Acoustic Study of Noise Generated by Arzew's Industrial Units in Limited Batteries

Arbaoui. Iliace [1], *Hamou. Ahmed*[1], *Tadjeddine Ali Abderrezak*[3], *Harrouz Abdelkader*[2], *Benoudjafer Cherif* [4]

[1] SCAMRE Laboratory, National Polytechnic School of Oran, Algeria
[2] Laboratory of Sustainable Development and Computer Science (L.D.D.I), Adrar University, Algeria
[3] University of Oran1, Ahmed ben Bella, Oran, Algeria
[4] University of Tahri Mohamed, Smart Grid & Renewable Energy (SG&RE) Laboratory, Algeria
ili.arbaoui@univ-adrar.edu.dz

Article Info

Article history:

Received 02 June, 2020
Revised 30 August, 2020
Accepted 24 November 2020

Keywords:

Bruit
Pollution sonore
Limite batterie
Arzew area.

ABSTRACT

This study carried out concerns about noise pollution from the Arzew industrial zone. Currently, noise is an integral part of our environment and represents a major current issue, due to its dangerous health effect. Due to the proximity between industrial sites and residential areas, which very often generates noise-related conflicts that require the intervention of an acoustic expert to resolve and protect the neighborhood from noise exposure from the complexes in the Arzew industrial zone. We have dedicated our work to the assessment of noise emissions generated by several oil and gas plants located in the ARZEW industrial zone and to the verification of the application of laws relating to the limitation of noise levels emitted into the environment by the various facilities. We focused our study on noise measurements in the periphery of the plants, known as the "property limit", also known as the "battery limit".

I. Introduction

Noise is the second environmental factor in terms of health damage (WHO) [1], its dangerousness depends on the nature of the source that generates it (transport, industry, etc.). Algerian industry is an essential segment of the country's economic development [2], but generates significant pollution of our environment by different types of pollution (atmospheric [3─6], solid [7─9], marine [10], etc.). Among these types of pollution, noise pollution is quite rare in scientific circles.

Today, concern about noise pollution is of considerable importance, especially in an industrial environment where there is a large amount of machinery and equipment [11]. Several research studies have been carried out to address the problem of noise in urban and industrial environments [12─26]. Recent studies have shown that noise from industrial sites is more annoying than transport noise (at equivalent noise levels) [27]. This is mainly due to the specific characteristics of the industrial noise source, which emits different noises with dangerous characteristics (tonal, impulsive, etc.) [28 ─30]. These noises therefore directly affect workers at industrial sites and indirectly affect the residents in the vicinity of these sites. To combat this industrial noise nuisance, individual preventive equipment is required from workers on industrial sites to protect them (noise helmets, active noise control, passive noise control, etc.). [31─33]. For the residents, near industrial sites, international standards and laws have been promulgated to preserve the health of the inhabitants. At the Algerian Level Executive Decree No. 93-184 of 27 July 1993 regulates noise emission [34]. The regulation of the Occupational

Safety and Health Administration (OSHA) sets the authorized noise doses according to the exposure time [35]. In France, the decree of January 23, 1997, on the limitation of noise emitted into the environment by Installations Classified for the Protection of the Environment was promulgated. Noise emissions must not cause an emergence higher than the admissible values set in the property limit (70 dB during the daytime and 45 dB during the night) [36]. All these regulations aim to preserve the health of industrial workers exposed to noise [37] on the one hand and to protect the inhabitants and avoid dangerous health effects that may be caused by noise (hearing fatigue, deafness, stress, cardiovascular manifestations, etc.) [38] on the other hand. In this study, we have evaluated the noise emissions generated by several oil and gas plants located in the ARZEW industrial zone and we verify in parallel the application of the laws related to the limitation of the noise levels emitted into the environment by the different installations. We have focused our study on noise measurements in the periphery of the plants, known as the "property limit", also known as the "battery limit".

