

Study the impact of electrical generators (Household generators) to the surrounding environment

Dr. Siddig .M .Dabbahi¹
Faculty of Engineering
Sabratha University

Prof. Abdulmagid .A.Khattabi
Higher institute of Marine
sciences techniques and fisheries.
Sabratha

¹⁻ siddig.dabbashi@sabu.edu.ly

الملخص:

تناولنا في هذا البحث تأثير المولدات الكهربائية على البيئة من حيث تلوث الهواء وما تسببه مولدات الديزل ومولدات البنزين. لوحظ أن درجة تركيز الملوثات الناتجة عن مولدات الديزل ومولدات البنزين مختلفة، حيث أن درجة التركيز (CO ، NO ، SO₂ ، Pb) الناتجة عن مولدات البنزين تزداد بمعدل أكبر من مولدات الديزل وتكون أكبر. من المعدل المسموح به دوليًا. في حالة استخدام مولد البنزين تكون تركيزات الملوثات SO₂ الناتجة من مولدات البنزين منخفضة جدًا مقارنة بتركيزات الملوثات SO₂ الناتجة من مولدات في حالة مولد الديزل المشكلة الرئيسية لمحركات الديزل الرائحة والدخان. أما النوع الآخر من التلوث فهو التلوث الضوضائي، يلاحظ أن انخفاض مستوى ضغط الصوت في حدود (6-7 ديسيبل) عندما تتضاعف المسافة بين المصدر والمستمع، وهذا يعني أن مستوى ضغط الصوت يتناسب لوغاريتميًا. وبالمقارنة مع محددات منظمة الصحة العالمية للضوضاء البيئية للمناطق السكنية في ليبيا، تم توفير المسافات المطلوبة. الكلمات الدلالية: المولدات الكهربائية، البيئة، مولدات البنزين، مولدات الديزل، التلوث الضوضائي، مستوى ضغط الصوت. منظمة الصحة العالمية

Abstract

In this research, we dealt with the effect of electric generators on the environment in terms of air pollution and what caused by diesel generators and gasoline generators. It has been observed that the

degree of concentration of pollutants resulting from diesel generators and gasoline generators is different, as the degree of concentration (Pb, SO₂,NO,CO) resulting from gasoline generators increases by a greater rate than diesel generators and is greater than the internationally permitted rate. As diesel generators produce approximately 10% of carbon monoxide, which is produced by gasoline generators, it is higher than the national standard (35ppm) in gasoline generators, while lead compounds are non-existent in diesel generators but notice the increase in the amount of lead to more than the suggested national limit (1.5 μ g / m³) in the case of using a gasoline generator The pollutant concentrations SO₂ produced from gasoline generators are very low compared to the pollutant concentrations SO₂ produced from diesel generators and are higher than the national standard (0.1ppm) in the case of a diesel generator The main problem for diesel engines is odor and smoke. As for the other type of pollution is noise pollution, observed that the decrease in sound pressure level within the limits (7-6 dBA) when the distance between the source and the listener doubles, and this means that the sound pressure level is logarithmically proportional By comparison with the World Health Organization's determinants of environmental noise for residential areas in Libya, the required distances were provided.

Keywords: electric generators, environment, gasoline generators, diesel generators, noise pollution, sound pressure level. World Health Organization

I. INTRODUCTION

The use of various types of electrical generators is imposed situation on Libyan cities and its people Due to a shortage in the electric power output of electricity because of wars The electric generators caused two types of direct pollution and addition other undirected types.

First pollution- Air pollution from the use of two types of fuel (Diesel & gasoline) and outputs of multiple burning of

this fuel Hydrocarbon compound Sulfur dioxide, nitrogen oxide, carbon dioxide and the heavy elements, especially lead, all have a variety of damage to public health, animal, plant and environment the most prominent damage to health is allergies, certain eye diseases and the effect on the physical and mental growth of children

Second pollution - it is noise pollution which effect negatively on human health aspects physical psychological and neurological and causes of hearing impairment, heart disease, atherosclerosis, tumors and immune deficiency and blood sugar and other but the indirect damages include water oils and oil products leaked due to operating and contamination of soil and vegetation caused by fuel leaks[1].

