as shown in (Table 2) and (Figure 2).

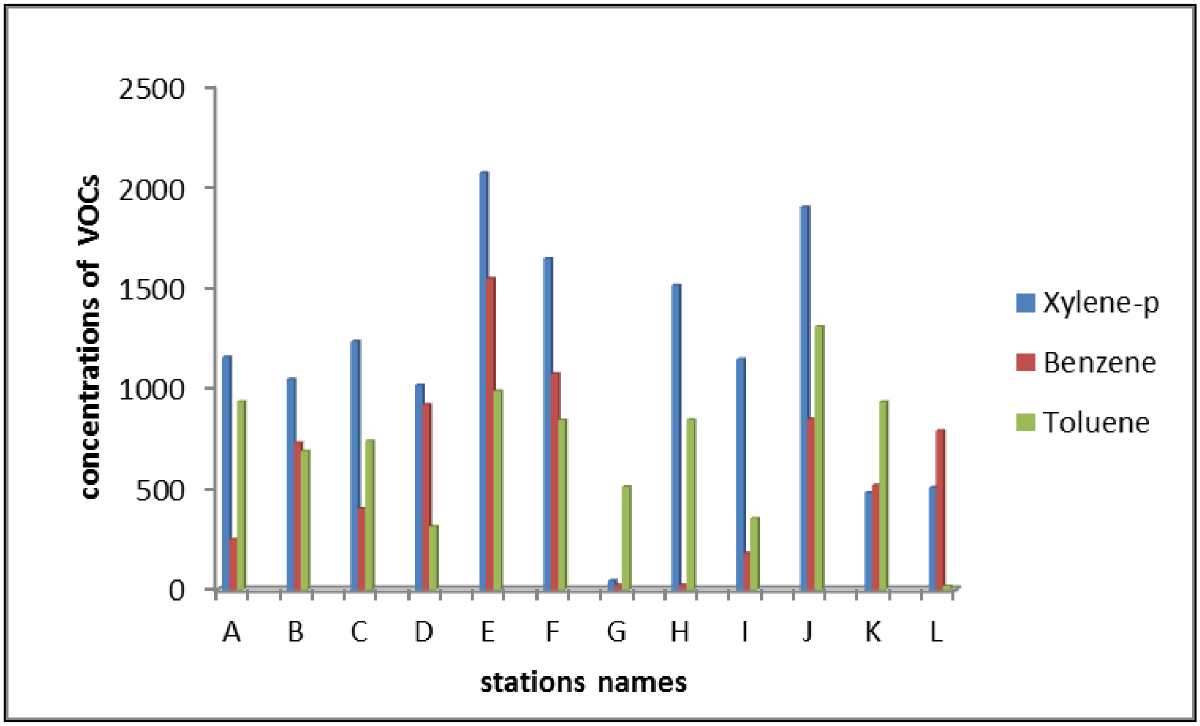

Figure 2: Concentration of BTX

Table 2: Concentrations of *P*-xylene (BTX), benzene, and toluene

Name of station	*P*-Xylene mg/m^3	Benzene mg/m^3	Toluene mg/m^3
A	1155	250.7	933.2
B	1044	729.4	687.9
C	1234	403.8	739
D	1015	918.2	315
E	2068	1544	987
F	1643	1072	843
G	46	25.4	511.9
H	1512	24.3	844.1
I	1145	180.7	354.5
J	1900	848.3	1306
K	481.6	519.3	932.1
L	508.8	790.2	19.4

(Table 3) shows the data obtained at fuel supply stations (C and J) near the tank nozzle of a station during refueling, where it was noted that the values were raised.

Table 3: Concentration of pollutants at the tank nozzle (during refueling).