I.1. Standards and Regulations:

Occupational health and the protection of the noise environment are important issues regardless of the location of the industrial establishment in the world. The international regulatory and normative framework tends to be strongly reinforced and increasingly harmonized, particularly in Europe. The protection of the environment, the location of a plant, and its integration in the environment become strategic elements of a project [39]. To better understand the noise level in our complex, we considered it useful to identify noise from the regulatory point of view to have an overview of the legislative texts that deal with noise directly or indirectly.

1) At the Algerian level:

Since the 1990s, there has been Decree No. 01/01 of 19 January 1991 and Decree No. 93-120 of 15 May 1993, which govern health and safety protection and the prerogatives and role of the occupational physician. Executive Decree No. 93-184 of 27 July 1993 regulates the emission of noise.

The installations subject to the legislation of the Classified Establishments for the Protection of the Environment are subject to the prescriptions of the executive decree n°93-184 of July 27, 1993, regulating the emission of noises. Concerning this text, the values set in residential areas may not exceed 70 dB(A) during the daytime and 45 dB(A) at night, unless the residual noise is greater than these values.

2) At the European level:

The new Directive 2003/10/EC will repeal Directive 86/188/EEC with effect from 15 February 2006, the deadline for transposition of the new Directive. The new noise directive is characterised by the desire to establish a clear and coherent prevention strategy capable of protecting the safety and health of workers exposed to noise.

Table 1. Comparison of the 1988 Regulations and Directive 2003/10/EC [41].

Main impacts	Decree of 21 April 1988	**2003/10/EC Directive**
1st level triggering action: Hearing protection available Special medical surveillance Noise abatement action plan	$L_{ex,8h}$, 85 dB(A) $P_{crête}$ 135 dB(C)	$L_{ex,8h}$, 80 dB(A) $P_{crête}$ 135 dB(C)
2nd level triggering action: Wearing hearing protection is mandatory Special medical surveillance Noise abatement action plan	$L_{ex,8h}$, 90 dB(A) $P_{crête}$ 140 dB(C)	$L_{ex,8h}$, 85 dB(A) $P_{crête}$ 137 dB(C)

3) At the American level:

The regulations of the Occupational Safety and Health Administration (OSHA) set the authorized noise doses according to the exposure time [42]. 42] For example, the regulation stipulates that industrial employers must limit the noise exposure of their employees to 90 dB (A) for 8 hours.

II. Research Method

The apparatus used is the brand sound level meter (Roline RO-1350) with a 94 dB calibration, time weighting "Fast" and frequency weighting "A".

Algerian regulations lay down, for each period of the day (day and night), the noise levels not to be exceeded at the battery limit of an industrial site, determined in such a way as to ensure compliance with the admissible emergence values. The values set by the authorization order may not exceed 70 dB (A) for the day and 45 dB (A) for the night period at the battery limit. Our approach consists of two steps:

- Measurements at the battery limit, knowing that the measurement points correspond to the positioning of the noise sources for each oil complex. Verification of the compliance of the measures noted with Algerian regulations.
- In our study, the measurements are taken during the daytime period from March 20, 2016, to May 31, 2016. The noise measurement at the battery limit is carried out according to the NFS 31 010 standards. However, due to certain authorizations that we were unable to obtain, we couldn't carry out nighttime measurements inside the Arzew industrial zone. Thus, for production reasons, all the equipment cannot be stopped (it works 24H /24H). To this end, we carried out our series of measurements using the so-called masked point method, a method defined in the NFS 31-010 standard relating to environmental noise measurements, which allows us to estimate the residual noise level of an industrial site without forcing it to be shut down
- Given the diversity of noise sources present on the sites, as well as the continuous operation of the production systems, no measurement locations could be identified to characterize the residual noise level of the sites in a representative manner.
- The measurements include the phases of activity that give rise to noise emissions representative of a normal day's exposure at the site. The measurements were carried out following standard NF-S 31-010 relating to acoustic measurements in the environment.

