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Modeling the effect of sound insulation on reducing the sound pressure level in the gas pressure reducing station

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Abstract

Among all occupational pollutants, noises have the highest levels of emissions, and there are almost every industry. Noise interferes with conversations and prevents hearing loss as one of the most common stresses and causes the occurrence of cardiovascular problems and, more importantly, reduces hearing in exposed individuals. In the City Gas Station(CGS), gas pressure is reduced from 700 psi to 250 psi, and at Town Board stations(TBS), the gas pressure is reduced from 230psi-250psi to 60psi.In gas pressure reduction stations, due to the equipment installed and the geographic location of the station, in order to maintain the safety and health of the station, appropriate measures are needed to measure noise and reduce noise. Due to the high noise pollution, the CGS and TBS gas pressure reduction stations are compared. Therefore, in this research, an appropriate modeling with Matlab and a mathematical program to analyze the intensity level of sound at different intervals from the source of sound and various frequencies and different sound power in a non-insulated

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state and in insulated mode, by changing the surface density of the insulator, it examines the effect of reducing the level of sound intensity. The most important results are:

1. Reduces the intensity of the sound by increasing the distance from the sound source. However, under operating conditions, the size of the valve=6 " , Frequency = 500HZ, Sound pressure = 2Watt, Insulation density=100kg/m^2 , the existence of an insulator with a surface density of 100 kg/m^2 would reduce the 12db level of sound level at a level between 66db to 106db became.

2-Voice intensity increases with increasing sound power at identical intervals from the sound source. However, for operating conditions, the Size of valve=6", Frequency=500HZ, Distance=25m, Insulation density=100kg /m^2 with sound power change from watt1 to 20watt Sound level levels from 6db to 11db for safe and no Insulation changes.

3. As the distance from the sound source increases, the intensity of the sound decreases with decreasing frequency. However, under operating conditions, the size of the valve=6 ", Frequency= 400HZ, Sound pressure=2Watt, Insulation density = 100kg/m^2. Sound intensity level An insulator with a surface density of 100kg/m^2 at a level between 66db and 106db reduces from about 20db to 26 db, respectively.

4. With increasing insulating surface density, the level of sound balance decreases at identical intervals. However, under operating conditions, the size of the valve=6", Frequency=500HZ, Sound pressure = 2Watt, Distance of source=25m. Insulation with a surface density of 1kg/m^2 reduces about 7db. Sound and sound level levels with a surface density of 100kg/m^2 will reduce the sound power level by about 20db.

Key words: Gas Pressure Reducing Station, Sound Pollution, Sound Distribution modeling with Matlab , Sound Insulation.

1- Introduction

Noise pollution is one of the most important types of pollution that causes direct physical and mental harm to humans. Therefore, it is important to analyze and recognize it and study it in order to prevent its publication. Sound is the result of the vibration of an object and is propagated as a wave in the material environment (air or water) and we perceive it in our auditory system through physiological interactions. For the production and propagation of acoustic waves, the vibrations that cause the production and transmission of acoustic waves are divided into three categories according to their frequency limits: Acoustic vibrations that are effective in creating sound and are heard by the ear. The frequency range of vibrations of this type that are effective in creating sound and can be heard by the ear is between 20 to 20,000 cycles per second. Ultrasonic vibrations are from frequencies of 20,000 cycles per second and up and ultrasonic vibrations are from frequencies of 20 cycles per second down. Sound is the pressure waves that pass through an interface. These waves are defined according to their amplitude and frequency [1],[2]. Zhao et al. [3] investigated the prominent oleophilic PP / PTFE PP / PTFE nanocomposite foam and the sound insulation of microcellular injection molding. A novel strategy was employed to prepare lightweight, oleophilic, and sound-insulating polypropylene (PP)/polytetrafluoroethylene (PTFE) composite foams by combining the microcellular injection molding (MIM) and in-situ fibrillation technologies. Notably, the nano-scale structures on cell walls together with thin cell-wall thickness of the PP/PTFE foam, significantly increased the open-cell content to 98.3%. The high porosities and large expansion ratios, assisted by the capillary penetration action caused by the uniquely elongated cells, effectively increased the oil absorption capacity up to 22.5 g/g with a high recovery of 97.4%, particularly for raw crude oil. Hammer MS et al. [4] in addition, the omnipresent noise pollution, acting as a terrible annoyance, seriously disrupts the balance of human beings' life and even causes severe diseases. Thus, sound insulation is also widely concerned by both developed and developing countries. Abidli et al. [5] in order to achieve high efficiency of oil uptake and sound absorption, porous sorbent materials, such as aerogels, fibrous mats, and foams, have been extensively studied in the field of academic and industry, due to their high porosity, versatile design, mass production, excellent hydrophobic properties, and outstanding oleophilic performance. Korhonen and et al. [6] however, these materials still have their own inherent advantages and disadvantages. For instance, aerogel shows the superior capability of oil and sound absorption, which are more than 60 g/g in oil uptake and close to 100% in sound absorption coefficient, but its manufacturing process is relatively complex, together with comparatively low mechanical properties, which both considerably limited the industrial application. Lei Z et al. [7] as for the fibrous sorbent mat, its various amusing properties, such as high porosity, low density, good connectivity between micro and nano pores, and easy scalability with low cost, endow such materials good oil absorption and acoustic performances. Nevertheless, there is still tough challenges faced by the fibrous sorbent mats in large-scale industrial application, including poor mechanical property, limited recyclability, and possibility of introducing secondary pollution [6]. Rizvi A et al [8] and Wang G et al [9] Tiuc AE and et al [10] and Hou J et al [11] in this context, polymer-based foam is considered as a good candidate for multifunctional engineering materials, due to its high specific strength, outstanding reusability, cost-effective and simple manufacturing process, easy mass production, high oil uptake capability, good acoustic properties, and remarkable chemical and physical stability. By considering the sound, it is felt that instead of pressure, the amount of sound energy is considered, so that the ratio of the two sound energies is as follows:

