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Key words: *power plant, pollution, Al Diwaniyah city, heavy elements*
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STUDY THE EFFECT OF OPERATING OF THE NORTH AND SOUTH AL DIWANIYAH POWER PLANTS ON THE CITY OF AL DIWANIYAH

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This study was conducted to find out the impact of two diesel plants (southern and northern) of the city of Al Diwaniyah by studying the concentrations of some heavy elements (Cu, Pb, Zn, Mn and Fe) in the soil and plants around the two stations as a result of operating with heavy fuel and the absence of techniques for filtering exhaust waste. The results showed that heavy metals in plants are higher than their concentration in the soil. Moreover, the highest percentage of contamination with heavy elements for each of Fe, Zn, Mn, Cu and Pb in the soil is 293.1, 133.8, 365, 55, 46 and 0.093 mcg/gm, respectively against, 440, 201.8, 446, 130,98 and 35.12 mcg/gm in the plant. These percentages are higher than the recommended values, according to the World Health Organization (WHO). The results also showed that the pollution level from heavy metals in soil and plant samples was higher in the areas south of the two stations. The lowest values were located to the north of stations because the wind blew from north to south, carrying the pollutants most of the year. This has resulted from the incomplete combustion of heavy fuel in the two plants to the populated city center, located to the south of the North Al Diwaniyah station.

Key words: power plant, pollution, Al Diwaniyah city, heavy elements

INTRODUCTION

Since the onset of the industrial revolution, pollution of the environment with toxic metals has been increased dramatically [1]. Although heavy metals such as cadmium, lead, chromium, and copper are naturally present in the soil, the contamination could come from local sources. These sources are primarily industrial (power plants, non-ferrous industries, iron, steel and chemical industries), agriculture (irrigation with polluted waters, sewage sludge and fertilizers (especially phosphates), contaminated manure and pesticide containing heavy metals, waste incineration, combustion of fossil fuels and road traffic. Long-range transport of atmospheric pollutants adds to the metals in the natural environment [2]-[7]. In recent years, it has been shown that lead levels in soil and vegetation have increased considerably due to traffic pollution, especially from the usage of leaded petrol and exhaust combustion [8]. This problem increase as daily traffic increases [9]. Heavy metals can be found generally at trace levels in soil and vegetation, and living organisms feel the need for micro-elements of these metals. However, these have a toxic effect on organisms at high levels. Heavy metal toxicity has an inhibitory effect on plant growth, enzymatic activity, stoma function, photosynthesis activity and accumulation of other nutrient elements, damaging the root system [10]. It is known that the production and use of energy from its various traditional sources cause many types of environmental pollution with harmful effects on the components of the environment, such as air, water, and land, leading to the imbalance prevailing in them. In general, pollution poses many risks due to its direct and indirect impact on human health due to the contamination of food, water, and air sources [11]. Combustion of different fossil fuel types such as natural gas, diesel, and heavy oil for electricity production in power plants produces a pollutant of a complex mixture in the atmosphere. This includes SOx, NOx, CO, heavy metals, acid gases, and organic compounds, solid wastes (such as ash) represents serious environmental issues [12]-[21]. Despite its possession of various renewable energy sources such as solar energy, wind energy, and biofuels (cane, rice straw, wheat, barley, and corn), Iraq relies entirely on fossil fuels to operate the electrical power stations across the country [13]. Studies on environmental pollution by heavy metals from power plants in Iraq are limited. In Al- Qadisiyah Governorate, the pollution resulting from the operation of the electricity-generating stations in the north and south of the governorate, which operate with heavy oil, is considered one of the most significant pollutants in the city in addition to the sound pollution (noise). This study shows the percentage of pollution in the soil and plant with heavy elements around power stations in different Al- Qadisiyah city regions. This research also highlights

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the destructive effects of these elements to assess the environmental impact on sustainable development in Al-Qadisiyah governorate.

