ACTUAL STAGE OF INDUSTRIAL NOISE REDUCTION

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Abstract: The sources of noise pollution have increased due to fast development of the industry. Impetuous development of industry in decades has increased the number and power of noise and vibration, and resulting noise pollution in the many jobs and in the some large areas. Scientific investigations have revealed that noise and vibration, which exceed certain limits, adversely affecting the functional and safety features on the aggregates facilities located in polluted areas, with negative effects on safety in operation and product quality.

Keywords: noise pollution, industrial noise, noise reduction.

1. INTRODUCTION

The industry is dominated by noise, in each domain was recorded various noise levels, the major difference between them is given by the intensity, duration and sound pressure level on each sector [1].

Noise in industry is a problem of great importance to the complex influence exerted on the human body, on the ability to work, on the numerous implications for professional, technical, economic, medical, social and urban [2, 3].

Noises are generated by functioning of a diversity of aggregates, machine tools and equipment. The industry provides a series of noise problems which are not always easily resolved, due to the different types of noise. [4].

To combat the harmful effects of noise is necessary to apply a set of technical measures, starting from the design stage. This should cover the structure and architecture of the hall, equipment characteristics, acoustic devices and personal protective means [5, 6].

2. METHODS OF NOISE CONTROL

The combat of noise is a problem of work and is represented by the assembly consisting in noise sources, the propagation medium of the acoustic energy and noise receptors [5, 6].

The methods of noise control are [5, 6, 7, 8]:
- methods of noise control at source;
- methods of noise control on the pathways;
- methods of noise control at receiver.

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Combating at source, on transmission path from source to receiver constitute the active protection and the reducing noise on the transmission paths or at receiver is the passive protection [2, 7].

The methods of reducing noise at source are the most efficiency of assuming that since the design phase of a system or a car to consider solutions to obtain their quiet operation.

2.1. Methods of noise control at source

The main solutions to combat noise source consists of fitting noise source (machinery, equipment) on vibroinsulator elements. This measure ensures noise attenuation, mainly for low-frequency component of the acoustic oscillation, between 75 ÷ 1200 Hz [7, 9, 10, 11].

If is necessary to reduce noise in a specific point, between it and the noise source is interposed a soundproofing screen. By placing such a screen to obtain noise attenuation for almost the entire range of frequencies, higher attenuation occurring at frequencies above 2400 Hz. Location screen should be such as to not disturb the process and to allow machine operation and access to the control elements [5, 6, 12].

To achieve a higher attenuation of noise, where practical conditions permit, the equipment shall be provided with an acoustic enclosure, resulting a attenuation for all over the frequency range.

If special conditions are needed to soundproofing, equipment can be mounted in a double enclosure while the equipment and acoustic enclosure are mounted on vibroinsulator. By these measures the level of noise at frequency components above 600 Hz falls below 40 dB, and minimum attenuation is 22 dB achieved at frequencies of 150 Hz [5, 6].

Ways to combat noise at source are [5, 6, 9, 10]:

- the use a machine that emits a low noise level;
- avoiding the impact of metal on metal;
- the noise attenuation or the isolation of components who vibrating ;
- attaching of silencers;
- perform the preventive maintenance because the parts wear may increase noise levels;
- decoupling technical equipment of the physical medium of work;
- modification of equipment and technologies;
- avoidance of sudden vibration.

2.1.1. Attenuation systems - silencers

The use of silencers fall in the control methods of noise at source, being an effective and commonly used to attenuate the effects of aerodynamic type of noise sources [5, 11, 13, 14]:

- **the active silencers** have the operating principle who is based on eliminate of the sound wave by a simultaneous transmission of acoustic waves identical to the same energy but in phase opposition with the initial wave. The energy sum of those waves is zero. If anti-noise product is not exactly the mirror image of the noise generated by the source, then there is not an overall reduction of noise, but a decrease in noise level. This type of attenuator made an attenuation of about 20-30 dB. If on this type of attenuator were attached the absorbent panels are obtained the active cellular, lamellar, circular or baffle soundproofing attenuators [5, 6];
- **absorption attenuators** are used to reduce noise whose spectrum is continuous. These take the form of a channel lined with absorbent material. On the absorbent material it is put perforated sheet to prevent its disintegration at high speed equipment working. Depending on the chosen diameter and type of perforations these have a resonator effect. They can increase the attenuation for low frequency waves and to decrease for high frequency waves. The noise reduction is done by dissipation of energy on pressure oscillations at friction of the pipe wall and at the passing of gas through a sleeve made of absorbent material. Types of absorption silencers are: attenuator low, attenuator "honeycomb", dampers with lamellae, circular attenuator with interior bulb, attenuator with the pressure chamber, silencer with baffle [6, 11];
- **the reactive attenuators** helps at dissipation of acoustic energy by forming a "acoustic wave stopper" that prevents passage of the sound at some frequencies due to the influence of mass and elasticity of air in the attenuator cells [5, 13, 15]. Such a damper consists of a series of cavities and ducts mounted so that the discontinuities they create, to reduce the level noise [15, 16]. The researches in the field

confirmed that in practical terms is not recommended the use of more than two rooms identical. The mounting of tube of coupling between rooms of attenuator is desirable to make in inside [6, 11, 15, 17].