A. The main air pollution

air pollution Characterized from other forms of pollution spreading quickly in terms of it is impact is not limited to the source region, but extends to the neighboring and distant areas, and air pollution cannot control it after release from the source Therefore be controlled and treated before it spreads. As well it is difficult to note air pollution by naked eye and to identify the components because it have multi- sources and because the complex installation and configuration, the following are some of the major pollutants of air and it is impact of public health [2],[3]

1- Sulfur oxides-(sulfur dioxide) (SO_x), the sulfur dioxide it is one of the chemical compounds known as . (SO_2) sulfur dioxide this SO_2 emitted from volcanoes and various industrial processes.

2- Nitrogen oxides- the nitrogen dioxide NO_2 and nitrogen monoxide NO is made up when oxygen and nitrogen union Under high temperatures, such as the combustion of gasoline and diesel fuel .these gases are considered toxic gases

3- Carbon monoxide - a colorless, odorless and poisonous gas this gas produced from a process of non-full combustion of fuel such as natural wood or coal or gas

4- Carbon dioxide - (CO_2) is a greenhouse gases this gas emitted from the combustion process However, it is one of the necessary gases of the living.

5- Ozone- this gas naturally found in low atmosphere levels and the degree of focus increasing as a result of pollution increasing which emanating from vehicle exhausts,

6- Lead-is one of the most prevalent metals in the air and the most dangerous and deserves more attention because it is considered more prevalent than other metals, Lead and its compounds are used as raw materials, such as in the manufacture of pesticides, paints and batteries, WHO has identified the maximum concentration of this element in the air ($0.05-1\text{Micrograms} / m^3$) as annual rate table 1 shows the Specifications of air quality of the proposed national boundaries

Table1.Specifications of air quality of the proposed national boundaries

Polluted	Limit	Exposure period
TSP	3350 Micrograms/ m^3	24hours
SO2	0.1Part of a million .03Part of a million 0	hour 24 One year
CO	35 Part of a million 9Part of a million	1 hour 8 hour
Pb	1.5 Micrograms / m^3	24hours

7- There are a lot of other pollutants such as particulate matter, metals, ammonia(NH_3) and odors emitted from garbage and sewage and other industrial processes as well as the radioactive contaminants. The air pollutants has been compared with the quality of specifications for the limits of national proposed taking into account the weather factors of temperature and relative humidity

B. The concept of noise

Noise stems from the novelty element of the environment, adversely affecting on the general health situation of the human person organically And psychologically, the noise damage the auditory and nervous system. And increase tension and fatigue. The noise can be defined as: Voices heterogeneous, severity exceeding the normal range allowed for the ear, it is voices undesirable due to the increased intensity and severity and out of the ordinary natural sounds that people are accustomed. The Noise is measured by unit called dB (Decibel), it is a unit to measure the level of intensity of pressure. the noise level must be less than 25 dBA that human able to sleep and rest, but if the noise level exceeds 65 dBA.m The human cannot able to focus in thinking[3] The noise depends on several factors as:

- 1- The length of exposure: the noises increases as time of exposure increase as well The high sound are more dangerous than continuing sounds
- 2- Unit volume: the sharp sounds is most influential from the hard voices and the damage increases with increase of the Sound intensity
- 3- The distance between the audio source and the person who hears, as the distance decreases the sound effect on human increased.[5]

The main Noise pollution damage is Impact on the hearing power and impact on blood pressure. Fig.1 showed the audio sources and their damaging.