Name of station	Carbon monoxide CO ppm	Oxygen O_2 Vol%	H_2S ppm	Methane CH_4 LEL%	Toluene mg/m^3	Benzene mg/m^3	P-Xylene mg/m^3
C	378	20.4	15.7	20	1047	802.7	3617
J	126	20.6	7.2	10	1447	2667	3096

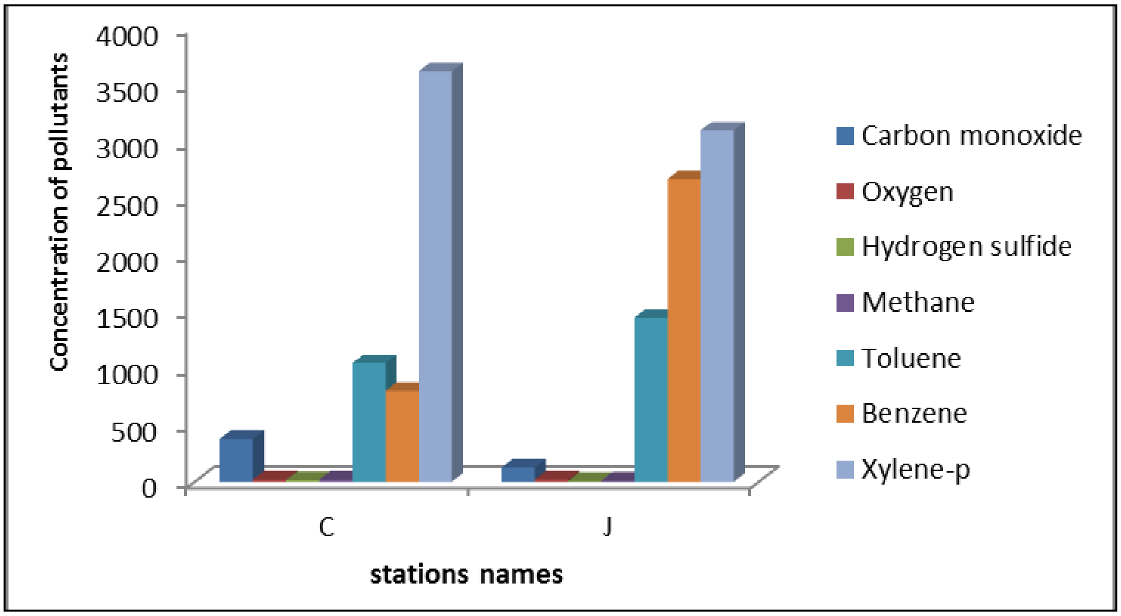

Figure 3: Concentration of pollutants at the tank nozzle (during refuelling).

In addition, table 4 shows high readings recorded at the (H) station. The high values recorded were concentrated near the station's washing machine. It appears that benzene was used as a cleaner**.**

Generally, BTX compound concentrations were acceptable in most of the stations, especially those that have a large area and good ventilation. However, the concentrations of BTX compounds were high, as well as the concentrations of methane, hydrogen sulphide, and carbon monoxide gas during the supply of stations with fuel, which led to the alarm of the measuring device sounding. It was also found in some stations that benzene was used as a cleaning substance without considering the dangers of this use and without any protection. Furthermore, liquid waste resulting from car wash centres and oil change workshops inside the stations are discharged to the municipal sewer networks without any treatment or restrictions**.**

Table 4. Concentration of pollutants near the station's washing machine.

Name of station	Toluene mg/m^3	Benzene mg/m^3	***P*-Xylene** mg/m^3
H	3485	808	2033

4. Conclusion

In conclusion, the results show that the construction projects and operations of gas stations within the city of Benghazi are not subject to any monitoring or control, which led to the expansion of various activities within these stations, without considering the risks of such activities to public health and the environment. Furthermore, this study has shown that the measured concentrations of polluting gases inside the stations were somewhat acceptable, except for those measured at the tank nozzle, which requires taking more means of protection for workers inside the station**.**

It is recommended that all filling stations and their activities are placed under inclusive control, in addition to locating them away from residential areas**.**

Acknowledgments

The authors would like to address thanks to Sirte Company for oil in Libya.