2.2. Ways to combat noise on the propagation pathways

The absorption of noise produced at the working place (workshop, hall, etc.) can be achieved by [5, 6, 18, 19, 20, 21]:

- soundproofing techniques;
- soundproofing treatment of the walls, by covering with absorbent materials such as:
    - porous materials (polyurethane foam with open pores, mineral foam, rigid mineral foam and expanded - foam of clay);
    - fibrous material (glass wool);
    - closed-cell materials (expanded polystyrene).

At the acoustic insulation to an enclosure, which is realized by interposing an acoustic barrier to the propagation of sound, it can adopt the following solutions [5, 6, 19]:

- acoustic enclosure for the noise source;
- layout between the noise source and employees an acoustic screens;
- protecting employees through isolation booths or acoustic stalls;
- soundproofing for the rooms noisy;
- isolation of procedures which involve noise emissions;
- the positioning of the machine tools and equipment so that the area in which working the human operator to be the least noisy.

One of the most used methods to reduce noise on the pathways is the complete closure of noise sources in an acoustic enclosure. The noise can be propagated in outside in the following ways [20]:

- through the enclosure walls – the air noise;
- through leakages or the technology openings - the air noise;
- through enclosure structure - structural noise;
- through components of the machine - structural noise.

2.2.1. Methods to reduce the noise with the soundproofing materials

The characteristic of the soundproofing materials is that have a porous structure (wool, felt, plywood - wood fiber-porous) so that the pores communicate with each other through channels or openings in the material. One such material, under the sound field incidence has air molecules in motion, because of the acoustic energy of the incident field sound. Depending of the air viscosity between the air particles and pore walls occur forces of friction. This forces transform irreversible a part of acoustic energy of the waves into the heat [18, 21].

The dissipation of the acoustic energy of waves who cross the absorbing material is performed by the thermal conductivity of air. This thing is because once with the air and the fibers of material are set in motion with bending movements and internal friction of the fibers of material (who appear from their deformations) have the result the increased sound absorption of the material. Hence, the importance to use as sound absorbing material the ones with open pores and to form deep channels for communication [18, 22].

Sound absorbing materials are classified into:

- absorbents porous with rigid or flexible framework:
    - porous plasters;
    - plates of mineral wool;
    - vegetable fiber stiffened with binder;
    - mineral fiber stiffened with binder.
- absorbents on the resonators simple and grouped type;
- vibrating membranes;
- compound structures.

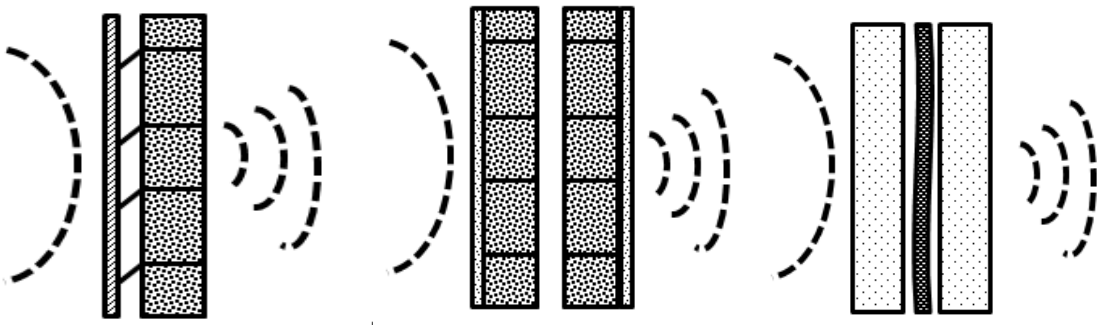
2.2.2. Methods to reduce noise by the soundproofing structures

The absorbing structures are the damped oscillatory systems that absorb sound energy because under the action of incident sound waves start to vibrate and the accumulating energy becomes the partial heat by friction

mechanisms. Sound absorption of these structures is maximum at the resonance frequency, because at this frequency are obtained the highest values of velocity oscillation. The intensification of the friction phenomenon is resulting sound energy dissipation in a higher proportion [18, 21].