It is worth mentioning that most of the owners of household electrical generators, are forced to disarm absorbent structure of sound and noise, Since the open engine allows for ventilation and cooling caffeine, which increases the noise emanating from them [4]. Table .2 shows the Allowable exposure hours for noise

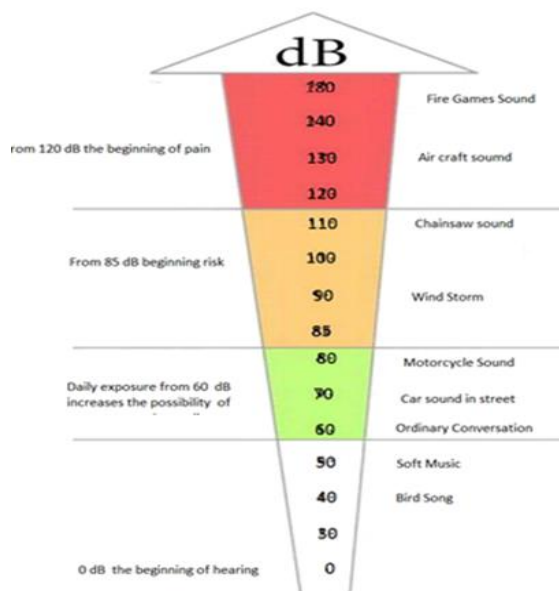


Figure1. Sources of sound and its damage according to its level in disible (dB)

Table2. Allowable exposure hours for noise

Noise level (dB)	Allowable exposure hours
85-90	8 Hours
100	2 Hours
106	0.5 Hours

II. Practical study

In this research process we study two types of pollutants (Air and noise pollutants) for generators used in houses (gasoline& diesel generators) as described in the following paragraphs for generator sets

1- The first aspect of the tests included examination of air pollution resulting from the generators , took two types of electric generators that

operate in accordance with the mechanisms of internal combustion engines (gasoline & diesel).these Tests taken at a height 1.5m above the ground. Assuming that the period of operation equal ,the generators status of it old or new are similar and the rate of fuel consumption is equal, the study period between 15.08.2014 to 15.11.2014and Compared with air quality limits for the Libyan specifications [6].

2- The second aspect of the tests included checking noise pollution output of electric generators that operate with two types of (gasoline & diesel) fuel for a residential neighborhood on the rise (1.0-2.0) m above the ground using the Environmental test meter Fig. 2 For noise measuring , relative humidity, temperature and light Where the measurement taken in four directions of the generator and at same dimension to extract the highest and the lowest value of the noise and compared with the World Health Organization for environmental noise which is (50-55) dBAAnd for 16 hours period of exposure Assuming that the period of operation of the generator is equal status and the amount of the voltage which used in all homes is equal and absence of any other source of noise[7].



Figure2. Environmental test meter

The several measuring for noise levels are taken, namely;

1- The maximum noise level during the period of measurement

LA_{max}

2- The minimum noise level during the period of measurement

LA_{min}

3- The volume ratio is more than 20%, 60%, 100 % from time

measurement, L_{20} , L_{60} and L_{100}

4- Average Noise Equivalent LA_{eq} during the period of measurement and by using the following equation.

$$LA_{eq} = L_{60} + \frac{(L_{20} - L_{100})^2}{60} \quad 1$$

5- Noise climate calculated by using equation

$$NC = L_{20} - L_{100} \quad 2$$

Noise climate represents the fluctuations in sound levels during periods of time

III. Results and tests

1- Air pollution results

TABLE.3 THE RATE OF TEMPERATURE AND HUMIDITY FOR STUDY PERIOD

Month	Temperature	Relative humidity
August	42	65
September	35	55
October	28	50
November	23	40

TABLE.4 MINIMUM & MAXIMUM RATES AND MONTHLY CONCENTRATIONS OF CARBON DIOXIDE (CO) UNITS (ppm)

Fuel type	Gasoline			Diesel		
	Min.	Max.	Average	Min.	Max.	Average
Month						
August	24	41	36	2.3	4.0	4.0
September	23	38	32	1.2	3.7	3.0
October	21	39	34	1.85	2.9	2.7
November	20	35	33	1.31	2.6	2.0

تم استلام الورقة بتاريخ: 2023/6 /6م وتم نشرها على الموقع بتاريخ: 2023/7 /15م

TABLE.5 MINIMUM & MAXIMUM RATES AND MONTHLY CONCENTRATIONS OF LEAD (pb) UNITS (ppm)

