24th ABCM International Congress of Mechanical Engineering
December 3-8, 2017, Curitiba, PR, Brazil

COBEM-2017-2621
EVALUATION OF OCCUPATIONAL NOISE IN WELDERS DURING DIFFERENT WELDING PROCESSES

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Abstract
This study presents an assessment of occupational noise exposure in welders using welding processes like coated electrodes, MIG, MAG and TIG in the Metallic Materials Characterization Laboratory (LCAM) of the Federal University of Pará (UFPA). The aim of the research was to analyze if the welders are exposed to noise levels above the limits established by NR 15 operations and unhealthy activities). In addition, there is also exposure suffered by other potential partners in different locations of the welding laboratory. In this context, it is of great relevance for this research relate the concepts of acoustics and vibrations in machines with the security area of work. Besides that the absence in some cases of need, the ear protectors were poorly dimensioned in relation to the necessary attenuation levels, leading to insufficient protection and even to the overprotection of the welder.

Keywords: Welding, occupational noise, acoustic

1. INTRODUCTION

It is necessary the permanent and effective control of the agents that cause the physical hazards to which the welders are exposed in the work environment in order to prevent possible harmful effects to them.

Welder is part of a huge group of activities that inevitably subject the worker to noise, and in many cases these levels are quite high, not only by the act of welding itself, but also by the operation of equipment associated with the process as the grinding, drilling and sawing operations.

In addition to deafness, the most obvious effect of noise on the worker, noise can contribute to gastrointestinal disturbances, disturbances related to the human nervous system (irritability, nervousness, vertigo, etc.), can accelerate the heartbeat, raise blood pressure, to contract the blood vessels, to contract the muscles of the stomach and to provoke other alterations according to the susceptibility of each organism (SALIBA, 2004).

Another problem relates to the fact that the worker is not always adequately protected or even without any protection, being exposed to noise levels that can not only hinder the good performance of their activities but also compromise their health and safety.

For the correct control of noise in the work environment of the welders, it is necessary to quantify this agent, as well as evaluation of the data obtained and the correct dimensioning of preventive and control measures, which will be addressed throughout this work.

The permanent and effective control of the agents that cause the physical hazards to which the welders are exposed in the work environment is carried out in order to prevent possible harmful effects to them. The occupation of welder is part of a huge group of activities that inevitably subject the worker to noise, and in many cases these levels are quite high, not only by welding, but also by the operation of equipment associated with the process as the grinding, drilling and sawing operations.

2. THEORETICAL FOUNDATION

2.1 Welding

Welding is the process of joining two metal parts, using a heat source, with or without applying pressure. Solder is the result of this process described (WAINER; BRANDI; MELLO, 1992).

The classification of welding processes can be defined according to the origin of the energy used by these processes. Thus, according to the energy source, the processes are classified into seven areas: solid phase, thermochemistry, electrical resistance, unprotected arc, fused flux arc, gas protected arc, and radiant energy. Welding processes can also be related to the control of the atmosphere surrounding the weld site (WAINER; BRANDI; MELLO, 1992).

According to Modenesi 2006, Shielded Metal Arc Welding (SMAW) is a process in which the coalescence (union) of metals is obtained by heating them with an arc established between a special coated electrode. The electrode is formed by a metal core ("core"), 250 to 500 mm long, covered by a layer of minerals (clay, fluorides, carbonates, etc.) and / or other materials (cellulose, ferro alloys, etc.) with a typical overall diameter between 2 and 8 mm.

In welding to the electric arc with protection gas (GMAW, Gas Metal Arc Welding), also known as MIG / MAG (Metal Inert Gas and MAG, Metal Active Gas) welding, an electric arc is established between the part and a consumable in the form of wire. The arc continuously melts the wire as it is fed into the melting pool.

The TIG process as it is known in Brazil, can also be called Gas Tungsten Arc Welding (GTAW), in this process the metal union occurs with its heating and fusion located through an electric arc established between a non-consumable tungsten electrode, and the workpiece.

2.2 Noise exposure level

According to Bistafa (2011), the sound is the sensation produced in the auditory system, since the noise is an undesirable sound, being in general of negative connotation. Sounds are vibrations of air particles that propagate from vibrating structures. The complete elimination of noise is not usually the goal, besides being expensive. Trying to sleep in a very quiet room can also be disturbing as it needs some noise to avoid the feeling of total deprivation. Sound can be defined as a variation of the ambient pressure detectable by the auditory system. At sea level, the ambient pressure is 101, 350 Pa. The smallest variation of ambient pressure detectable by the auditory system is in the order of 2 x 10-5 Pa. This pressure is called the hearing threshold. Sound is a mechanical wave, so it needs a material medium to propagate, not propagating in the void. The propagation speed differs depending on the medium of sound propagation. In general, the propagation of sound waves is faster in solids than in liquids, being faster in the latter than in gases.