The values for Battery Limit Sound Levels are rounded to the nearest 0.5 dB (A). Daytime period (7h-22h)

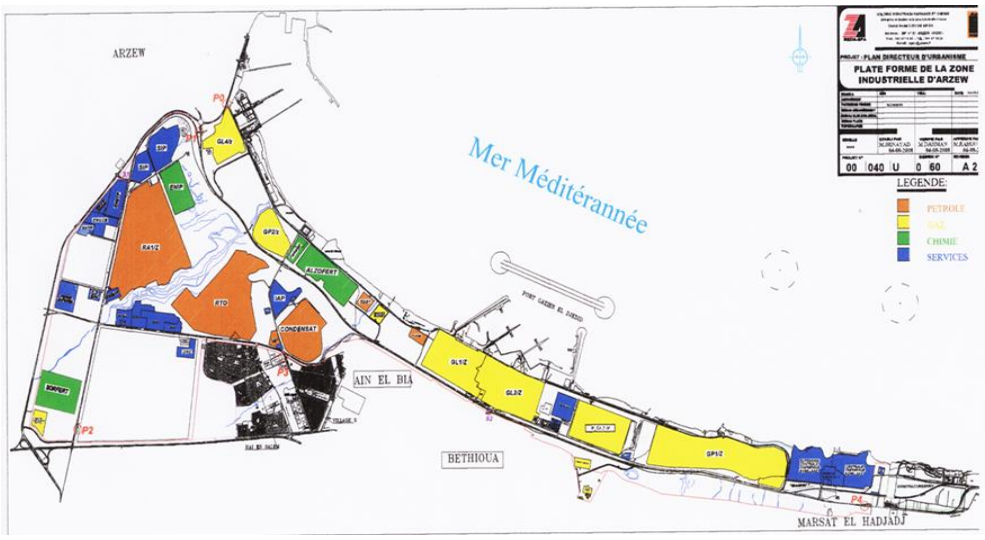

Figure 1. General layout plan of the Arzew industrial zone

II.1. Meteorological Conditions:

Weather conditions can influence and interfere with the measurement results, especially by acting on the

microphone. Measurements should therefore not be made when the wind speed is higher than $5m.s^{-1}$, when there is heavy rain and when the noise source is far away. The measured sound pressure level is a function of the meteorological propagation conditions. The further away from the source, the more important this influence is. Nevertheless, in our study, the meteorological readings during each measurement day were following the standard and the measurement procedure was carried out under favourable conditions.

II.2. Sound Sources:

1) Noise sources in the site environment:

Road traffic on the road, nearby (the main axis of the complex almost 17 km).

- Passage of workers.
- Painting work, weeding, etc.

2) Sound sources on the sites:

Aerosols, compressors, pumps, turbines, etc.

III. Results and Discussions

The main focus of our study is to measure, evaluate, and determine the noise levels emitted by the complexes in the ARZEW industrial zone at the Limited Batteries. We will try to help identify the origins of airborne or solid-borne noise transmission that are likely to compromise the health or safety of the neighbourhood or constitute a nuisance to it.

In our research, we carried out successive measurements at the GP1Z, GL1, GL2, GL3, and SORFERET complexes following standard NF S 31-010 "Characterization and measurement of environmental noise" without derogating from any of its provisions.

We started our measurements with the GP1 /Z complex because it is characterized by a large area of 120 hectares and it contains nine (09) gas treatment trains that emit very high noise levels. Eight (8) measurement points were carried out. The locations of these points are defined on the map below.