Fuel type	Gasoline			Diesel		
	Min.	Max.	Average	Min.	Max	Average
August	1.3	1.99	1.64			
September	1.4	1.8	1.6	-	-	-
October	0.65	1.52	1.08	-	-	-
November	0.75	1.45	1.1	-	-	-

TABLE.6 MINIMUM & MAXIMUM RATES AND MONTHLY CONCENTRATIONS OF SULFUR DIOXIDE SO_2 UNITS (ppm)

Fuel type	Gasoline			Diesel		
	Min.	Max.	Average	Min.	Max.	Average
August	0.05	0.13	0.12	2.8	3.2	3.2
September	0.05	0.11	0.092	2.0	3.0	2.77
October	0.04	0.09	0.077	1.2	2.2	2.0
November	0.03	0.08	0.06	1.9	2.68	2.2

TABLE.7 MINIMUM & MAXIMUM RATES AND MONTHLY CONCENTRATIONS OF NITROGEN OXIDES (NO) UNITS (ppm)

Fuel type	Gasoline			Diesel		
	Min.	Max.	Average	Min.	Max	Average
August	4.4	6.0	5.71	3.75	5.8	5.2
September	2.88	5.1	4.7	3.2	4.55	4.0
October	4.0	4.2	3.95	2.78	3.75	3.39
November	2.28	3.1	2.88	2.29	2.75	2.3

تم استلام الورقة بتاريخ: 2023/6 /6 م وتم نشرها على الموقع بتاريخ: 2023/7 /15 م

TABLE.8 MINIMUM & MAXIMUM RATES AND MONTHLY CONCENTRATIONS OF THE OUTSTANDING PARTICULATE UNITS (ppm)

Fuel type	Gasoline			Diesel		
Month	Min.	Max.	Average	Min.	Max.	Average
August	0.2	0.285	0.28	0.31	0.41	0.43
September	0.17	0.28	0.21	0.34	0.38	0.38
October	0.10	0.18	0.19	0.25	0.30	0.29
November	0.06	0.18	0.14	0.18	0.20	0.185

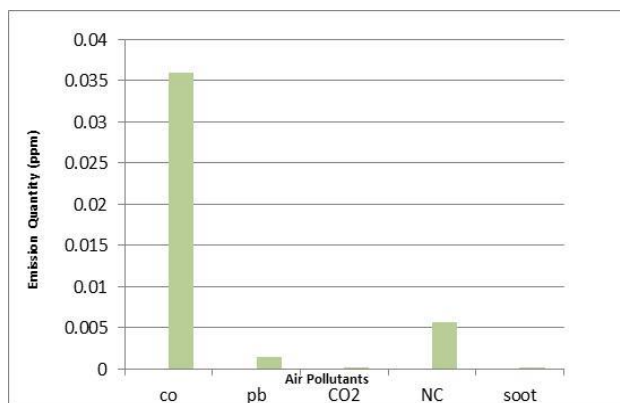


Figure 3. The type of pollutant that results from gasoline generators

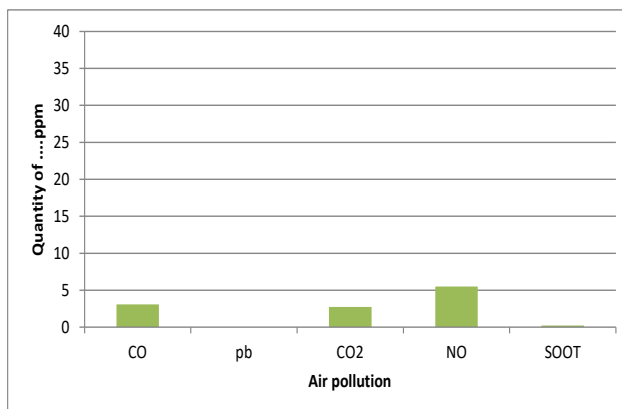


Figure 3a The type of pollutant that results from diesel generators

2-Noise pollution results

A. Pollution from gasoline generator

When the temperature 22°C , relative humidity 49%

From Fig.4. $L_{20}=87.5\text{dBA}$, $L_{60}=77.5\text{dBA}$ and $L_{100}=72.5\text{dBA}$, by substituting in equation (1) the $LA_{\text{eq}}=81.25\text{dBA}$, and from equation (2) $NC = 15\text{dBA}$ where $LA_{\text{max}} = 87.7 \text{ dBA}$ at distance 0 meter and $LA_{\text{min}} = 72.5\text{dBA}$ at distance 10 meter