$$\log_{10}^{\left(\frac{W}{Wref}\right)} \quad (1)$$

Where W_{ref}, W indicates the energy of sound waves and the amount of energy based on watts. Given that the energy is proportional to the square of the pressure, then the above ratio can be expressed as follows:

$\log_{10}^{(p^2/p^2{}_{ref})}$ (2)

Where P: sound pressure

P_{ref} : Base pressure value

$2\log_{10}^{(p/p_{ref})}$ (3)

The above phrase can be simplified as follows:

We call this phrase conventionally Bell. If we divide this unit by 10, its use will be easier and it will be prevented from being deducted, in this sound it is called decibel. The minimum pressure that the human ear can detect is around 2×10^{-5} N/m^2, and this data would be appropriate. Considering 2×10^{-5} N/m^2 as a base value, the amount of sound pressure level (SPL) in decibels and denoted by dB will be defined as follows:

$$SPL = 20\log_{10}^{(p/p_{ref})} \quad (4)$$

Where SPL: sound pressure level

P: Sound pressure

P_{ref}: Sound base pressure, equal to 2×10^{-5} N/m^2

1-1-Frequency:

The number of oscillating movements in a given period of time is called the frequency. (Each complete motion is called periodic oscillation). The measurement time of the oscillations is seconds and their number is specified in Hz. Seconds / number of oscillations Hz. The higher the frequency of the sound, the faster the vibrational motion, the lower the resulting sound, and the lower the frequency, the lower the Sound. But the human ear can only hear sounds in the frequency range between 20 Hz and 20,000 Hz.

1-2- wavelength:

The vibrating body performs any complete rotation at a specified time. The unit of wavelength is meters, and the shorter this value, the lower the sound and the louder the sound.

1-3- Amplitude:

The maximum distance that a vibrating object travels from its equilibrium point in the middle to both sides (peak points).

1-4- Sound environment:

The sound environment is the area where sound is emitted.

1-5- Sound pressure:

Sound pressure is affected by the energy output from the sound source, the distance from the sound source and the surroundings.

1-6- Voice power:

Sound power is the sound energy output from a sound source that is not affected by the environment.

1-7-Sound intensity:

Sound intensity is the amount of sound energy that passes through a unit perpendicular to the direction of propagation of waves in one second, the following factors affect the sound intensity.

1-7-1-Vibration range:

Waves carry energy with them (at the surface of the water or rope). This energy is proportional to the amplitude and frequency squared $E=(1/2)mw^2A^2$, on the other hand, according to the definition of sound intensity, sound intensity is directly related to energy, so we conclude that sound intensity is directly related to the amplitude square.

1-7-2-distance:

The farther we go from the sound source, the weaker the sound. To understand this, consider the S sound source, which creates spherical waves in space. If you ignore the loss of sound energy in the air, in a unit of time energy p reaches the surface of a sphere with area $4\pi r^2$ (r radius of the sphere) as a result of the intensity of sound as $I= P/4\pi r^2$. This relationship shows that moving away from the S source reduces the Sound.

1-7-3-Release environment:

The environment in which sound is emitted more or less absorbs sound energy, the absorption of sound energy in the environment depends on the frequency of sound. For example, in air, the higher the frequency of sound, the more sound is absorbed.

1-7-4-Frequency squared:

According to the relation $E=(1/2)mw^2A^2$, the intensity of sound is also directly related to the square of frequency. But a sound with a certain frequency that is emitted in a certain environment can be said that the most effective factor in the intensity of sound is the square of the amplitude.