III.1. GP1Z Complex:

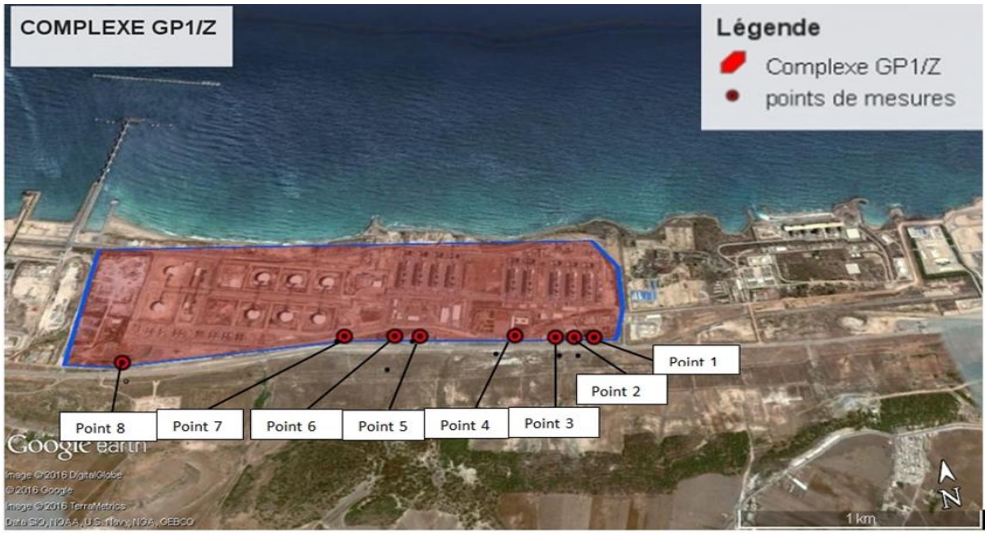

Figure 2. Battery limit noise measurement positions for the GP1/Z complex.

The line in blue indicates the battery limit of the site. The dots in red indicate the position of the sound level meters. During the measurements, the site was operating effectively. The table below shows the

recorded noise levels; the values are rounded to the nearest 0.5 dBA.

Table 2. GP1Z complex the limited Batteries noise measurement results

Points	Spatial coordinates	The ambient noise level in dB(A)	Permissible level in dB(A)	Compliance
N° 1	35°47’47,15°N/0° 12’23,77°N	50,0	70,0	Yes
N°2	35°47’52,°N/0°12 ’27,27°0	61,0	70,0	Yes
N°3	35°47’48,43°N/0° 12’31,78°0	53,5	70,0	Yes
N°4	35°47’49,57°N/0° 123851°0	47,5	70,0	Yes
N°5	35°47’52,31°N/0° 12’55,21°0	51,0	70,0	Yes
N°6	35°47’53,09°N/0° 13’0,13°0	54,0	70,0	Yes
N°7	35°47’54,77°N/0° 13’10,17°0	49,0	70,0	Yes
N°8	35°47’55,39°N/0° 13’41,05°0	48,5	70,0	Yes

III.2. GP2/Z Complex:

Figure 3. Limited Battery noise measurement positions for the GP2/Z complex.

Table 3. GP2Z complex battery boundary noise measurement results.

Points	Spatial coordinates	The ambient noise level in dB(A)	Permissible level in dB(A)	Compliance
N° 1	35°49’41.43"N/ 0°17’58.68"O	69,0	70,0	Yes
N°2	35°49’38.80"N/ 0°18’0.61"O	47,0	70,0	Yes
N°3	35°49’38.79"N/ 0°18’7.56"O	52,0	70,0	Yes
N°4	35°49’41.92"N/ 0°18’16.90"O	52,0	70,0	Yes

N°5	35°49’45.30"N/ 0°18’20.82"O	69,0	70,0	Yes
N°6	35°49’49.74"N/ 0°18’23.61"O	50,0	70,0	Yes

III.3. GL3 /Z complex:

Figure 4. Limited Battery noise measurement positions for the LNG3/Z complex.

Table 4. LNG complex battery boundary noise measurement results.

