Regular Article

AL Hasnawi Fatima Mohsen Kizar*, AL Mahbobi Suhad Abdulsattar and AL Asadi Layth Abdulrasool

Study of emitted gases from incinerator of Al-Sadr hospital in Najaf city

https://doi.org/10.1515/eng-2022-0016
received September 05, 2021; accepted October 18, 2021

Abstract: Medical waste incinerator of Al-Sadar hospital in Najaf city is one of the environmental pollution sources in the city due to reasons related to the quantity and quality of gases emitted from it, so this study aims to estimate environmental damage by determining the concentrations of some of these emitted gases. The study is concerned with determining the concentrations of six gases over five months (November 2013–March 2014), these gases were oxygen (O_2), silane (SiH_4), hydrogen (H_2), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and hydrogen sulfide (H_2S), in addition to studying some weather factors such as wind speed and temperature that affect on the concentrations of the gaseous pollutants. It is found that the study area suffers from pollution with SO_2 gas, which is one of the main standard pollutants for assessing polluted areas, where the mean of gas concentration during the study period was 0.205 [ppm] and thus exceeded the permissible limits. Moreover, some of the studied gases (like NO_2 and H_2S) have concentration close to the upper limit of the standards, where NO_2 gas concentration in December and January were 0.17 [ppm] and 0.2 [ppm], respectively, and H_2S gas concentrations in February and March were 3.5 [ppm] and 4.4 [ppm], respectively, which poses a threat to public health and other elements of the environment, which confirms the existence of an air pollution problem that the study area and the nearby areas suffer from.

Keywords: air pollution, gases, incineration, concentration, Al-Sadr hospital

*** Corresponding author: AL Hasnawi Fatima Mohsen Kizar,** Department of Civil Engineering, University of Kufa, Najaf, Iraq, e-mail: fatimahm.alhasnawi@uokufa.edu.iq
AL Mahbobi Suhad Abdulsattar: Department of Civil Engineering, University of Kufa, Najaf, Iraq, e-mail: suhad.almahboobi@uokufa.edu.iq
AL Asadi Layth Abdulrasool: Department of Water Resourse Engineering, University of Kufa, Najaf, Iraq, e-mail: laitha.alasadi@uokufa.edu.iq

Nomenclature

EPA	environmental protection agency
ppm	part per million
O_2	oxygen
SiH_4	silane
H_2	hydrogen
O_3	ozone
NH_3	ammonia
CEST	center for environmental of science and technology
SO_2	sulfur dioxide
NO	nitric oxide
NO_2	nitrogen dioxide
CO	carbon monoxide
H_2S	hydrogen sulfide
NAAQS	national ambient air quality standards

1 Introduction

Air pollution is the pollution that affects the atmosphere as a result of the discharge and emission of solid, liquid, and gaseous substances in unwanted concentrations. Air is considered as polluted when any substance which is extra than the natural limits of its natural composition or foreign is added to its natural composition [1]. The Environmental Protection Agency (EPA) defines air pollution as the presence of pollutants or polluted substances in the air in a manner that affects public health and human well-being or in a manner that leads to other harmful environmental effects [2]. Air pollution is the existence in the outdoor atmosphere of one or more air pollutants (dust, fumes, gas, mist, odor, smoke, and vapor) in adequate amounts, of such characteristics, and of such period as to be or to threaten to be harmful to human, plant, and animal life or to belongings, or which reasonably affects with the relaxed enjoyment of life or belongings [3]. Air pollution is the oldest type of pollution. First, humans have been affected by this type of pollution. The discovery of fire and neglect of control on it have increased forest fires and the huge quantities of pollutants that result from them. With the emergence of civilizations and cities, the problem of air pollution became magnified, especially after the emergence of industry and increased transportation and fuel consumption [4]. Indoor air pollution outcomes from products used in production materials, the insufficiency of general ventilation, and geophysical factors that may result in exposure to naturally occurring radioactive materials. Industrial and moveable sources contribute to air pollution that pollutes the ambient air that surrounds us outdoors [5]. Improper incineration of medical waste is considered one of the sources of air pollution because pollutants, ash residues, and harmful fumes are released into the air; also, emitted materials may contain carcinogens and other harmful substances. The cineration of some types of medical waste, especially those containing chemicals, causes the emission of toxic substances into the air when an insufficient temperature is used for incineration or when the emissions are not controlled properly. When medical waste is not completely burned, it emits in addition to toxic substances black smoke and volatile impurities that affect the environmental life in the surrounding area, especially plants, vegetables, fruits, leaves, and open water bodies. The information confirms the danger of incineration of medical waste as it flies into the air and pollutes it, causing a danger to plant and animal life, food, and drinking water if it reaches it or leaks into the aquifer [6].