1-8-Sound intensity level:

The intensity level of a sound is the logarithm (in base 10) of the ratio of the intensity of that sound to the intensity of the base sound. The

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Sound level is denoted by β, and its units are named bell (b) and decibel (db).

$$\beta = K\log_{10}^{I/I_0)} \qquad (5)$$

In this equation I_0, the base sound intensity, which is equal to the hearing threshold of a healthy ear at a frequency of 1000 Hz, is considered. I is the sound intensity, K is a constant value that if K = 1 is a unit of β bell and if K = 10, β is in decibels.

2. Process description:

In city gate gas pressure reducing stations (CGS), the gas enters with a pressure of 600 PSI -800 PSI and during two stages of pressure drop in the regulator, its pressure decreases to 240 PSI-250 PSI, due to pressure failure in the station regulator and Jules Thomson phenomenon. Hydrate formation occurs after the pressure reduction process, which preheats the gas before the pressure reduction process to prevent hydrate formation in the stations. Gas heating operations take place in the heaters [12],[13].

Table 1 - Design and actual specifications of the heater, one of the gas pressure reducing stations in the northeast of the country

	Design value	*Real amount*
he station	*120000*	*10419*
tering the	*68*	*34.5*
the station	*17*	*16.5*
tering the	*68*	*34.5*
eater from	*67*	*33.5*
id input to	*15*	*11-15*

id leaving	21	19-21
d entering	15	11-15
the heater	30	27-33
luid in the	75	66
n burning	8631	8631
	175	135

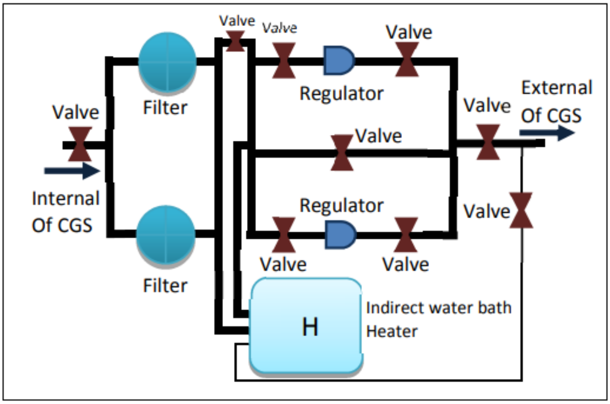

Figure 1- View of one of the gas pressure reducing stations in the northeast of the country [14]

Table 2 - Molar components of natural gas

Component	Mole percent
CH4	95%
C2H6	2%

C3H8	*1%*
N2	*1%*
ETC	*1%*

In pressure reduction stations, different equipments may be used depending on the type of station. These equipments are:

1. Insulation joint

2. Cyclone for large solid particle removal filter

3. Filter separator

4. Dry gas filter

5. Isolating valves

6. Heater (Indirect water path heater)

7. Safety shut off valve

8. Valve pressure reducing & control regulator

9. Metering system

10. Safety relief valve

11. Sound attenuator

12. Odorizer

13. Indicator units such as thermometers and barometers

14. Sensing line control and communication lines

15. Drain valves

16. Supports and steel or concrete frame holding

17. Enclosure and fence (storage compartment)

18. Lighting and protection systems [15]

Since noise occurs in the station regulator, we will examine the regulator further.

2-1-Regulator:

A regulator is a device that regulates the pressure to a certain level by controlling the amount of gas flow. The regulator building consists of three main parts:

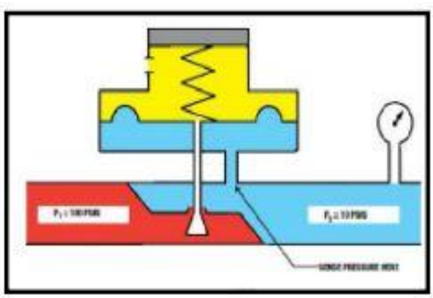

Figure 2 - Schematic of spring regulator[16]

Loader part (weight - spring - gas pressure)
Comparative part (diaphragm)
Operating part (Sit and Orifice)

2-1-1- Spring regulator building:

As can be seen in the figure, the pressure from the spring force is applied to one side of the diagram and the gas pressure is applied to the other side. Open the gas passage opening. First, by pressing the spring, the opening of the duct is opened and the gas enters the outlet chamber which is directly connected to the diaphragm. Whenever the gas pressure in the lower chamber exceeds the spring pressure, the duct is closed and the outlet pressure decreases due to continued consumption [15].