Points	Spatial coordinates	The ambient noise level in dB(A)	Authorized level in dBA	Compliance
N° 1	35°48’14.99"N/ 0°14’4.16"O	53,0	70,0	Yes
N°2	35°48’11.96"N/ 0°14’4.83"O	51,0	70,0	Yes
N°3	35°48’10.02"N/ 0°14’5.25"O	53,0	70,0	Yes
N°4	35°48’7.60"N/ 0°14’6.40"O	49,0	70,0	Yes
N°5	35°48’4.27"N/ 0°14’7.29"O	49,0	70,0	Yes
N°6	35°48’2.50"N/ 0°14’9.12"O	48,0	70,0	Yes
N°7	35°48’2.66"N/ 0°14’14.35"O	56,0	70,0	Yes
N°8	35°48’3.59"N/ 0°14’17.83"O	50,0	70,0	Yes
N°9	35°48’5.61"N/ 0°14’25.61"O	61,0	70,0	Yes
N°10	35°48’6.71"N/ 0°14’30.51"O	53,0	70,0	Yes
N°11	35°48’7.83"N/ 0°14’34.96"O	54,0	70,0	Yes
N°12	35°48’8.90"N/ 0°14’38.34"O	57,0	70,0	Yes
N°13	35°48’9.37"N/ 0°14’40.38"O	52,0	70,0	Yes

N°14	35°48’9.87"N/ 0°14’42.13"O	51,0	70,0	Yes
N°15	35°48’10.65"N/ 0°14’45.09"O	50,0	70,0	Yes

III.4. GL1 /Z Complex:

Figure 5. Limited Battery noise measurement positions for the LNG3/Z complex.

Table 5. LNG1Z complex battery boundary noise measurement results.

Points	Spatial coordinates	The ambient noise level in dBA	Authorized level in dBA	Conformity
N° 1	35’48’32,71°N/0°15’59,21°0	60,0	70,0	Yes
N°2	35°48’34,42°N/0°16’3,08°0	63,0	70,0	Yes
N°3	35°48’35,53°N/0°16’5,84°0	63,0	70,0	Yes
N°4	35°48’35,36,65°N/0°16°9,13°0	67,0	70,0	Yes
N°5	35°48’37,99°N/0°16’12,26°0	66,0	70,0	Yes

III.5. Gl2 /Z complex:

Figure 6. Limited Battery noise measurement positions for the LNG2/Z complex

Table 6. LNG2/Z complex battery boundary noise measurement results.

Points	Spatial coordinates	The ambient noise level in dBA	Authorized level in dBA	Compliance
N° 1	35°48’21,96°N/0°15’33,13’’0	62,0	70,0	Yes
N°2	35°48’22,90°N/015’36,90’’0	56,0	70,0	Yes
N°3	35°48’24,21’’N/0°15’40,50’’N	58,0	70,0	Yes
N°4	35°48’25,44’’N/0°15’43,81’’0	54,0	70,0	Yes
N°5	35°48’27,68°N/0°15’49,11’’0	60,0	70,0	Yes

III.6. Fertial complex

Figure 7. Limited Battery noise measurement positions for the GP1/Z complex.

Table 7. Noise measurement results at the battery boundary of the FERTIAL complex.

Points	Spatial coordinates	The ambient noise level in dBA	Permissible level in dB(A)	Compliance
N° 1	35°49’16.86"N/ 0°17’16.23"O	53,0	70,0	Yes
N° 2	35°49’14.67"N/0°17’22.87"O	47,0	70,0	Yes
N°3	35°49’21.20"N/ 0°17’33.98"O	53,0	70,0	Yes
N°4	35°49’26.07"N/ 0°17’41.53"O	56,0	70,0	Yes
N°5	35°49’30.81"N/ 0°17’50.76"O	47,0	70,0	Yes
N°6	35°49’ 34.39"N/ 0°17’54.97"O	50,0	70,0	Yes
N° 7	35°49’38.16"N/0°17’58.70"O	52,0	70,0	Yes
N° 8	35°49’42.19"N/0°17’56.49"O	49,0	70,0	Yes

We note that the battery limit levels recorded during the operation of the GP1Z, LNG1, LNG2, and GP2Z sites are lower than the admissible values and therefore comply with Algerian regulations.