The study aims to determine the concentrations of some emitted gases from the incinerator of Al-Sadar hospital by measuring the concentrations of some important gases and comparing the results with the adopted local and international standards in order to assess the existence of an air pollution problem that the study area and the nearby areas suffer from and then reduce the effect of air pollution causing from the incineration on the elements of the ecosystem, especially human.

2 Materials and method

This section contains a summary of the description of the study area, gaseous pollutants, emitted hazardous materials, gas meter, air quality standards for gases, and methodology.

2.1 Description of the study area

Al-Sadr hospital is located near the University of Kufa, where it is considered a training center for students of medicine, pharmacy, and nursing faculty. The hospital contains an incinerator to burn medical waste, and for this, it has become necessary to study air pollution resulting from the burning of waste and its effect on people in hospitals and universities.

Al-Sadr hospital contains two incinerators, one large and the other small, as these two incinerators are run on an irregular schedule, but the largest share of operation is for the large incinerator, which is the main incinerator in the hospital.

The incinerator is run seven days a week, at a rate of several hours a day, but with different periods. It is a Japanese-made incinerator with a capacity of 350 kg per day, and it was equipped in 1983 when it was running on natural gas, so pollution was less. Nowadays, natural gas has been replaced by kerosene, the incinerator is shown in Figure 1.

Waste is isolated from each other and distinguished by colored waste bags to be placed in the incinerator for incineration purposes. The efficiency of the incinerator is very low due to the lack of continuous maintenance, so small quantity of wastes are placed for burning, so the volatile fumes are not of the required intensity for the absorptive incinerator's energy, but in many cases, they are prepared in large quantities, so the fumes and flying dust are dense and of high intensity.

The incinerator does not have a filter in the chimney, so the flying dust and fumes are more harmful and toxic than incinerators that contain a filter.

Figure 1: The incinerator of Al-Sadr hospital.

The annual mean temperature for the study area is 24.6°C [1], and the temperature starts to rise from March and continues to rise until it reaches its highest in July, and after that, it decreases until it reaches its lowest in January. From the above, it is concluded that there is a clear variation in temperatures according to the months of the year.

The wind speed in the study area is active starting from March and reaching its highest levels in June and July; then, it begins to decline to reach its lowest speed in December and January. The speed and direction of the wind are of great importance in the excitation and diffusion of solid and gaseous air pollutants. The effect of rapid wind is prominent in two directions; the first is negative; it prevents the rise of pollutants emerging from the chimneys in a vertical direction, on the contrary, as it works to spread them horizontally, especially in the case of low-rise chimneys. As for the positive side, the high speed diffuses pollutants and does not concentrate them in a specific area. Finally, the wind velocity is directly proportional to the dispersion of the pollutants.

2.2 Gaseous pollutants

Gases constitute the largest percentage of the total air pollutants. The current study dealt with 10 gases: O_2, SiH_4, H_2, O_3, NH_3, SO_2, NO, NO_2, CO, and H_2S.