TABLE 9 RESULTS OF GASOLINE GENERATORS

Distance (m)	Noise level(dBA)	Time (minute)	Increasing of noise level(xdBA)	<i>INCREASING VALUE</i> * <i>TOTAL VALUE</i> 100%
1	92	1	72	100
2	88	2	73.8	100
3	85.8	3	75	80
4	83.2	4	76.2	60
5	80	5	78.5	50
6	78	6	80.1	30
7	75.8	7	83	30
8	73.1	8	87.1	20
9	72.6	9	90	10
10	71	10	92	0

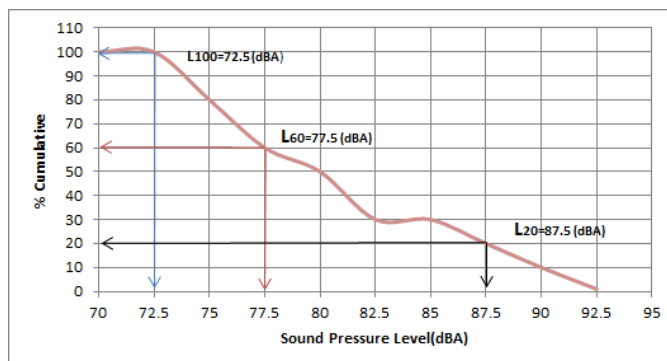


Figure4. The statistical distribution of the gasoline generator

B. Pollution from diesel generator

1- Generator in a container wrapped with noise-absorbent materials: Where the temperature $20C^0$, relative humidity 47% From Fig.5. $L_{20}=77.5$ dBA, $L_{60}=67.5$ dBA and $L_{100}=62.5$ dBA and by substituting in equation (1) the $LA_{eq}=71.25$ dBA and from equation (2) $NC = 15$ dBA where $LA_{max} = 77.8$ dBA at distance zero and $LA_{min} = 62.5$ dBA at distance 10 meter

TABLE 10 RESULTS OF DEISEL GENERATOS
(WITH SILENCER)

Distance (m)	Noise level(dBA)	Time (minute)	Increasing of noise level(xdBA)	$\frac{INCREASING\ VALUE}{TOTAL\ VALUE} *$ 100%
1	81	1	60	100
2	76	2	62.8	100
3	74	3	65	80
4	71.3	4	67.5	60
5	69.7	5	70	50
6	68.1	6	72	30
7	65.3	7	75	30
8	64.2	8	77.5	20
9	63	9	80	10
10	62.2	10	82.5	0

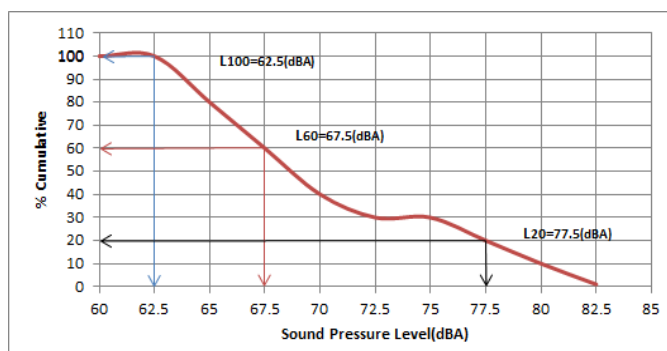


Figure 5. The statistical distribution curve for the diesel generator (with silencer)

2- Generator with Non-container wrapped with noise-absorbent materials: Where the temperature 19°C , relative humidity 53%. From Fig.6 , $L_{20}=102.5\text{dBA}$, $L_{60}=92.5\text{dBA}$ and $L_{100}=87.5\text{dBA}$ and by substituting in equation (1) the $LA_{eq}=96.25\text{dBA}$ and from equation (2) $NC = 15\text{dBA}$ where $LA_{max} = 87.5 \text{ dBA}$ at distance zero and $LA_{min} = 108 \text{ dBA}$ at distance 10 meter