Prolonged exposure to noise has dangerous consequences involving the hearing aid when exposed to significant loudness. One of the earliest effects of this exposure is hearing loss in the 4 to 6 kHz frequency range (Gerges, 2000). The effect is perceived when the sensation of noise pickup occurs, even after leaving the room or switching off the noisy source. This sensation is temporary and the original auditory level is restored after some time.

However, if there is exposure to noise before the hearing aid is restored, this hearing loss can be made permanent and irreversible because it has caused damage to the nerve cells of the inner ear and in this case the hearing loss will not necessarily be only in the range of 4 to 6 kHz, but in any other frequency range.

Welders are exposed to various occupational hazards. The noise, a subject addressed in this work and already defined previously, is recognized as one of the main causes of work diseases in the metallurgical and metallurgical industry and is closely related to the activities of the welder.

The regulatory standard dealing specifically with noise and employee exposure to this agent is NR 15 (Activities and Unhealthy Operations). This regulatory norm establishes that the limit of tolerance is the maximum or minimum concentration or intensity, related to the nature and the time of exposure to the agent, that will not cause harm to the health of the worker.

Also according to NR 15, continuous or intermittent noise, for the purposes of applying tolerance limits, is understood to mean noise other than impact noise. continuous or intermittent noise levels shall be measured in decibels (dB) with sound pressure level instrument operating in the compensation circuit "A" and slow response circuit (SLOW). Readings should be made close to the ear of the worker (SANTOS, 2015).

According to the Occupational Hygiene Standard (NHO) 01, the reference criterion based on the daily exposure limits adopted for continuous or intermittent noise corresponds to a dose of 100% for exposure of 8 hours at the level of 85 dB (A).

The evaluation criterion considers, in addition to the reference criterion, the increase in dose doubling (q) equal to 3 and the integration threshold level equal to 80 dB (A).

3. METHODOLOGY

For this research, noise measurements were performed during four different welding processes frequently performed in a machine shop:

- Process A: Coated electrode;
- Process B: Metal Inert Gas (MIG);
- Process C: Metal Active Gas (MAG);
- Process D: Tungsten Inert Gas (TIG).

The choice of processes was based on the fact that they were among the most used in the studied area.

3.1 Methodological Procedures

The methodology used for this study consists of performing noise measurements at five different points in the workshop of the LCAM. The measurement was made in this way, because in this workshop, different activities are carried out such as polishing, grinding, sawing, among others, besides welding. Each area is divided by islands of activity, and only welding is separated using curtains.

In this way, the following activities were carried out:

- Measurement of the sound pressure level during process A
- Measurement of the sound pressure level during process B
- Measurement of the sound pressure level during process C
- Measurement of sound pressure level during process D
- Comparison of the values obtained in the measurements with the limits established by NR 15.
- Determination of the noise dose for the welder and other employees.

Measurements were taken at 5 different points of the room, as can be observed in Fig. (1), spaced 2 m apart each. Measurements were made in third 1/3 oitive bands, in the range 12,5 to 12500 Hz, in order to capture all possible variations in the frequency spectrum. It is worth noting that the main objective of the research is to evaluate the overall sound pressure level in dB (A) for each type of welding process. This factor is related both to the type of technology used and also to the acoustic characteristics of the environment, which in this research will not be addressed as a priority.

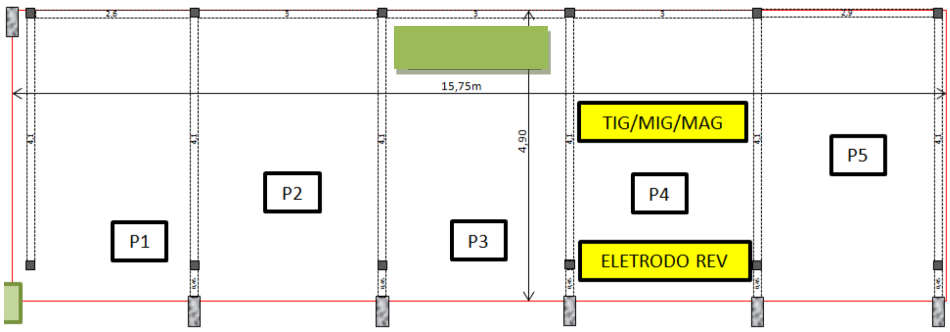

Figure 1. Sketch of the LCAM Workshop
Source. Author's elaboration

After obtaining the data in this short interval, the value of the daily exposure of the worker to the occupational noise was determined by calculating the Lex of 8 h, according to Eq. (1)