1) O_2: Oxygen gas is the second largest component of the atmosphere, the most abundant chemical element in the earth's crust, and is being 89% of oceans mass and 23% of air mass. It is necessary for respiration and life and is not rival in quantity or importance with any other component. The general concept of air pollution means a significant change (increase or decrease) in the proportions of air-forming substances that lead to harmful consequences; therefore, despite the importance of this gas, it is considered harmful in some cases of exceeding the permissible limits (19.5–23.5) [ppm], according to US EPA [1]. The presence of this gas in nature can be expressed simply that this gas is absorbed from the environment during the process of aerobic respiration and released into the atmosphere by photosynthesis.
2) SiH_4: It is a colorless inorganic compound, and its characteristics are that it is highly flammable when in contact with air and has an unpleasant smell similar to the smell of acetic acid. This gas is more toxic than methane [7] and can be used in industrial and medical fields.
3) H_2: Hydrogen ranks ninth among the elements on the surface of the earth in terms of abundance if the elements are arranged according to their weight ratios. It is a colorless, tasteless, and odorless gas, and it is the simplest known element, as the nucleus of an atom consists of a single proton. This gas has great flammability and reacts strongly with chlorine and fluorine to produce harmful acids to the lungs and tissues. When H_2 is mixed with O_2, it explodes upon ignition. It is expected that H_2 will be the fuel of the future because its combustion produces great energy that is characterized by its cleanliness; it is an environmentally friendly fuel. This is its combustion produces one compound, which is environmentally friendly water vapor [1].
4) O_3: Ozone gas constitutes about 0.000002% of the total volume of the atmosphere. Although this percentage is small, it is one of the most important gases affecting the life of living organisms on the surface of the earth. It is a toxic, unstable, oxidant, and one of the gases that pollute the air and cause global warming. The composition of its particles depends on the consumption of ultraviolet rays coming from the sun toward the earth, leaving only 3% of the total amount flowing toward the earth, and from here comes the importance of this gas because this percentage is suitable for the life of living organisms on earth. Pollution worked to deplete the stratospheric O_3. This depletion resulted in 3% of the ultraviolet rays exceeding the normal limit, which threatens the occurrence of serious environmental damages. This matter placed the problem of O_3 layer erosion in the list of the second most important environmental problem after global warming, according to the Center for Environmental of Science and Technology. Finally, O_3 is formed under suitable atmospheric conditions when molecular O_2 reacts with atomic O_2, and it consists of three O_2 atoms. It was found that stratospheric O_3 is in a natural equilibrium [1].
5) NH_3: It is a colorless gas that is highly soluble in water, alkaline, pungent, and has a sharp odor. The most important non-natural sources of this gas are petrochemical industries, canning factories, paper industry, textile factories, waste treatment, and wastewater treatment plants [1].
6) SO_2: It is a colorless gas with an unpalatable odor and has flammability. It is the most dangerous air pollutant to humans and the environment. This gas reacts with O_2 under certain conditions, producing sulfur trioxide gas, which dissolves in water vapor, producing sulfuric acid, which disperses in the air in the form of mist and then falls with rainwater, causing an imbalance in the ecosystem [1].
7) Nitric oxide (NO): It is one of the important oxides in the study of air pollution, colorless, odorless gas with

high toxicity. Microbial decomposition of organic compounds in the soil is a major source of NO. Car exhaust is the main source of nitrogen oxides emissions; it is responsible for more than 50% of the amount emitted into the atmosphere, followed by electric power plants, factories, fires, and other combustion processes. Cement plants also spread gaseous pollutants to the surrounding environment, including NO [8].

8) Nitrogen dioxide (NO_2): It is a colorless and mostly odorless gas, and it may be reddish-brown or yellow liquid in a temperature below 21.1°C. It is produced from the oxidation of nitrogen and nitrogenous materials in fossil fuels as well as formed as a result of oxidation of atmospheric nitrogen at high temperatures. NO_2 gas is released with the exhaust of car engines polluting the areas near the street, as well as other constant sources such as power plants, industries that burn fuel in quantities at high temperatures, and burning fuel in homes. The gas contributes to the formation of the phenomenon of photochemical smog as a result of complex interactions with light [9].
9) CO: It is a highly toxic gas that results from incomplete combustion in cars, so it is considered one of the most dangerous gases to human health [10]. This gas is considered a common and dangerous pollutant, colorless, tasteless, odorless, and it is found in high concentrations in the atmosphere of cities, especially large and crowded cities with population and transportation. Transportation is the main source of air pollution with this gas due to incomplete combustion in internal combustion engines, as well as petroleum refining, pulp making, and steel industry.
10) H_2S: This gas has a rotten egg smell [11]. It is one of the most annoying air pollutants due to its toxicity and unpleasant odor. The gas is colorless and heavier than air, so it is found in low-lying areas, and one of its most important sources is the decomposition of organic compounds by the action of anaerobic bacteria as well as from soggy water swamps, mud, and others. Continuous exposure to this gas causes low blood pressure, numbness, nausea, disruption of the sense of smell, eyelid inflammation, pneumonia, and sometimes the activity of the central nervous system is disrupted [12].

2.3 Emitted hazardous materials

There are elements and heavy compounds emitted into the air during the burning of medical waste. They may cause poisoning as a result of the pollution that occurs, which may have catastrophic effects on the human body and may cause chronic or serious diseases. The most prominent of these materials are

1) Dioxin: Toxic chemical material that affects human life and environment and enters the fatty tissues in the body, and is difficult to break down or eliminate. It is produced by burning waste and can threaten both human and animal life and warns of its dangers to all sources of life. The World Health Organization declared that dioxin is a carcinogen, and US EPA concluded in its assessment of dioxin as a carcinogen.
2) Mercury: It is a dangerous and toxic material that evaporates quickly and is difficult to contain so, which increases its risk. Exposure to mercury, even in small quantities, causes motor health problems in humans, brain and kidney damage, and poses a threat to the child's growth inside the mother's womb in the early stages of his life [13]. The World Health Organization has set the highest permissible level of mercury should not exceed 0.05 mg per cubic meter in the air.
3) Cadmium: This material is very toxic and dangerous if it enters the human body, as it affects the kidneys, skeleton, and respiratory system and is classified as a human carcinogen [14].
4) Chlorine: It is a toxic gas characterized by its yellow-green color and suffocating smell. Chorine is a cause of cancer and heart disease and may cause miscarriages in pregnant women and problems with teeth, hair, and skin.
5) Furan: This compound is colorless, flammable, and very toxic that causing cancer.