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Figure 3 - View of the spring regulator [16]

2-1-2 ***-Pilot operator regulators*****:**

The manufacturers of regulators, while taking measures in spring regulators while countering the DROOP phenomenon, made regulators that use gas pressure as a load force. Such regulators were called pilot regulators. In this type of regulator, the changes in output pressure are compared with the spring force of another spring regulator called the pilot, and the exhaust gas from this small regulator is transferred to the diaphragm of the main regulator. At the beginning, the regulator is blocked by a fixed spring. By pressing the pilot spring, LOAD load pressure is produced by this regulator and applied below the aperture of the main regulator. If the PL pressure is higher than the P_2 pressure plus the stabilizing spring pressure, the regulator opening opens and P_2 increases. This increase is transmitted to the pilot and compared to its spring pressure. This operation continues until the regulator opening is in a fixed position. In this case, the excess gas received from the pilot is transferred to the regulator output through an internal or external duct [17].

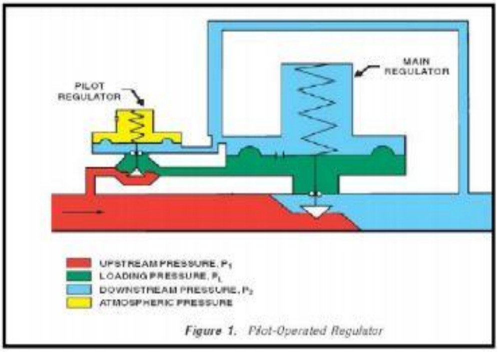

Figure 4 - Schematic of a pilot regulator[17]

3- Modeling the production of noise pollution:

Modeling the production of noise pollution by different sources is generally a complex process. The nonlinearity of the effect of different sources and the effect of spatial characteristics including obstacles and existing surfaces as well as the direct effect of resource density are among the factors that make the analytical evaluation of noise pollution production not a straightforward process.

Table 3 - Examination of laboratory results in pressure reduction stations in Tehran province according to ISO19961 standard

duction station	Distance (m)	Sound pressure level (db) according to ISO19961 standard	Sound pressure level (db)
vince Gas Company nalleh area	25	60	65

vince Gas Company d-Abali region	*25*	*60*	*53*
vince Gas Company region	*25*	*70*	*7.72*
vince Gas Company r Region - geh	*25*	*60*	*85*
vince Gas Company	*25*	*55*	*81.2*

In analyzing the sound intensity level and insulation equations, the sound intensity level equation has been reached at different distances.

$$L = LW + 10log\ (Q/4\pi r^2) - \sigma \quad (6)$$

LW: Power source level in decibels

Q: The eye factor for the various forms of sound source that is considered here 1.

r: Distance to the sound source in meters

σ: Correction of differences due to air and ...

$$LW = 10Log\ W + 120 \quad (7)$$

LW: Power source level in decibels

W: The same sound power in watts.

The following table shows the ocular factor for the different shapes of the sound source indicated by Q [18].

Table 4- Eye factor for different forms of sound source [18]

Source position	Q(Eye factor)
Outdoors	1
At the free level	2
Connect two levels	4
Connect three levels	8

The following figure shows the eye factor for the different shapes of the sound source indicated by Q.

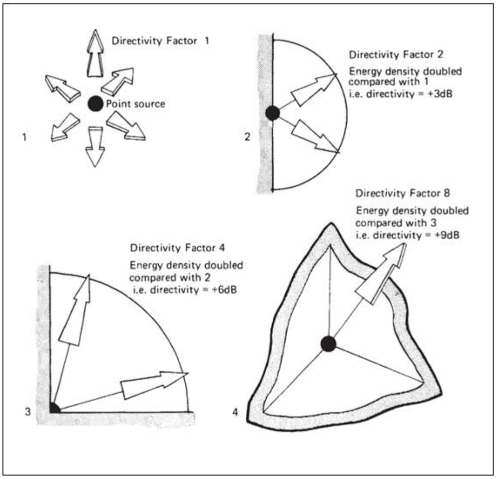

Figure 5 - Eye factor for different forms of sound source[18]

Because the human hearing frequency range is between 20 Hz to 20000 Hz. In particular, this range is between 500Hz to 4000Hz, which is why sound insulation should have a good performance in this frequency range to cause less damage to the human ear. The table *below shows the percentage of sound absorption for a number of insulators at different frequencies [18].*

Table 5 - Sound absorption percentage for a number of insulators at different frequencies[18]

Frequency (Hz)	*125*	*250*	*500*	*1K*	*2K*	*4K*
Sprayed Acoustic Plaster	*0.30*	*0.35*	*0.5*	*0.7*	*0.7*	*0.7*
Breeze Block	*0.2*	*0.3*	*0.6*	*0.6*	*0.5*	*0.5*
Fibre board (solid backing)	*0.05*	*0.1*	*0.15*	*0.25*	*0.3*	*0.3*
Acoustic timber wall panelling	*0.18*	*0.34*	*0.42*	*0.59*	*0.83*	*0.68*

Sound Reduction Index (SRI) according to the law of mass, the factors influencing the reduction of pressure level are a function of the following four items:

1- Insulation weight or the same as surface insulation density

2. Homology and appearance

3. Hardness

4- Insulation cohesion

Among these four items, weight or surface density is the most important and in the graph below, the amount of sound pressure level absorption in terms of insulation surface density is shown [18].