DESCRIPTION OF SITE LOCATION UNDER STUDY

These two stations are two diesel stations located to the north and south of Al Diwaniya were established in 2012 and built by the Korean company STX at the cost of 232 million dollars and with a completion period of six months. Each station has 48 engines, and the design capacity is approximately 200 MW for each one. The size of each engine is 4,061 kW, and each engine has four strokes (internal combustion). These engines work on two types of fuel (heavy fuel and diesel) at a consumption rate of 250 liters of fuel per megawatt-hour (100-101). At a time, Iraq was suffering from a severe crisis in the production of electrical energy; these two stations were a temporary and quick solution to solve this crisis. We notice an absence of a study of the environmental impact of establishing the two stations, as the stations are located to the south and north of Al Diwaniyah (Al- Qadisiyah Provincial Center) shown in Fig. 1 [14]-[15].

Figure 1: Location of the two stations concerning the city center of Al Diwaniyah (S.D.E.S: South Al Diwaniyah Power Station; N.D.E.S: North Al Diwaniyah Power Station)

SAMPLES COLLECTION AND WORKING METHOD

Soil samples from the research site were randomly collected from four directions of each station, at one kilometre from each direction and with a depth of 15-30 cm. Various parts of plants at the research site were collected and then put in clean plastic bags until reaching the laboratory. Heavy elements ions were extracted from the soil by taking 0.5 g of soil with grinding and scrutinizing. These samples were placed in a Teflon baker, adding 6 ml of the central mixture (HCl and HNO3) in a 1: 1 ratio and digesting at a temperature of 80 ° C until it dried. Later, 4 ml was added from the central mixture (HF and HClO4) in a ratio of 1: 1 and digestion at a level of 80 ° C until it reached dehydration. A 20 ml of dilute HCl acid 0.5 N was added later. After termination, the measurement is preserved with the flame atomic absorption spectrum apparatus. The result is expressed in units of micrograms/g Java weight [16]. As for plants, after collecting the samples, they were transferred to the laboratory in clean, clearly marked plastic bags. In the laboratory, the samples were washed with tap water and then with warm distilled water. The vegetable parts were washed with distilled water free of ions and dried at a temperature of 70 ° C for 48 hours. The dry samples were later crushed and passed through a sieve with a capacity of 40 mesh and then took a weight of 0.5. The sample was placed in a Pyrex-digested tube, and 5 ml of HNO3 concentrated acid was added to it. The samples were left for 16 hours, and then digested by placing them at 100 ° C. One hour later, 3 ml of perchloric acid (70%) was added and performed reflux for 30 minutes at a temperature of 200 ° C until the solution became clear and to eliminate the possibility of suspended substances in the solution. Centrifugation of the samples was carried out for 10 minutes at a speed of 2000 rpm. The samples were completed to a volume of 50 ml using ion-free water and placed in special plastic containers to test the atomic absorption spectrum device and expressed the result in micrograms/gm by dry weight [17]. Concentrations of heavy elements in soil and vegetation were calculated according to the equation below

$$E_{\text{Con.}} = \frac{A \times B \times \text{df}}{D}$$

Econ.: The concentration of the element in the sample (mg/g dry weight).

A: concentration of the component extracted from the titration curve (mg/l).

B: final sample size (ml).

df: Dilution factor, if used, it is as follows:

$$df = \frac{\text{volum of dilution sample solution in ml}}{\text{volum of a liquid taken for dilution in ml}}$$

D: dry weight of the sample (grams).

RESULTS AND DISCUSSION

From the figures (2) and (3) of heavy elements concentrations in soil and plants, respectively, we noted the following: 1- Iron (Fe): The lowest value of iron in the soil was recorded in sample No. (1), which is located in the north of the North Al Diwaniya station, and reached 33,3 mg/gm dry weight, and the highest value was recorded in sample No. (5), which is to the south of the southern station of Al Diwaniyah, it reached (293,1) mg/gm by dry weight. As for the plants, the lowest value recorded for iron was found in samples (1) and (2), located north of the southern station of Al Diwaniyah. It reached 38 mg/g. Java weight: The highest value was 440 mg/g weight in