2.4 Advanced sense environment at test meter 2012 Gray Wolf, USA

This device was used in this study. It is a modern device that can be used in the laboratory (fixed) and can be carried (portable) and used in the field. The device detects 10 gases instantly; in addition to that, it bears the computer specifications as shown in Figure 2.

2.5 Air quality standards for gases

America air quality standards for gases (national ambient air quality standards, NAAQS) were adopted in this study. These standards were illustrated in Table 1.

Figure 2: Gases measuring device.

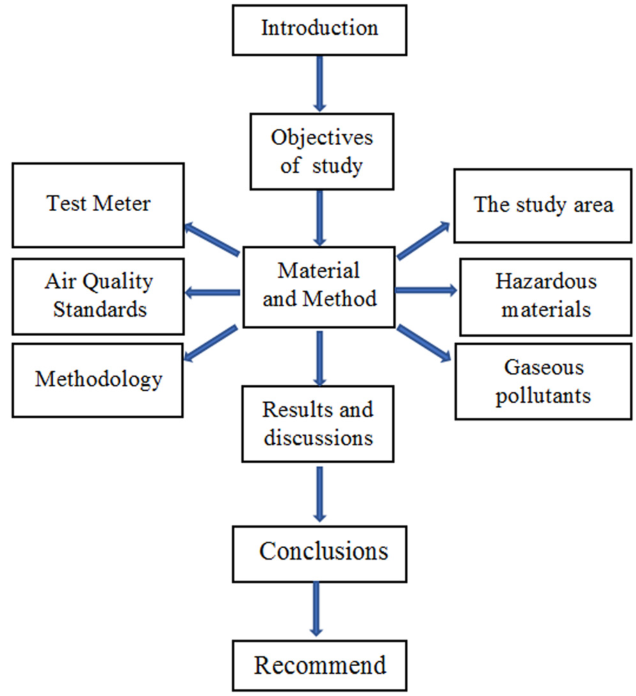

Figure 3: The research methodology.

2.6 Methodology

This research is organized as shown in Figure 3.

3 Results and discussions

The concentrations of some emitted gases from the incinerator of Al-Sadar hospital were determined. These gases were O_2, SiH_4, H_2, SO_2, NO_2, and H_2S. The descriptive statistical analyses for the measured gases are presented in Table 2.

The monthly and overall means of determining gases are denoted graphically in Figures 4–9.

The temperature and wind speed were also measured during the study period in order to know their effect on the concentration and spread of pollutants. These measured values are shown in Table 3. Values are also plotted in Figures 10 and 11.

Figure 4 shows that the mean of all concentrations of O_2 gas during the study period was 20.04. The lowest concentration of O_2 (19.5%) was in December, and the highest concentration (20.5) was in March. Perhaps the reason is that gas concentration is affected by the general state of the atmosphere. In Spring, the weather is moderate, and the trees are green and leafy, which means an increase in the photosynthesis process in plants. This increases the amounts of O_2 released to the atmosphere by plants. In general, all O_2 concentrations recorded in the study area are within the permissible limits locally and internationally, according to the US EPA.

The mean and monthly concentrations of silane (SiH_4) gas are represented graphically in Figure 5. This figure shows that the mean was 0.18, and the highest concentration was recorded in march month, while the lowest concentrations were recorded in months: November, December, and January. It is noticed that there was a decrease in the concentration in November, December, and January when compared with the concentration in March, which indicates that there is a positive relationship between temperature and concentration of SiH_4 gas. The high temperatures liberate SiH_4 gas from the sandy soil that covers most of the study

Table 1: America air quality standards for gases (NAAQS)

Gases	O_2 [%]	SiH_4 [ppm]	H_2 [ppm]	SO_2 [ppm/h]	NO_2 [ppm/h]	H_2S [ppm/h]
Stand.	19.5–23.5	5	_	0.01	0.25	5