References

Air Quality Guidelines for Europe, Second Edition,. (2000). 91.

Almeida-Silva, M., Faria, T., Saraga, D., Maggos, T., Wolterbeek, H. T., & Almeida, S. M. (2016). Source apportionment of indoor PM10 in Elderly Care Centre. Environmental Science and Pollution Research International, 23(8), 7814–7827. https://doi.org/10.1007/s11356-015-5937-x

Aprajita, Panwar, N. K., & Sharma, R. S. (2011). A study on the lung function tests in petrol-pump workers. Journal of Clinical and Diagnostic Research, 5, 1046–1050.

Battista, G., Pagliaroli, T., Mauri, L., Basilicata, C., & De Lieto Vollaro, R. (2016). Assessment of the air pollution level in the city of Rome (Italy). Sustainability (United States), 8(9). https://doi.org/10.3390/su8090838

Chan, C.-C., & Hwang, J.-S. (1996). Site Representativeness of Urban Air Monitoring Stations. Journal of the Air & Waste Management Association, 46(8), 755–760. https://doi.org/10.1080/10473289.1996.10467510

Colman Lerner, J. E., Sanchez, E. Y., Sambeth, J. E., & Porta, A. A. (2012). Characterization and health risk assessment of VOCs in occupational environments in Buenos Aires, Argentina. Atmospheric Environment, 55, 440–447. https://doi.org/https://doi.org/10.1016/j.atmosenv.2012.03.041

Cyrys, J., Eeftens, M., Heinrich, J., Ampe, C., Armengaud, A., Beelen, R., Bellander, T., Beregszaszi, T., Birk, M., Cesaroni, G., Cirach, M., de Hoogh, K., De Nazelle, A., de Vocht, F., Declercq, C., Dėdelė, A., Dimakopoulou, K., Eriksen, K., Galassi, C., … Hoek, G. (2012). Variation of NO2 and NOx concentrations between and within 36 European study areas: Results from the ESCAPE study. Atmospheric Environment, 62,374–390. https://doi.org/https://doi.org/10.1016/j.atmosenv.2012.07.080

Garzón, J. P., Huertas, J. I., Magaña, M., Huertas, M. E., Cárdenas, B., Watanabe, T., Maeda, T., Wakamatsu, S., & Blanco, S. (2015). Volatile organic compounds in the atmosphere of Mexico City. Atmospheric Environment, 119(722), 415–429. https://doi.org/10.1016/j.atmosenv.2015.08.014

Govender, P., & Sivakumar, V. (2020). Application of k-means and hierarchical clustering techniques for analysis of air pollution: A review (1980–2019). Atmospheric Pollution Research, 11, 40–56.

Hazrati, S., Rostami, R., Fazlzadeh, M., & Pourfarzi, F. (2016). Benzene, toluene, ethylbenzene and xylene concentrations in atmospheric ambient air of gasoline and CNG refueling stations. Air Quality, Atmosphere & Health, 9(4), 403–409. https://doi.org/10.1007/s11869-015-0349-0

He, H., Li, M., Wang, W., Wang, Z., & Xue, Y. (2018). Prediction of PM2.5 concentration based on the similarity in air quality monitoring network. Building and Environment, 137, 11–17. https://doi.org/https://doi.org/10.1016/j.buildenv.2018.03.058

Kim, E., Hopke, P. K., Pinto, J. P., & Wilson, W. E. (2005). Spatial variability of fine particle mass, components, and source contributions during the regional air pollution study in St. Louis. Environmental Science & Technology, 39(11), 4172–4179. https://doi.org/10.1021/es049824x

Kingham, S., Longley, I., Salmond, J., Pattinson, W., & Shrestha, K. (2013). Variations in exposure to traffic pollution while travelling by different modes in a low density, less congested city. Environmental Pollution, 181, 211–218. https://doi.org/https://doi.org/10.1016/j.envpol.2013.06.030