**TABLE 11 RESULTS OF DEISEL GENERATOS
(WITHOUT SILENCER)**

Distance (m)	Noise level(dBA)	Time (minute)	Increasing of noise level(xdBA)	$\frac{\text{INCREASING VALUE}}{\text{TOTAL VALUE}} * 100\%$
1	106.7	1	85	100
2	103.2	2	87.5	100
3	100	3	91	80
4	97.1	4	92.5	60
5	95.3	5	96	50
6	93.8	6	97.5	30
7	92.3	7	100	30
8	91	8	102.5	20
9	90	9	104	10
10	89.1	10	107.5	0

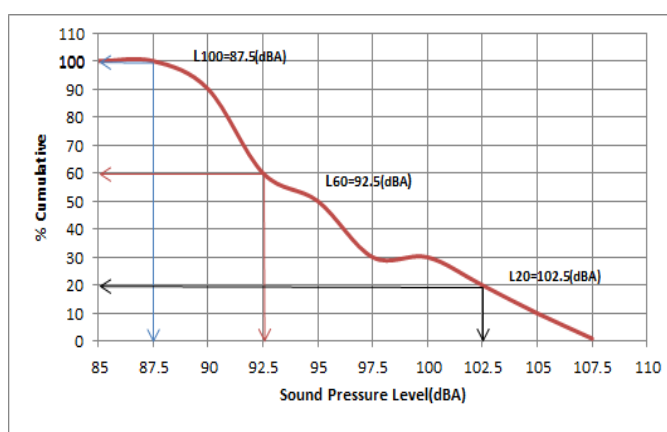


Figure 6 .The statistical distribution curve for the diesel generator (without silencer)

IV. Discussion and Conclusion

In the first aspect of air pollution noted that in Table 4 the concentrations of pollutants from diesel generators is approximately equal (10%) from carbon monoxide which is produced by gasoline generators and higher than the national limit (35 ppm) for gasoline generators. This helps to increase air pollution where lead compounds are non-existent in diesel Generators, from table 5 noted that increased concentrations of lead is more than the proposed national exact ($1.5\mu\text{g} / \text{m}^3$ in the months of August and September when using gasoline generator ,from table 6 the concentrations of SO_2 polluter output of gasoline generators are very small compared to the concentration of SO_2 output of the diesel generators and higher than the national limit 0.1ppm in diesel generators The concentrations of contaminated NO output of gasoline generators is slightly larger than the polluter NO output of diesel generators as shown in Table 7. The particles as emitted smoke and vapors hydrogen, which may be a liquid or solid and sizes less than 10 micrometers note that the amount in gasoline generator is lower than in diesel generator Table 8. Since the main problems in diesel engines is the smell and smoke as well as the wind speed in Libyan summer is low . This helps on dispersing air pollutants. Where The high temperature and low humidity increases the concentrations of pollutants by Comparing Table 3 with tables 4-8 the diesel fuel is considered more economical and more safer when the gasoline engines is fast-moving, and low-torque, where in diesel engines have slow rotation speed , high torque and .The ignition process in diesel engine need more time. As observed in Fig.3 and 3a. The difference in the concentrations of pollutants caused by gasoline and diesel generators, where the increasingly concentrations of pollutants as($\text{CO}, \text{NO}, \text{SO}_2, \text{Pb}$ and Soot) which resulting from gasoline generators is more than pollutants from diesel generators. In general some of the pollutants that increase concentrations in gasoline generators decreases in diesel generators and vice versa. The second study are considered in terms the electrical generators send audio waves in all directions, which are spread around the