Table 2: The statistical summary of measured gases

Gases	Max.	Min.	Mean	Std. dev.
O_2	20.5	19.5	20.04	0.361
SiH_4	0.3	0.1	0.18	0.093
H_2	9.75	1	4.85	3.76
SO_2	0.3	0.1	0.205	0.064
NO_2	0.2	0.1	0.15	0.0361
H_2S	4.4	0.1	2.23	1.774

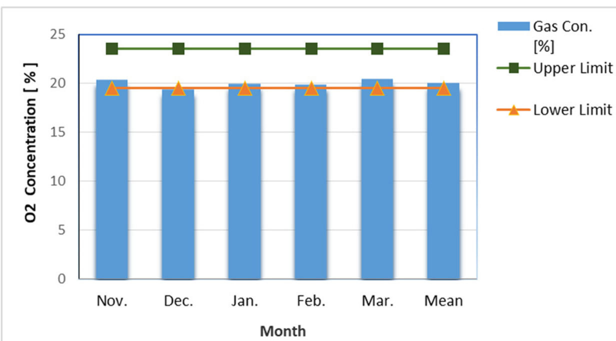

Figure 4: Monthly concentrations and overall mean of oxygen gas during the study period.

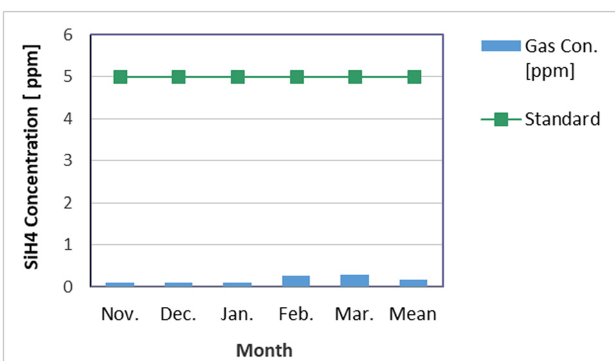

Figure 5: Monthly concentrations and overall mean of SiH_4 gas during the study period.

area, as well as the role of the wind factor, which increases the presence of sandy soil particles in the atmosphere as silicon is the main component of sandstone rocks. The recorded concentrations were compared with the standards shown in Table 1, and the comparison showed that all the concentrations were within the international permissible limits.

Figure 6 displays that the highest concentration of H_2 gas was in March, while the lowest concentration was recorded in November, with an overall monthly rate of 4.85%. It is noticed that there were two months whose

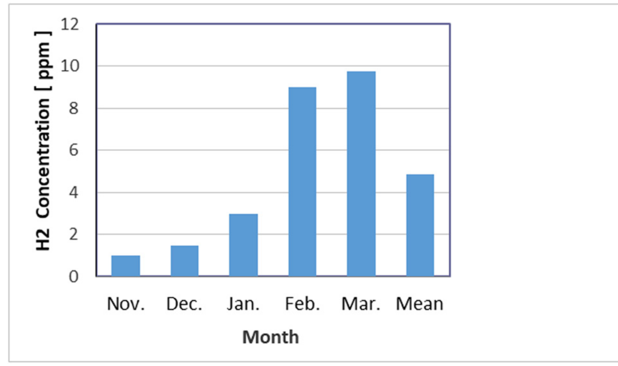

Figure 6: Monthly concentrations and overall mean of H_2 gas during the study period.

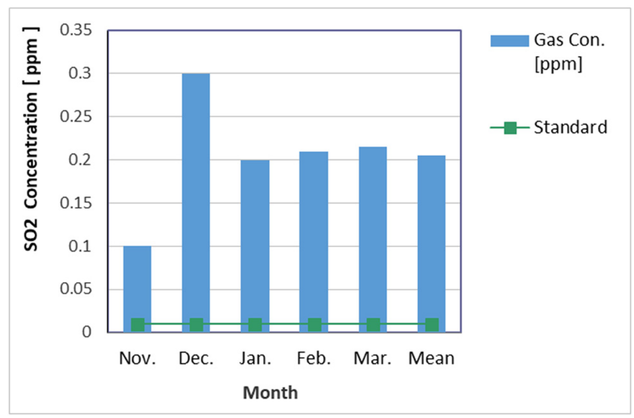

Figure 7: Monthly concentrations and overall mean of SO_2 gas during the study period.

concentrations exceeded the total average, while three months were less than the total monthly average. H_2 gas does not pose a danger when its concentration