$$Lex, 8H = LA, eq, Te + 10\log(\frac{Te}{To}) \quad (1)$$

In this equation, To is the normalization period of 8hs, and Te is the exposure time.

The Leq is the average sound pressure level over a period of time. Leq is often described as the "average" level of noise during a noise measurement (see Eq. (2)), which, while technically incorrect, is often the easiest way to think about Leq.

$$Leq = 10\log[\frac{1}{T}(\int_{t1}^{t2} p^2(t)dt/po^2)] \quad (2)$$

Where p is the instantaneous sound pressure in Pa, po is the reference sound pressure of 20 x 10^$^{-5}$ Pa, and T is the integration time evaluated.

The measurements were performed with the welders positioning the sound pressure meter close to the operator (Fig. (2)), in order to avoid hampering their activities and obtaining data consistent with the situation. During the experiment, the operator was observed to avoid any situation that would compromise the research, such as talking loudly next to the microphone in order to characterize the insalubrity.

It was also observed that during the measurement, the surrounding environment represented the maximum possible of the situation routinely lived in the workshop.

Figure 2 Positioning of the sound pressure level meter during welding.
Source. Author's elaboration

4. RESULTS

With the measurements made it is possible to elaborate the environmental noise map for each type of process based on the data presented in Table 1.

Table 1: Results of occupational noise measurements

Process	Leq dB (A) 5 min	Lex, 8hs dB (A)	Valor máx dB (A)
A	64,4	61,4	98,9
B	77,5	74,5	118,1
C	82,4	79,4	106,4
D	67,1	64,09	93,6

By means of Tabel 2 it is possible to observe that the highest sound pressure levels occur during processes B and C with a weighted sound pressure level value of 77.5 and 82.4 dB (A) and maximum values of 118.1 and 106.4 dB (A) respectively, followed by process D with a sound pressure level of 67.1 dB (A) and a maximum level of 93.6 dB (A) and process A which had the lowest pressure level value sound of 64.4 dB (A) and a maximum value of 98.8.

In analyzing the results of the measurements performed, it can be concluded that the airborne noise exposure values for the four analyzed processes are within the unhealthy limit Annex 1 Tolerance Limits for Continuous or Intermittent Noise established by NR 15. However, these results do not imply that the welder fails to use PPE (Personal Protective Equipment) during welding because noise levels are in the range of safety action level.

It is also worth mentioning that due to lack of acoustic insulation between the areas of the machine shop, the use of PPE must also be adopted by other workers at the place.

Analyzing the coated electrode process, it was possible to observe that point P4 was the one that presented the highest values referring to LAeq. It is possible to observe that this type of source excites the environment mainly in the region of high frequencies (1000 to 12500 Hz), as can be observed in Fig. (3).

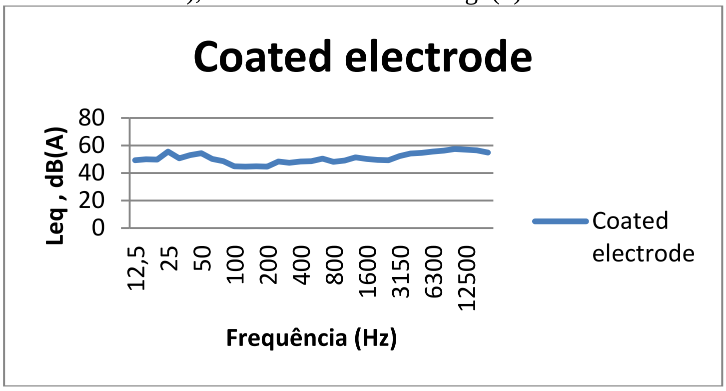

Figure 3 Sound Pressure Level of P4 , Coated electrode process.
Source. Author's elaboration

The small variation in LAeq values, eq may be related to the controlled arc heating process. Unlike the case of coated electrodes, the MAG process presents a difference between lows (up to 400 Hz) and high frequencies (1000 to 12500 Hz) of approximately 20 dB (A), as shown in Fig. (4).