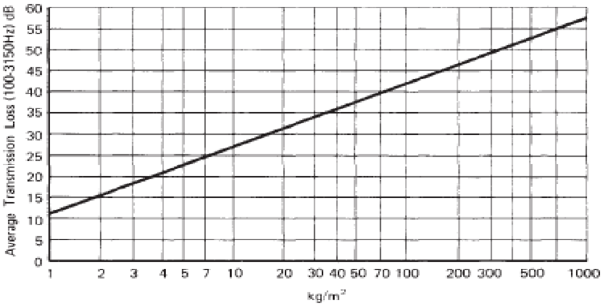

Figure 6- Curve of sound pressure level absorption in terms of insulation surface density[18]

In this diagram, the value of SRI index in the frequency range of 100 Hz to 3150 Hz is shown in terms of surface density of insulation, which is a function of the following equation in the frequency of 500 Hz:

$$SRI_{500} = 0.04594\rho_{surface} + 11.28 \quad (8)$$

SRI: Sound reduction index in decibels

ρsurface: Surface density in kilograms per square meter

In the above function, the amount of ρsurface is given by the user according to the type of insulation [18].

For other frequencies we have:

$$SRIv = SRI_{500} + 5log_2^{\left(\frac{fr}{500}\right)} \quad (9)$$

Finally, we come to the following general equation for the sound relationship in a gas pressure reducing station and the effect of insulation on it:

$$L = LW - SRI + 10Log(s) = 10Log(Q/4\pi r^2) - \sigma \quad (10)$$

LW: Power source level in decibels

Q: The eye factor for the various forms of sound source that is considered here 1.

r: Distance to the sound source in meters

σ: Correction of differences due to air and etc in decibels

S: The area of the absorber around the sound source is in square meters [18].

The area of the absorber around the sound source (here is the industrial valve) is entered by the user in the MATLAB program. Creates. The area S is also a form of the surface area of a square cube and we have:

$$d = 5 \times (valve\ size) \quad (11)$$

$$S = 6 \times d^2 \quad (12)$$

In the analysis of the final equation of sound and the effect of insulation on it, the factors affecting the sound intensity level in the program are given by the user and the condition is examined without insulation, which is one of the most important factors affecting the sound intensity level. Inches and frequencies in hertz and sound power in watts as well as distance from the sound source in meters. Factors affecting the level of sound intensity in the state with sound insulation and without sound insulation are examined in MATLAB engineering software program, which are analyzed in the results of the program, including:

Expansion valve size: The size of the pressure reducing valve in terms of inches, which is set to 6" by default.

Sound frequency (Hz): The sound frequency produced by the pressure relief valve in hertz, which is set to 500Hz by default.

Sound power (w): Sound power in watts, which is set to 2watt by default.

Insulation surface density (kg/m²): Insulation surface density in kilograms per square meter, which is assumed to be 100 kg/m² by default.

Distance from the valve (m): The distance from the valve is in meters, which is set at 25m by default.

Insulation: The same state with insulation and without insulation as shown with none insulation and insulation.

Sound pressure level (db): The same sound pressure level in decibels, which is calculated in two cases with insulation and without insulation at the desired point.

Factors affecting the Sound level in the MATLAB program are given and the conditions in the insulated state are investigated. Also, the distance from the sound source is in meters, and at the same time, one of the most important factors influencing the insulation is the surface density of the insulation, which is different in different types.

4-Process optimization

4-1-Investigating the effect of distance from sound source on sound pressure level:

In this case, we examine the effect of the distance from the sound source on the sound pressure level with the following operating conditions
Size of valve=6"
Frequency=500HZ
Sound pressure= 2Watt
Insulation density=100kg/m²

Table 5 - Sound pressure level in terms of distance from the sound source for insulated and uninsulated

Size of valve=6" *Frequency=500HZ* *Sound pressure= 2Watt* *Insulation density=100kg/m²*		
Distance from source (m)	*Sound pressure level for insulated mode (dB)*	*Sound pressure level for uninsulated mode(dB)*
1	*95.564*	*106.0182*
10	*75.56*	*86.018*
25	*67.6*	*78.059*
50	*61.585*	*72.0388*
100	*55.564*	*66.018*