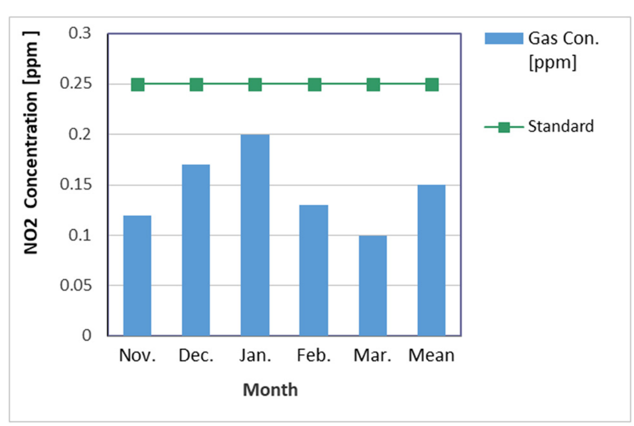

Figure 8: Monthly concentrations and overall mean of NO_2 gas during the study period.

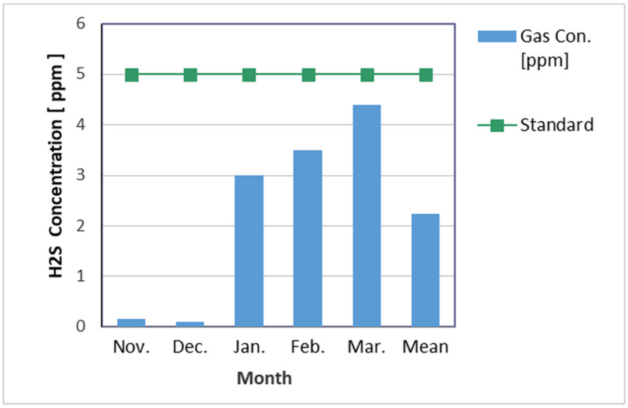

Figure 9: Monthly concentrations and overall mean of hydrogen sulfide gas during the study period.

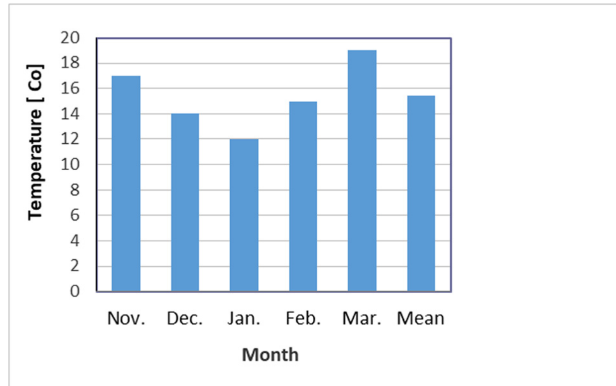

Figure 10: Monthly values and overall mean of temperature during the study period.

increases, but the extreme danger and caution from the presence of other gases such as chlorine and sulfur, which have a great ability to interact with H_2, and the product of this reaction is very dangerous represented by toxic hydrochloric acid and hydrogen sulfide.

In the chemical industries, the concentration of these two dangerous gases is controlled to prevent the reaction from occurring, noting that H_2 has a large explosive flame.

In Figure 7, it is noticed that the highest concentration of sulfur dioxide (SO_2) 0.3 [ppm] was in December, the lowest concentration 0.1 [ppm] was in November, and the overall mean during the study period was 0.205. Generally, it was noticed the convergence of some monthly gas concentrations, especially in January, February, and March, with a clear difference in November and December. When comparing the values of the monthly concentrations and the total mean with the global environmental limits, it is found that they exceed the permissible limits. The main reason for this is that the existing decomposing organic materials in medical waste are considered one of the most important natural sources of SO_2 emissions. One of the most important health effects of SO_2 is respiratory irritation and bronchospasm accompanies. Also, exposure to the gas for a long time leads to the gas reaching the blood through the respiratory tract, which leads to defects in the enzymatic processes, and the exposure is more dangerous and more

Table 3: Temperature and wind speed values during the study period

	Nov.	Dec.	Jan.	Feb.	Mar.	Mean
Temp. [°C]	17	14	12	15	19	15.4
Wind [m/s]	2.8	1.7	2.2	1.7	1.7	2.0

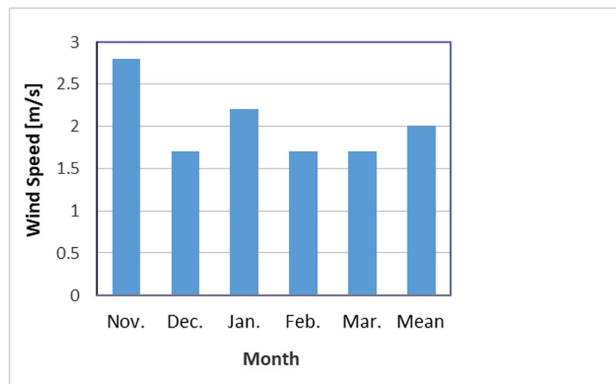

Figure 11: Monthly values and overall mean of wind speed during the study period.

severe if the gas is in the form of solid particles, in addition to the great effect of gas on plants, causing lethargy of plant cells and may cause damage to their tissues and leaves to appear dark due to acid rain.