spherical source site in the air[8]. From table 9,10 and 11 observed that decrease in the level of the sound pressure by(6-7 dBA) at double distance between the source and the listener. Also noted that the difference in the sound level at the beginning is greater then gradually decrease as distance increasing. at distance 10m the amount of acoustic pressure for gasoline generator is 72.5dB and for diesel generator with existence silencer is 62.5dBA and diesel generator without is silencer 87.5dB Based on the previous conclusion that at double distance the acoustic pressure decreased by 6-7 dBA found that we need to put gasoline generator after (80 m) in order to get at least the amount of sound pressure level to meet the World Health Organization And we need to put the diesel generator (with silencer) at 40 m or more in order to get the amount of audio compression asymptotic to the terms of the World Health Organization. That means after 10 m it is enough for gasoline and diesel generators with silencer and 20 m or more for gasoline and diesel generators without silencer. In case of repeating the same previous measurements on the same generator at different temperatures and humidity. noted that the increase in air temperature increases the speed of noise As well the intensity of noise affected by relative humidity, found that the wind speed and it is direction effect on noise transmission, noted that the amount of noise climate (NC) decrease with increasing in the average amount of noise equivalent LA_{eq} during the period of measurement

V. Conclusions

1- through tables and figures observed the air pollution and the different concentrations of contaminants caused by gasoline and diesel generators that increase the concentrations of pollutants which (CO, NO, SO_2 , pb and soot) resulting from gasoline generators is largest of those pollutants from diesel generators.

2- High temperatures , low relative humidity and wind speed increases the concentration of air pollutants emitted from diesel and gasoline generators.

- 3- The increase in air temperature increases the speed noise as well as the intensity of the noise affected by relative humidity ,the wind speed and direction effect on noise transmission.
- 4- It observed from tables the noise pollution decrease the level of sound pressure limits by (6-7 dBA) at Doubling the distance between the source and the listener, this means that the sound pressure that is Decreases by rate of 6-7 dBA at doubling the distance at the source
- 5- The distance 80 m for gasoline generator and distance 40 m for diesel generator (with silencer) is suitable for audio compression asymptotic to the terms of the World Health Organization.

Recommendations

- 1- exhaust filters for generators to reduce the impact of polluting gases is needed
- 2- Packaging large generators inside rooms lined by sound-absorbent materials
- 3- Ongoing maintenance and lubrication necessary to ensure that reduce the emission of pollutants that are increasingly due to bad operating
- 4- Build giant generators Friendly to the environment work by black oil in order to save fuel and reduce pollution resulting from household generators
- 5- Take away as possible the generators out of residential areas taking into account the air direction to avoid outputs of inhalation combustion and reduce the noise level
- 6- Generators placed near a dense forest of trees for use in creating an environment where there are large quantities of oxygen required for the oxidation of air pollutants

ACKNOWLEDGMENT

I would like to thank saif Salah Alkizwini and Aness Kadhim Idris from Faculty of Engineering, University of Babylon As well Ms. Rasha Mahdi Salah from the Faculty of Engineering, University of Babylon Who help us to use their research's which provide us useful information.

REFERENCES

- [1] Internet 2012 "noise and bustle ... the most dangerous types of environmental pollution on Human Health".
- [2] Aboabdoon, Adesan Ibrahim.2009 Environmental pollution and its dimensions sources, Fuel and transportation and communication facilities, "University of Sharjah-Chemistry Department, Sharjah-state United Arab Emirates.
- [3] Albhrani, Hosen Shaker Mahmoud 2009 "A field study on the most important noise pollution in residential neighborhoods of the cities of Najaf and Kufa sources" Journal of Engineering Science Qadissiya-Issue 4 Volume 2.
- [4] Altorngi, Abdolwahab Abdulla Kasem, " Financial costs of noise pollution and its effects on the socio-economic units"2008.
- [5] Shammari, Hussein and Mona Jaber Mohammed Ali.internet 2012 "study the effect of noise pollution on the environment field study in the Iraqi holy city of Najaf" Literature magazine Kufa -volume 4.
- [6] Al-Husseini, Alaa Hamed 2010 "study the environmental effects of the use of diesel generators " Second Annual Scientific Conference of the Faculty of Engineering / University of Babylon
- [7] Study the effect of noise in city planning" Journal of Engineering-Anbar University .volume 1,Issue 2Technical Institute/Anbar.
- [8] Internet 2013" environmental pollution arising from the use of Electric generators