III.7. Surfers Complex

Figure 8. Limited Battery noise measurement positions for the LNG3/Z complex.

Table 8. SURFER complex Limited battery noise measurement results.

Points	The ambient noise level in dBA	Authorized level in dBA	Compliance
N° 1	67,0	70,0	Yes
N°2	69,0	70,0	Yes
N°3	68,0	70,0	Yes
N°4	66,0	70,0	Yes
N°5	68,0	70,0	Yes
N°6	73,0	70,0	No
N°7	68,0	70,0	Yes
N°8	67,0	70,0	Yes
N°9	70,0	70,0	No
N°10	67,0	70,0	Yes

When performing the battery limit measurement series, we observed the following peculiarities:

- Due to vehicle traffic on the main road in the industrial zone, the maximum noise levels at the property limits are slightly high at the measuring points in the vicinity of the road.
- Due to the shutdown/shutdown of certain equipment within the complexes, significant differences are found between ambient noise levels at battery limits.
- Due to the large compression equipment located within the Sorfert complex, the noise level at the battery limit in two locations was above the permissible thresholds.
- Whatever the point of measurement, the noise levels observed at the battery limit during daytime periods are below the permissible threshold, except in the case of the Sorfert complex.
- We observed that the first inhabitants in the vicinity of the complexes are located less than 500 m from the complex. Since noise, levels are below the acceptable threshold, then the risk is extremely low.

According to the measurement results obtained in the figures and tables 2,3,4,5,6,7 and 8, we note that the majority of the complexes in the Arzew industrial respect completely the standards relating to the limitation of noise emitted into the environment by Installations Classified for the Protection of the Environment (ICPE), thanks to The remoteness of the noise sources within the sites and the large surface area of the complexes, which allows the noise flow between the source and battery limits to decrease.

- Some complexes take into consideration a significant number of safeties means to combat noise.
- Some complexes have new production technologies that are less noisy, such as the LNG3 complex.

This study has also led us to know the real main noise sources that present a noise nuisance for residents living near the Arzew industrial zone. These are the noise coming from the neighbourhood and road traffic. The origins of these noises are therefore not the complexes of the industrial zone.

IV. Conclusion

At the end of the study carried out, we note that the majority of the complexes in the Arzew industrial zone do not represent a source of noise transmission for the local residents living next to the zone (the population of Arzew, Batwa, Marsat El Hadjadj, etc). However, the noise values found within the battery limits of the complexes are not far below the values allowed by Algerian regulations. For this purpose, noise mapping is necessary to address, identify, and control the main noise sources.

Finally, to be able to plan noise reduction solutions, we recommend to the authorities of the industrial zone to implement noise reduction actions at source, at propagation, and especially at reception.