Figure 8 illustrates that the highest monthly concentration of NO_2 0.2 [ppm] was in January, while the lowest concentration of gas 0.1 [ppm] was in March, with a total monthly average of 0.15 [ppm]. It is concluded from the above that there is a variation in the NO_2 concentration according to the months of the study, especially the months of January and March, which indicates that NO_2 concentrations are inversely proportional to higher temperatures and that the temperature effect is greater than the effect of wind speed. The results show that the monthly concentrations and the total average during the study period for NO_2 gas are within the global limits of 0.25 [ppm/h], as shown in Table 1.

NO_2 gas is one of the main standard pollutants for assessing polluted areas, and what makes this gas more toxic is that in the presence of moisture, it turns into nitric acid, which inhalation leads to great damage to the lung and respiratory system, in addition to the fact that NO_2 gas causes damage to lung tissue, it causes inflammation of the nose and eyes. The gasworks alongside the SO_2 exacerbate the damages resulting from acid rain, while with hydrocarbons it forms the phenomenon of photochemical smog that has a great environmental impact, and it also has a clear effect on plants, especially citrus fruits, as exposure to a high concentration of it leads to tree leaves falling and causing chlorophyll pallor despite their tolerance to high concentrations of exposure to this gas.

The highest monthly concentration of hydrogen sulfide gas, 4.4 [ppm], was recorded in March, and the lowest concentration, 0.1 [ppm], was in November and December with a total monthly average of 2.23 [ppm], as shown in Figure 9. When comparing the monthly concentrations, and the total average with the international limits shown in Table 1, they are within those limits. However, it is noted that there are some monthly values characterized by a high concentration of this toxic pollutant as shown in Figure 9, it is found that the highest concentration in March, which is a concentration close to the maximum permissible limit for specifications, followed by February with a concentration of 3.5 [ppm] and after that January with the concentration of 3 [ppm].

Chronic exposure to low concentrations (non-lethal) of hydrogen sulfide through the skin, respiratory system, and eyes cause symptoms and risks that can be summarized as follows: It irritates the mucous membrane lining of the eyes and respiratory tract, it causes difficulty in breathing due to its effect on the work of many active enzymes in the body and episodes of loss of consciousness and may lead to death. People who are exposed to high concentrations of this gas for long periods become sluggish in thinking and inability to concentrate. These chronic symptoms, alone or in combination, depending on several reasons, including the duration of exposure, its level, the immunity of the human body and the type of food, as well as the gas, has a negative impact on pigments containing lead and other metals such as silver and copper and corroding or reducing the resistance of pipelines carrying gas.

Figure 10 shows that the maximum value of temperature 19°C was in March, and the minimum value 12°C was in January, with a total mean during the study period of 15.4°C. The results show that there is a variation in the effect of the temperature on the concentration of the studied gases.

Figure 11 illustrates that the maximum value of wind speed 2.8 [m/s] was in November, and the minimum value of 1.7 [m/s] was in December, February, and March, with a total mean during the study period of 2 [m/s]. The study shows that the wind speed is directly proportional to the dispersion of the polluted gas.

Al-Taghlubi measured the concentrations of gases (SO_2, H_2S, and O_2) emitted from Al-Sadr hospital incinerator and they were (2 [ppm], 5 [ppm], and 20.9%), respectively [15]. When comparing the above results with the average results of this study, it was found that the concentrations of SO_2 and H_2S were higher than their concentrations in the study. This is due to many reasons, including burning large quantities of medical waste when measuring concentrations. At the same time, the concentration of O_2 gas was close to the study concentration rate and within the permissible limits.