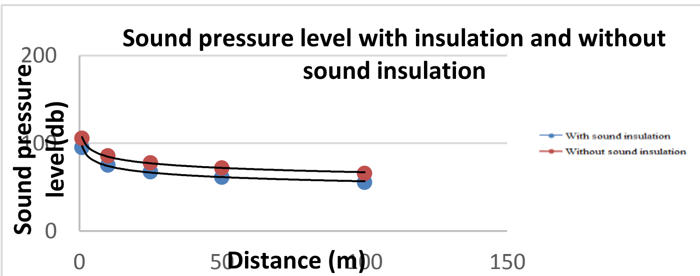

Figure 7 - Sound pressure level for insulated and uninsulated mode in terms of distance

In the above diagram, it can be seen that the sound pressure level has decreased with increasing distance from the sound source and the sound pressure level has decreased to more than about 10db using insulation with a surface density of 100 kg/m^2.

4-2- Investigating the effect of insulation surface density on sound pressure level:

The effect of insulation density on sound pressure level with operating conditions is discussed below:

Size of valve=6"
Frequency=500HZ
Sound pressure= 2Watt
Distance of source=25m

Table 6 - Sound pressure level in terms of insulation density for insulated and uninsulated

Size of valve=6" Frequency=500HZ Sound pressure= 2Watt Distance of source=25m		
Insulation surface density(kg/m^2)	Sound pressure level for insulated mode (dB)	Sound pressure level for uninsulated mode (dB)
10	71.74	78.05
20	71.28	78.05
40	70.36	78.05
80	68.5	78.05

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100	*67.6*	*78.05*

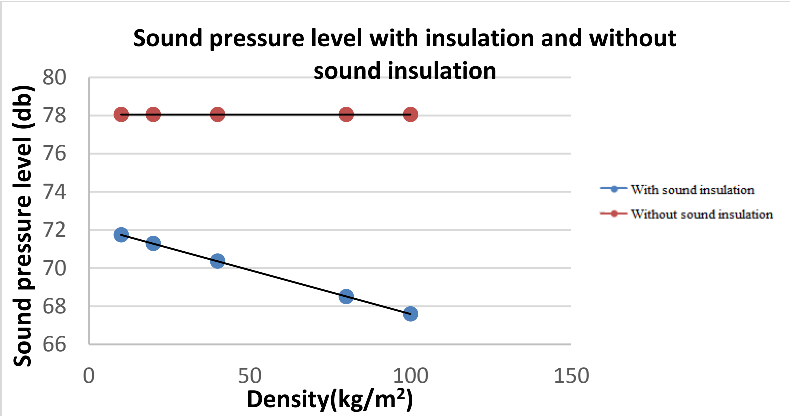

Figure 8 - Sound pressure level for insulated and uninsulated mode in terms of distance

In the above diagram, it is observed that at a certain distance from the sound source (in this case the distance is 25 m), the higher the surface density of the insulation, the more power it has in sound absorption. It is clear from the diagram that the sound pressure level with insulation with a surface density of 10 kg/m^2 decreases to about 6db, and this is important for insulation with a surface density of 100 kg/m^2 to about 12db, so the surface density of insulation are important and influential factors in sound absorption.

***4-3-Investigating the effect of sound power level on sound pressure level*:**

The effect of sound power on sound pressure level with the following operating conditions is investigated.

Size of valve=6"

Frequency=500HZ

Insulation density=100kg/m^2

Distance of source=25m

Table 7- Sound pressure level in terms of sound power for insulated and uninsulated mode

Size of valve=6" Frequency=500HZ Insulation density=100kg/m² Distance of source=25m		
power (watt)	*Sound pressure level for insulated mode (dB)*	*Sound pressure level for uninsulated mode (dB)*
1	*64.59*	*70.04*
2	*67.6*	*78.05*
4	*70.61*	*81.07*
8	*73.62*	*84.08*
20	*77.6*	*88.05*

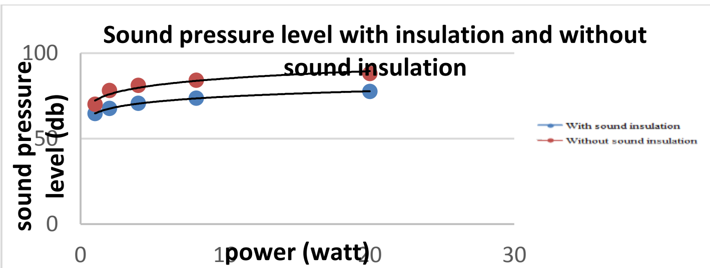

Figure 9- Sound pressure level in terms of sound power for insulated and uninsulated mode

In the above diagram, it is observed that as the sound power or in other words the sound power increases, as a result, the sound pressure level also increases. It is clear from the diagram that the sound pressure level with insulation with a surface density of 100 kg/m^2 at different powers has decreased to about 12db compared to the uninsulated state.