References

[1] Report of the World Health Organization, page 1, 2011.
[2] I. Arbaoui, A. Hamou1, H. Abderrahim, A. Tayeb, M. R. Chellali, Inter-comparison of noise pollution in Oran (Algeria): Urban and industrial areas, J. Mater. Environ. Sci., 2018 Volume 9, Issue 1, Page 1-10
[3] H. Abderrahim, A. Hamou, Preliminary properties of Saharan aerosol over tamanrasset (Algeria). J. Mater. Environ. Sci. 5 (3) (2014) 865-872.
[4] A. Tayeb, A. Hamou, S. Debbah, Modelisation of Atmospheric Pollution to Green House Gase CO2 of Arzew Industrial Pole. JSM. Environ. Sci. Ecolo., 3(1): 1015 (2015).
[5] A. Tayeb, A. Hamou, S. Debbah, Modelization of Atmospheric Pollution to Green House Gase NOx of Arzew Industrial Pole, JSM. Environ. Sci. Ecolo., 3(2): 1021 (2015).
[6] H. Abderrahim, R. Chellali, A. Hamou, Forecasting PM10 in Algiers: efficacy of multilayer perceptron networks, Environ. Sci. Pollut. Res., DOI 10.1007/s11356-015-5406-6, 2015.
[7] B. Bouhadiba, A. Hamou, M. Hadjel, Y. G. Kehila, Matejka, New schemes of Municipal Solid Waste Management for the wilaya of Oran, Algeria, Iran. J. Environ. Healt. Sci. Engine., 12/2014.
[8] N. Ramdani, Y. Al-Douri, A. Hamou, Study of the biodegradation and fertility of the co-composting produced from sewage sludge and green waste and its effects on the speciation of heavy metals, J. Mater. Environ. Sci. 6 (5) (2015) 1310-20.