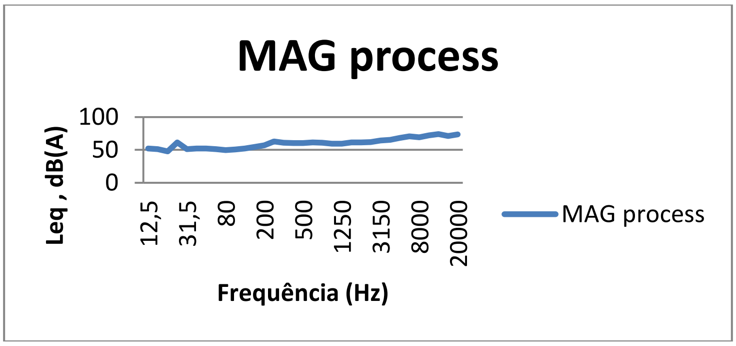

Figure 4 Sound Pressure Level of P3 , MAG process.
Source. Author's elaboration

The same can be observed in Fig.(5) in the MIG process, which concentrates mainly in the region of high frequencies, thus showing the electric arc wire consumption.

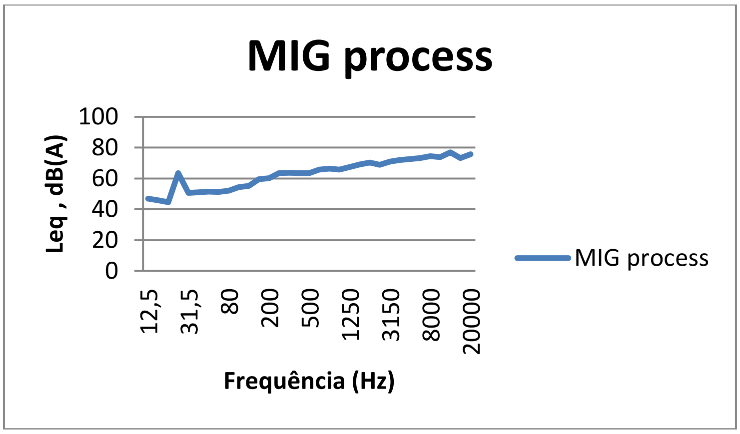

Figure 5 Sound Pressure Level of P3 , MIG process.
Source. Author's elaboration

Finally, (see Fig.(6) the TIG process has lower sound levels than the other ones, however, it also shows a peak in the region close to 20 Hz, which may represent some measurement problem or some specific characteristic of the source.

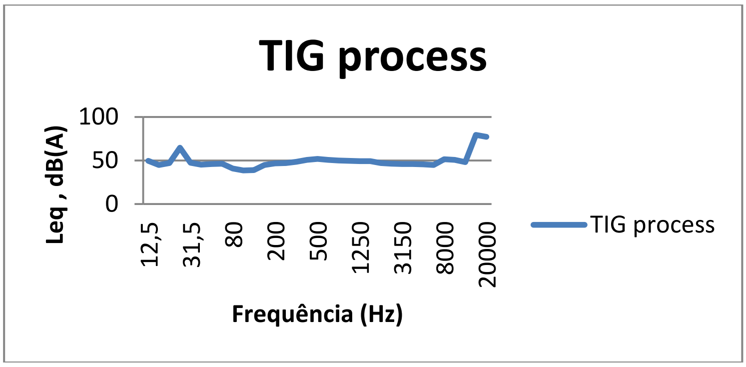

Figure 6. Sound Pressure Level of P3 , TIG process.
Source. Author's elaboration

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Having seen the results, the conclusions on this study were elaborated

5. CONCLUSIONS

Firstly, it can be concluded that in spite of the exposure values proposed by NR 15 to characterize the sound pressure levels related to insalubrity were not exceeded, when the extrapolated exposure in 8 h was evaluated, at some moments of measurement, mainly at the time of connection of the equipment, peaks of noise are perceived, which due to the daily repetition of the processes, can generate damage to the hearing of welders.

Considering the need to evaluate in more detail the sound pressure levels generated in the environment by the welding processes, it is the indication for future works that seek to evaluate the sound power of these different types of source processes, as a way to propose acoustic barriers that can serve to reduce the health damage to welders.

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7. RESPONSIBILITY NOTICE