Li, F., Zhou, T., & Lan, F. (2021). Relationships between urban form and air quality at different spatial scales: A case study from northern China. Ecological Indicators, 121, 107029. https://doi.org/https://doi.org/10.1016/j.ecolind.2020.107029

Nikolopoulos, D., Alam, A., Petraki, E., Papoutsidakis, M., Yannakopoulos, P., & Moustris, K. P. (2021). Stochastic and Self-Organisation Patterns in a 17-Year PM(10) Time Series in Athens, Greece. Entropy (Basel, Switzerland), 23(3). https://doi.org/10.3390/e23030307

Novikova, L. V, Stepanova, N. Y., & Latypova, V. Z. (2014). The human health risk assessment from contaminated air in the oil-producing areas (On the Example of Novoshehminsky Region of the Republic of Tatarstan). Advances in Environmental Biology, 109+.

Oleniacz, R., & Gorzelnik, T. (2021). Assessment of the variability of air pollutant concentrations at industrial, traffic and urban background stations in krakow (Poland) using statistical methods. Sustainability (Switzerland), 13(10). https://doi.org/10.3390/su13105623

Parliament, T. H. E. E., Council, T. H. E., The, O. F., & Union, P. (2008). 11.6.2008.

Qafisheh, N., Mohamed, O. H., Elhassan, A., Ibrahim, A., & Hamdan, M. (2021). Effects of the occupational exposure on health status among petroleum station workers, Khartoum State, Sudan. Toxicology Reports, 8, 171–176. https://doi.org/10.1016/j.toxrep.2020.12.025

Rahimi Moghadam, S., Afshari, M., Moosazadeh, M., Khanjani, N., & Ganjali, A. (2019). The effect of occupational exposure to petrol on pulmonary function parameters: A review and meta-analysis. Reviews on Environmental Health, 13(6), 732–738. https://doi.org/10.1515/reveh-2019-0048

Sówka, I., Chlebowska-Styś, A., Pachurka, Ł., Rogula-Kozłowska, W., & Mathews, B. (2019). Analysis of Particulate Matter Concentration Variability and Origin in Selected Urban Areas in Poland. In Sustainability (Vol. 11, Issue 20). https://doi.org/10.3390/su11205735

Spengler, J., Lwebuga-Mukasa, J., Vallarino, J., Melly, S., Chillrud, S., Baker, J., & Minegishi, T. (2011). Air toxics exposure from vehicle emissions at a U.S. border crossing: Buffalo Peace Bridge Study. Research Report (Health Effects Institute), 158, 5–132.

Zamanian, Z., Sedaghat, Z., & Mehrifar, Y. (2018). Harmful Outcome of Occupational Exposure to Petrol: Assessment of Liver Function and Blood Parameters among Gas Station Workers in Kermanshah City, Iran. International Journal of Preventive Medicine, 9, 100. https://doi.org/10.4103/ijpvm.IJPVM_296_16

Zhao, X., Gao, Q., Sun, M., Xue, Y., Ma, R. J., Xiao, X., & Ai, B. (2018). Statistical analysis of spatiotemporal heterogeneity of the distribution of air quality and dominant air pollutants and the effect factors in Qingdao Urban Zones. Atmosphere, 9(4), 12–16. https://doi.org/10.3390/atmos9040135

Žibert, J., & Pražnikar, J. (2012). Cluster analysis of particulate matter (PM10) and black carbon (BC) concentrations. Atmospheric Environment, 57, 1–12. https://doi.org/https://doi.org/10.1016/j.atmosenv.2012.04.034

Scientific Journal For the Faculty of Science – Sirte University

Sjsfsu@su.edu.ly

journal.su.edu.ly/index.php/JSFSU

Scientific Journal Impact Factor

TOGETHER WE REACH THE GOAL