[9] N. Ramdani, A. Hamou, A. Lousdad, Y. Al-Douri, Physicochemical characterization of sewage sludge and green waste for agricultural utilization, Environ. Techno. 2015, Vol. 36, No. 12, 1594–1604.
[10] A. Tayeb, M.R. Chellali, A. Hamou, S. Debbah, Impact of urban and industrial effluents on the coastal marine environment in Oran, Algeria, Marin. Pollu. Bull., Volume 98, Issues 1–2 (2015), 281–288
[11] Basorun, Joseph Omoniyi, Olamiju, Isaac Oluwadare, Environmental Pollution and Refinery Operations in an Oil Producing Region of Nigeria: A Focus on Warri Petrochemical, IOSR Journal of Environmental Science, Toxicology And food Technology (IOSR-JESTFT). Volume 2, Issue 6 (Jan. - Feb. 2013), PP 18-23
[12] TJ. Schultz, Synthesis of social surveys on noise annoyance. J. Acoust. Soc. Am., (1978);64(2), 377–405.
[13] A. A. Saadu, R.O. Onyeonwu, E.O. Ayorinde, F.O. Ogisi. Community attitudinal noise survey and analysis of eight Nigerian cities. Appl. Acoust., (1996) ; 49(1) 49–69.
[14] G. Belojecic, B. Jakovljecic, O. Aleksic, Subjective reactions to traffic noise with regard to some personality traits. Environ. Int., (1997) ; 23, 221–6.
[15] W. H. K. Lam, M.L. Tam. Reliability analysis of traffic noise estimates in Hong Kong. Transp. Res. D. (1998);3(4), 239–48.
[16] M. Arana, A. Garcia. A social survey on the effects of environmental noise on the residents of Pamplona, Spain. Appl. Acoust., (1998) ; 53(4), 245–53.
[17] C. Maschke. Preventive medical limits for chronic traffic noise exposure. Acustica., 85(1999): 444–8.
[18] P. H. T. Zannin, F. B. Diniz, A. Calixto, W. Barbosa, Environmental noise pollution in residential areas of the city of Curitiba. Acustica (2001) ; 87, 625–8.
[19] P. H. T. Zannin, F. B. Diniz, A. Calixto, W. Barbosa, Environmental noise pollution in the city of Curitiba, Brazil. Appl. Acoust., (2002) ; 63, 351–8.
[20] J. M. B. Morillas, R. V. G. Gómez, V. G. Escobar, J. A. M Sierra, C. T. Vidal, L. A. Bueno, Presentation of a survey for social studies on the impact of urban noise. Rev. Acust., 33 (2002) ; 27–31.
[21] P. H. T. Zannin, B. Szeremetta, Evaluation of noise pollution in the Botanical Gardens of Curitiba, Paraná, Brazil. Cad. Saude. Publica. 19(2), 2003 ; 683–6.
[22] E. C. Paz, A. M. C. Ferreira, P. H. T. Zannin. Comparative study of the perception of urban noise. Rev. Saude. Publica. (J Public Health), 39(3) 2005 ;467–72.
[23] P. H. T. Zannin, D. Q. Sant´Ana. Noise mapping at different stages of a freeway redevelopment project—a case study in Brazil. Appl. Acoust, ; 72(8) ;(2011) 479–86.
[24] Tadjeddine, A. A., Arbaoui, I., Harrouz, A., Hamiani, H., & Benoudjafer, C. (2020). Dispatching and scheduling at load peak with the optimal location of the compensation under constraints in real-time. Algerian Journal of Renewable Energy and Sustainable Development, 2(01), 34-41.
[25] P. H. T. Zannin, M. S. Engel MS, P. E. K. Fiedler, F. Bunn, Characterization of environmental noise Based on noise
[26] E. Atmaca, I. Peker, A. Altin, Industrial Noise and Its Effects on Humans, Polish Journal of Environmental Studies Vol. 14, No 6 (2005), 721-726
[27] Mario Rossi, Homme et son, Audio, PPUR presses polytechnics, PPUR Collection : Electricité -/2007, page 153.
[28] Impacts sanitaires du bruit, agence française de sécurité sanitaire environnementale, 94704 Maisons-Alfort Cedex, Novembre 2004
[29] DVISOR : Michel Roger, Modélisations analytiques du bruit tonal d'interaction rotor / stator par la technique de raccordement modal, thèse doctorat, janvier 2017
[30] Guillaume LE NOST, Thèse de doctorat, Contribution à l'étude d'impact environnementale sonore des sites industriels : une typologie perceptive de source de bruit ; Année 2007.
[31] Laoufi, A. M., Khelfaoui, R., & Deennai, B. (2020). Monitoring of a Photovoltaic Field with Electrochemical Storage. Algerian Journal of Renewable Energy and Sustainable Development AJRESD, 2(1), 51-55. Harry F. Olson, Electronic Control of Noise, Vibration, and Reverberation, The Journal of the Acoustical Society of America 28, 156 (1956).
[32] Le décret algérien exécutif n°93-184 du 27 juillet 1993 réglemente l'émission des bruits.
[33] Onur C, Sinasi Y, Ahmet O. Hearing parameters in noise-exposed industrial workers. J Auris Nasus Larynx 1998; 25 :369–75.
[34] Ministre de l'environnement française, Arrêté du 23 janvier 1997 relatif à la limitation des bruits émis dans l'environnement par les installations classées pour la protection de l'environnement.
[35] J.O. Osarenmwinda and A.A Onojoserio, Noise pollution in a Refining & petrochemical Company in Nigeria, Journal of Engineering Research and Applications, Vol. 5, Issue 4, (Part -5) April 2015, pp.01-05
[36] Ahmadi Orkomi A, Tavakoli B, Noorpoor A, Noise pollution analysis in Tehran cement plant, JOHE, Winter-spring 2013; 2 (1-2)
[37] Agence nationale française de sécurité sanitaire de l'alimentation, de l'environnement et du travail, évaluation des impacts sanitaires extra-auditifs du bruit environnemental, Février 2013 édition scientifique, page 12.
[38] José Biosca de Sagastuy, Direction générale de l'emploi, des affaires sociales et égalité des chances, Commission Européen : Magazine de l'agence européenne pour la sécurité et la santé au travail, le bruit au travail, huitième édition, page 3, 2005.
[39] Estève Amandine, Ferré Simon, Hube Marie-caroline1, Le bruit en milieu du travail. Projet UE 05, page 06, 2006/2007.
[40] Occupational Safety and Health Act. Code of Federal Regs, Title 29, Chapter XVII, Part 1910, 2006.
[41] Sayed Abas Ali, Industrial noise levels, and annoyance in Egypt, Applied Acoustics, Volume 72, Issue 4, March 2011, Pages 221-225, (2011).