Java in sample No. (2), located in the south of the North Al Diwaniya station. Note that the World Health Organization (WHO) has determined the recommended level of iron in plants 20 mg / g [21]. 2- Zinc (Zn): The highest value recorded for zinc in the soil was found in sample number (7), located to the south of Al Diwaniya North Station, and it reached 133.8 mg/gm by dry weight, and the lowest recorded value was 43.76 Mcg/gm dry weight in sample No. (3) which is located north of North Al Diwaniya station. As for the plants, the highest recorded value was 201.8 mg/gm dry weight in sample No. (2) that located in the south of North Al Diwaniyah Station and the lowest value was 93.26 mg/gm dry weight in sample No. (4), located in the north of the southern Al Diwaniyah station. Note that the recommended limit for zinc in plants according to the WHO is 50 mg /g [21]. 3- Manganese (Mn): The highest value of manganese element in sample No. (1) for the soil was 365 mg/gm, and dry weight in sample No. (6), that located in the south of South Al Diwaniyah Station and the lowest value was 35,16 Mcg/gm dry weight in sample No. (5), which is located north of South Al Diwaniyah Station. For the presence of the element manganese in the plants, the highest value recorded in sample No. (7) was 446,6 mg/gm dry weight, located in the south of the South Al Diwaniya station. In comparison, the lowest value was 60,7 mg/gm dry weight in sample No. (1), located to the north of Al Diwaniyah Station. According to the WHO, these ratios are within the permissible limits for manganese in nature, according to the WHO [21]. 4- Copper (Cu): From figure (2), the highest recorded value of copper was 55,46 mg/gm and dry weight in sample No. (7), which is located south of North Al Diwaniyah Station. The lower values were recorded in sample No. (1) is 14,42 mg/gm and dry weight, located north of Al-Al Diwaniya North Station. As for the plants, the highest value was in sample No. (7), located south of the southern Al Diwaniya station and was 130,98 mg/gm dry weight, and the lowest value was (34,88) mg / g weight by Java, which is located north of North Al Diwaniyah Station. The permissible copper limit for plants is 10 mg / g as recommended by the WHO [21]. 5- Lead (Pb): The highest recorded value of lead concentration in the soil was 0.093 mg/gm dry weight in sample No. (7), located in the south of the North Al Diwaniya station. In contrast, the lowest value recorded in sample No. (4) was 0.0101 mg/gm dry weight, located south of the southern Al Diwaniyah station. For the plants, the highest lead value found in sample No. (7) was 35.12 Mcg/gm by weight, located in the south of the northern Al Diwaniyah station. The lowest value was 4,1 Mcg/gm dry weight in sample No. (1), located north of the North Al Diwaniya station noting that the allowable limit for lead in plants recommended by the WHO is 2 mg / g. [22]

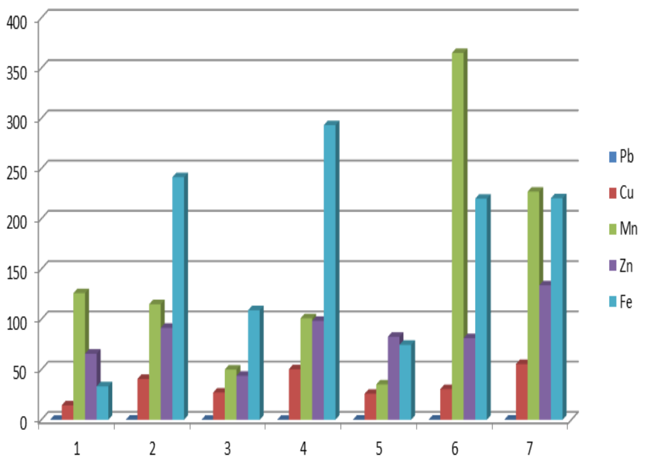

Figure 2: Percentages of heavy metals in the soil (mg/gm dry weight)