4-4-Investigating the effect of distance from sound source on sound pressure level in insulation density from 100 kg/m^2 to 1 kg/m^2

In this case, the effect of the distance from the sound source on the sound pressure level with the following operating conditions has been investigated. The only difference between this mode and the first mode is in changing the insulation surface density from 100 kg/m^2 to 1 kg/m^2

Size of valve=6"
Frequency=500HZ
Sound pressure= 2Watt
Insulation density=1kg/m^2

Table 8 - Sound pressure level in terms of distance from sound source for insulated and uninsulated

Size of valve=6" Frequency=500HZ Sound pressure= 2Watt Insulation density=1kg/m^2		
Distance of source (m)	Sound pressure level for insulated mode (dB)	Sound pressure level for uninsulated mode (dB)
1	100.11	106.0182
10	80.11	86.018
25	72.154	78.059
50	63.13	72.0388

100	*60.11*	*66.018*

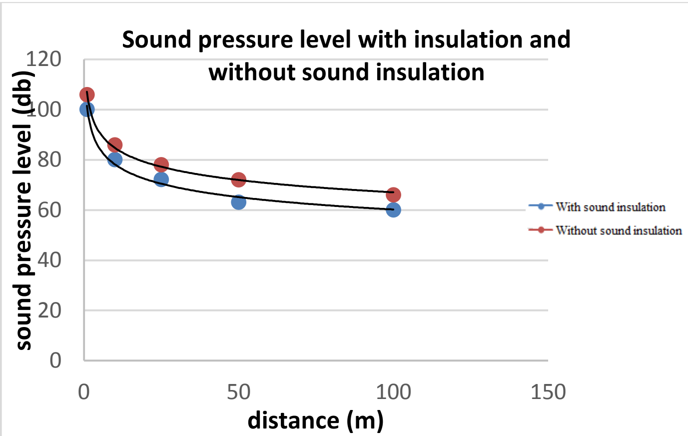

Figure 10- Sound pressure level for insulated and uninsulated mode in terms of distance

In the above diagram, it can be seen that the sound pressure level decreases with increasing distance from the sound source and the sound pressure level decreases to more than 10db at different distances by using insulation with surface density of 1kg/m^2 at different distances. The case where the surface density is less than 100 kg/m^2 and this shows the effect of surface density.

***4-5-Investigating the effect of the distance from the sound source on the sound pressure level in changing the frequency from 500 Hz to 400 Hz*:**

The effect of distance from the sound source on the sound pressure level with the following operating conditions is investigated. The difference between this mode and the first mode is in changing the frequency from 500Hz to 400Hz.

Size of valve=6"

Frequency=400HZ

Sound pressure= 2Watt
Insulation density=100kg/m²

Table 9- Sound level in terms of distance from sound source for insulated and uninsulated

Size of valve=6" *Frequency=400HZ* *Sound pressure= 2Watt* *Insulation density=100kg/m²*		
Distance of source (m)	*Sound pressure level for insulated mode (dB)*	*Sound pressure level for uninsulated mode (dB)*
1	*80.5*	*106.0182*
10	*60.56*	*86.018*
25	*52.6*	*78.059*
50	*46.58*	*72.0388*
100	*40.56*	*66.018*

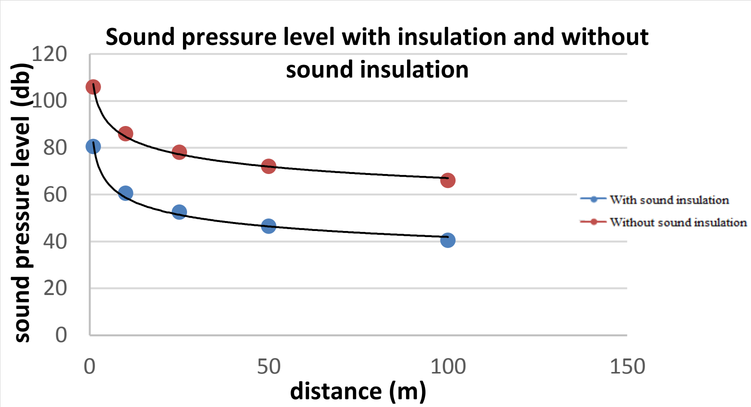

Figure 11- Sound pressure level for insulated and uninsulated mode in terms of distance

In the above diagram, it can be seen that the sound pressure level decreases with increasing distance from the sound source and the sound pressure level decreases to more than 15db using insulation with a surface density of 100 kg/m^2.