4 Conclusions

The information confirms the danger of burning medical waste; the danger lies in the polluting materials and gases resulting from burning, which affect those who are exposed (patients, medical staff, workers in the health care center, neighboring residents, and even passers-by in the areas where incinerators are located), because they may cause serious diseases. For that purpose, six gases were studied: O_2, SiH_4, H_2, SO_2, NO_2, and H_2S, in addition to measuring wind speed and temperature that affect the concentrations of the measured gases. The study proved that (1) incineration of medical waste is a high-degree thermal oxidation process through which harmful and dangerous wastes are converted in the presence of O_2 in the atmosphere into gases and solid, non-combustible deposits. Thus, the function of incinerators is to remove organic matter from hazardous waste. (2) The concentrations of the studied gases varied during the study area. (3) The study area suffers from pollution with SO_2 gas, which is one of the main standard pollutants for assessing polluted areas, and in light of this exceeding in the recorded values, the elements of the ecosystem in the study area are under the continuous negative impact of this dangerous pollutant. (4) Some of the studied gases (like NO_2 and H_2S) have concentrations close to the upper limit of the standards, which poses a threat to public health and other elements of the environment, which confirms the existence of an air pollution problem that the study area and the nearby areas suffer from. (5) The concentrations of O_2 and SiH_4 gases were within the permissible limits of NAAQS throughout the study period. (6) There is a clear variation in temperatures according to the months of the year; this has an effect on the measured gas concentrations. (7) The wind velocity is directly proportional to the dispersion of the pollutants. (8) Only modern incinerators operating at temperatures ranging between 850 and 1,100°C equipped with electrical and electronic supplements that ensure the complete burning of medical waste and special gas disposal technologies can comply with international standards of the World Health Organization to ensure the disposal of chemical and toxic gases.

5 Recommendations

1. The necessity of establishing a unified place for disposal of medical waste, whether through incineration or any other method. This place receives waste from all hospitals and medical care places, all the required specifications and standards apply to it, and it is located in an area far from the population centers.
2. Providing the medical waste incinerator in the hospital with electrical and electronic supplements that ensure the complete burning of medical waste.
3. Training workers in the medical waste incineration profession on proper incineration mechanisms.

Conflict of interest: Authors state no conflict of interest.

References

[1] Al-Duhaidahawi FJ. The spatial analysis of air pollution in Al-Najaf Al-Ashraf governorate. PhD Geography/environmental pollution thesis. Kufa, Iraq: Kufa University; 2015.
[2] Al-Mossawy AR. Determination of the concentration of air polluting elements and gases in the holy city of Karbala. Kufa, Iraq: Master of Science in Chemistry, Faculty of education for girls, Kufa University; 2013.
[3] Peavy H, Rowe D, Tchobanoglous G. Environmental engineering. New York: McGraw-Hill, International Editions; 1985, Civil Engineering Series.
[4] Mahmood TA. Environmental science and technology. Mosul University, Dar AI-kotob for the Printing and Publishing; 1988.
[5] Davis M, Masten S. Principles of environmental engineering and science. New York: McGraw-Hill Companies, Higher Education; 2004.
[6] Research and Technical Assistance Unit. Medical waste, real risks to public health and environment in Gaza Strip, Report, Gaza, Palestine, April 2019.
[7] Hsiao YT, Sheng W, Sin Y, Jeng R. Experimental studies on the ignition behavior of pure silane released into the air. J Loss Prev Process Ind J; 2010;23:170–77.
[8] Gadar H, Altlomate A, Al-Qarih A. Assessment of gaseous pollutants from an al-Burj cement factory in Zliten city. The third scientific conference on occupational safety and health and environmental protection; 12–13 December 2017. p. 1–11.
[9] Al-Kelaby AS. Geographical analysis of air pollution levels in Al-Manathira city. Geographical Res J. 2017;25:361–89.
[10] Hamid QA. The effect of carbon dioxide from car exhaust on the environment and the use of modern technologies such as laser and Coussian technology to detect pollutants in Amara and Nasiriyah cities. Sci J Dhi Qar Univ. December 2015;10(4):105–19.
[11] Al-Rubaii D, Al-Baghdady A, Al-Taghlubi Z. A geographic analysis of air pollution in Al-Najaf Al-Ashraf city. Kufa Lit J. 2015;1(22):87–120.
[12] Al-Mrayani AZ. Spatial analysis of air pollution, soil and noise in Dhi Qar oil refinery. J Coll Educ Hum Sciences, Dhi Qar Univ. 2018;8(2):402–46.
[13] World Health Organization, Mercury and health. http://www.who.int/mediacentre/factsheets/fs361/ar.
[14] World Health Organization, Cadmium. http://www.who.int/ipcs/assessment/public_health/cadmium/ar.
[15] Al-Taghlubi Z. A geographic analysis of air pollution in Al-Najaf Al-Ashraf city Master of Science in Geography. Iraq: Faculty of art, Kufa University; 2013.