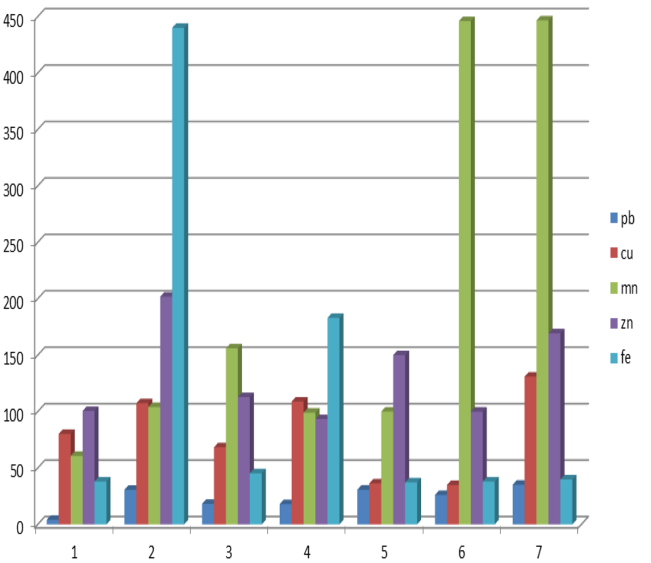

Figure 3: Percentages of heavy metals in the plants (mg/gm dry weight)

CONCLUSION

The study showed that choosing the location of the two stations is not adequately studied, as there is clear pollution with waste from the combustion of heavy fuel in areas from which samples were taken around the two stations. The concentrations were more than the permissible limit according to the WHO [21]. These elements were taken one kilometer away from the stations, and there is no purification of exhaust gases. Therefore, the gases are released directly to the air and heavy pollutants and other elements are transported by the winds that blowing most of the year from the north towards the south and then the city center. This increases the pollution process for the populated city center as it is located south of the northern Al Diwaniyah station.

RECOMMENDATIONS

For establishing new power stations in the future, choosing the appropriate and thoughtful place must be done considering the impact of their emissions on the population and plants and the proximity to fuel sources.

- Using specialized filters for engine exhaust in the stations, such as (cyclone collector, static pole, bag) to reduce environmental pollutants.
- Reducing impurities and purifying used fuel as much as possible in the two stations to try to reduce harmful emissions.
- Seeking and planning to use renewable and environmentally friendly energy sources.