4-6- Investigating the effect of distance from sound source on sound pressure level in changing sound power from 2watt to 4watt

In this case, we examine the effect of the distance from the sound source on the sound pressure level with the following operating conditions. The difference between this mode and the previous one is that the sound power has been increased from 2watt to 4watt.

Size of valve=6"
Frequency=500HZ
Sound pressure= 4Watt
Insulation density=100kg/m^2

Table 10- Sound pressure level in terms of distance from the sound source for insulated and uninsulated

Size of valve=6" *Frequency=500HZ* *Sound pressure= 4Watt* *Insulation density=100kg/m^2*

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Distance of source (m)	Sound pressure level for insulated mode (dB)	Sound pressure level for uninsulated mode (dB)
1	*98.57*	*109.02*
10	*78.57*	*89.02*
25	*70.61*	*81.06*
50	*64.59*	*75.04*
100	*58.57*	*69.02*

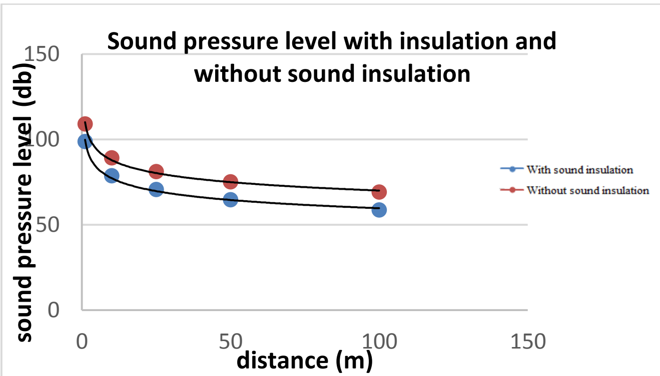

Figure 12 - Sound pressure level for insulated and uninsulated mode in terms of distance

In the above diagram, it can be seen that the sound pressure level decreases with increasing distance from the sound source and the sound pressure level decreases to more than 12db using insulation with insulation with a surface density of 100 kg/m^2.

2- Conclusion

1- The sound intensity level depends on the parameters of insulation surface density, distance from sound propagation source, sound frequency, sound power and lateral area of the sound source.

2. As the distance from the sound source increases, the sound intensity level decreases. However, in operating conditions Size of valve = 6 ", Frequency = 500HZ, Sound pressure = 2Watt, Insulation density = 100kg/m^2 , the presence of insulation with a surface density of 100 kg/m^2 will reduce the sound intensity level by about 12 db at levels between 66 db and 106 db.

3- By increasing the surface density of insulation, the amount of sound level at the same intervals decreases. However, in operating conditions Size of valve = 6 ", Frequency = 500HZ, Sound pressure = 2Watt, Distance of source = 25m, the presence of insulation with a surface density of 1kg/m^2 reduces the sound intensity level 7 db and insulation with a surface density of 100kg/m^2 will reduce the Sound level by about 20 db.

4. The sound intensity level increases with increasing sound power at the same distances from the sound propagation source. However, for operating conditions Size of valve = 6 ", Frequency = 500HZ, Distance = 25m, Insulation density = 100kg/m^2 by changing the sound power from 1watt to 20watt, the sound intensity level from 6db to 11db, respectively, for insulated and without Insulation changes.

5- By increasing the distance from the sound source, the sound intensity level increases with decreasing the surface density of the insulation. However, in operating conditions Size of valve = 6 ", Frequency = 500HZ, Sound pressure = 2Watt, Insulation density = 1kg/m^2, the sound intensity level despite the insulation with a surface density of 100 kg/m^2 in the levels between 66db to 106db reduces respectively about 6db to 16db.

6. By increasing the distance from the sound source, the sound intensity level decreases with decreasing frequency. However, in operating conditions Size of valve = 6 ", Frequency = 400HZ, Sound pressure = 2Watt, Insulation density = 100kg/m^2, the sound intensity *level despite the insulation with a surface density of 2100 kg/m in the levels between db66 to db106 reduces respectively It is about 20 db to 26 db.*

7- By increasing the distance from the sound source, the sound intensity level increases with increasing sound power. However, in operating conditions Size of valve = 6 ", Frequency = 500HZ, Sound pressure = 4Watt, Insulation density = 100kg / m^2, the sound intensity level despite the insulation with a surface density of 100 kg/m^2 in the levels between 69db to 109db causes a decrease, respectively about 10db to 11db.

8- According to the allowable sound level of 60 db, therefore, it can be seen in all the results that by considering the proper insulation at the appropriate distances from the sound source, the sound pressure level can be reduced to a good extent.

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