REFERENCES

1. Denholm, P., Hand, M., Jackson, M., & Ong, S. (2009). Land use requirements of modern wind power plants in the United States (No. NREL/TP-6A2-45834). National Renewable Energy Lab. (NREL), Golden, CO (United States).
2. Ouyang, W., Hao, F. H., Zhao, C., & Lin, C. (2010). Vegetation response to 30 years hydropower cascade exploitation in upper stream of Yellow River. Communications in Nonlinear Science and Numerical Simulation, 15(7), 1928-1941. doi.org/10.1016/j.cnsns.2009.07.021
3. Cabrera, F., Clemente, L., Barrientos, E. D., López, R., & Murillo, J. M. (1999). Heavy metal pollution of soils affected by the Guadiamar toxic flood. Science of the TotalEnvironment , 242(1-3), 117-129. doi.org/10.1016/S0048-9697(99)00379-4
4. Simón, M., Ortiz, I., Garcıa, I., Fernández, E., Fernández, J., Dorronsoro, C., & Aguilar, J. (1999). Pollution of soils by the toxic spill of a pyrite mine (Aznalcóllar, Spain). Science of the Total Environment, 242(1-3), 105-115. doi.org/10.1016/S0048-9697(99)00378-2
5. Vidal, M., López-Sánchez, J. F., Sastre, J., Jiménez, G., Dagnac, T., Rubio, R., & Rauret, G. (1999). Prediction of the impact of the Aznalcóllar toxic spill on the trace element contamination of agricultural soils. Science of the Total Environment, 242(1-3), 131-148. doi.org/10.1016/S0048-9697(99)00380-0
6. Madejón, P., Murillo, J. M., Marañón, T., Cabrera, F., & López, R. (2002). Bioaccumulation of As, Cd, Cu, Fe and Pb in wild grasses affected by the Aznalcóllar mine spill (SW Spain). Science of the Total Environment, 290(1-3), 105-120. doi.org/10.1016/S0048-9697(01)01070-1
7. Ötvös, E., Pazmandi, T., & Tuba, Z. (2003). First national survey of atmospheric heavy metal deposition in Hungary by the analysis of mosses. Science of the Total Environment, 309(1-3), 151-160. doi.org/10.1016/S0048-9697(02)00681-2
8. Onianwa, P. C., & Adoghe, J. O. (1997). Heavy-metal content of roadside gutter sediments in Ibadan, Nigeria. Environment international, 23(6), 873-877. doi.org/10.1016/S01604120(97)00098-6
9. Wheeler, G. L., & Rolfe, G. L. (1979). The relationship between daily traffic volume and the distribution of lead in roadside soil and vegetation. Environmental Pollution (1970), 18(4), 265-274. doi.org/10.1016/0013-9327(79)90022-3
10. Agrawal, P., Mittal, A., Prakash, R., Kumar, M., Singh, T. B., & Tripathi, S. K. (2010). Assessment of contamination of soil due to heavy metals around coal fired thermal power plants at Singrauli region of India. Bulletin of Environmental Contamination and Toxicology, 85(2), 219-223. doi.org/10.1007/s00128-010-0043-8
11. Öncel, M. S., Zedef, V., & Mert, S. (2004). Lead contamination of roadside soils and plants in the highways between Istanbul and Sakarya, NW Turkey. Fresenius Environmental Bulletin, 13(12), 1525-1529.
12. Vidal, M., López-Sánchez, J. F., Sastre, J., Jiménez, G., Dagnac, T., Rubio, R., & Rauret, G. (1999). Prediction of the impact of the Aznalcóllar toxic spill on the trace element contamination of agricultural soils. Science of the Total Environment, 242(1-3), 131-148. doi.org/10.1016/S0048-9697(99)00380-0
13. Alnasur, F. S., Almansoori, A. C., AL-Furaiji, M. A., & Kareem, M. I. (2020, November). A Study of the Chemical and Physical Properties of Cane as a Biofuel After Thermal Treatment Processes (Tarification). In Journal of Physics: Conference Series (Vol. 1664, No. 1, p. 012133). IOP Publishing. doi.org/10.1088/1742-6596/1664/1/012133
14. The Ministry of Electricity, General Directorate of Electric Power Production in the Middle Euphrates, North Al Diwaniyah Diesel Station, Operation Department, unpublished data, 2017.
15. Al-Tai,A,B,. (2018). Evaluation of the spatial suitability of electric power plants in Al-Qadisiyah Governorate using GIS. Al-Qadisiyah Journal For Humanities Sciences, 21(4), 322-343.
16. Hatanpää, E., Kajander, K., Laitinen, T., Piepponen, S., & Revitzer, H. (1997). A study of trace element behavior in two modern coal-fired power plants I. Development and optimization of trace element analysis using reference materials. Fuel processing technology, 51(3), 205-217. doi.org/10.1016/S0378-3820(97)00006-4
17. Allen, S. E. (1989). Chemical analysis of ecological materials, 2nd edn London.
18. Zhang, X., Ou, X., Yang, X., Qi, T., Nam, K. M., Zhang, D., & Zhang, X. (2017). Socioeconomic burden of air pollution in China: Province-level analysis based on energy economic model. Energy Economics, 68, 478-489. doi.org/10.1016/j.eneco.2017.10.013

19. Dockerty, T., Appleton, K., & Lovett, A. (2012). Public opinion on energy crops in the landscape: considerations for the expansion of renewable energy from biomass. Journal of Environmental Planning and Management, 55(9), 1134-1158. https://doi.org/10.1080/09640568.2011.636966

20. Shanker, A. K., Cervantes, C., Loza-Tavera, H., & Avudainayagam, S. (2005). Chromium toxicity in plants. Environment international, 31(5), 739-753doi.org/10.1016/j.envint.2005.02.003

21. Alnasur, F. S., & Al-Furaiji, M. A. (2021, August). Estimation the Performance of Gas Turbine Power Station with Air Cooling Fog System. In Journal of Physics: Conference Series (Vol. 1973, No. 1, p. 012040). IOP Publishing. doi.org/10.1088/1742-6596/1973/1/012040

22. Halalsheh, M., Kassab, G., Shatanawi, K., & Al-Shareef, M. (2018). Development of Sanitation Safety Plans to Implement World Health Organization Guidelines: Jordanian Experience. In Safe Use of Wastewater in Agriculture (pp. 101-130). Springer, Cham.

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