In Figure 1.a is represented a sound absorption structure and on the surface of the incidence of acoustic field is placed a perforated screen away from the base wall. The role of perforations is to allow penetration into the interior wave front, and is resulting attenuation of acoustic energy transmitted through multiple reflections [18].

The other variants of soundproofing are represented in Figure 1.b, which is a double-walled structure, efficient in areas with high noise level. The second is an insulation structure with a double-screen who used the soundproofing materials between the interstice and those two screens (Figure 1.c) [18].



a) b) c)

Fig. 1. Wall with perforated screen (a) and double screens (b, c) [18].

Figure 2 shows a structure consisting of concrete blocks with enclosures resonators, at which are used prefabricated elements in various materials, with one or more cavities that communicate with the indoor air through a calibrated channel.

Expanding the use of fibrous materials, lightweight and good acoustic properties involves establishing specific criteria for design for soundproofing treatments to construction and equipment.

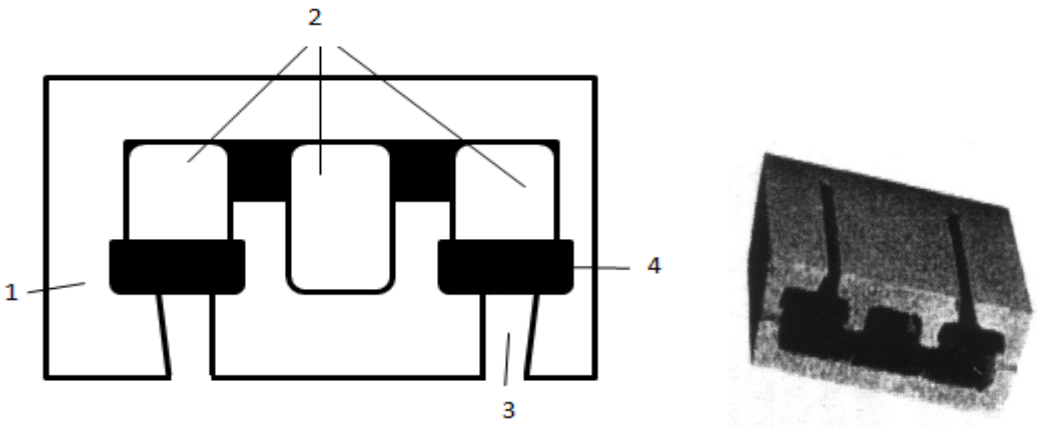


Fig. 2. Sound absorption structure with three cavities [18]:
1 - soundproofing materials; 2 – cavities; 3 – channel; 4 - metal membrane.

2.2.3. Methods to reduce noise: acoustic isolation with components from

Acoustic enclosure must be made to ensure the cooling of equipment components in the optimal conditions. The presence of slots in the wall of enclosure reduces noise attenuation capacity. To avoid this phenomenon, it is necessary to be provided with silencers the access at holes for cooling air [11, 23].

The acoustic enclosure is a rigid construction, box-shaped, surrounding the noise source completely or partially, is presented in Figure 3.

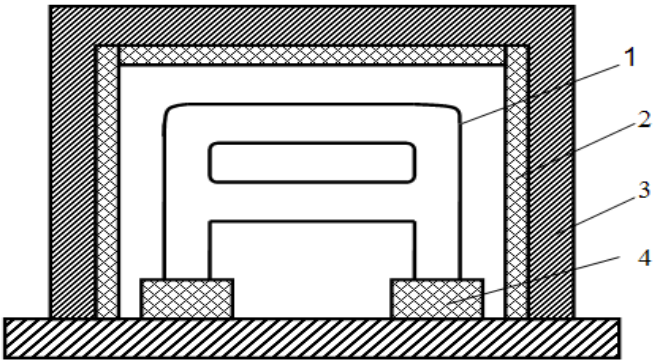


Fig. 3. Location modality of acoustic enclosure with the soundproofing material and equipment installation on vibroinsulator elements [6]:
1 – equipment; 2 - sound absorbing material; 3 - acoustic enclosure; 4 - vibroinsulator elements.

2.2.4. Methods to reduce noise: the acoustic isolation by acoustic screens
Acoustic screens are the soundproof walls, located between the noise source and the protected area. The screens are made in various ways [5, 6, 11, 24].

Acoustic screens are used to provide a work area with a less noisy environment, by attenuation of the direct waves and allowing to the waves refracted and the waves reverberated passing of the top edges of the screen [5, 6, 11, 24].

Where they are not recommended, it may use the acoustic screens modulated with which sources can be screened any form, giving areas with lower noise level. Screens can be built and of stiplex or glass. A screen with a thickness of 5 mm giving a attenuation of about 26 dB in the middle of the audible range. The refracted components are stronger at the lower frequencies. The evaluation of the fraction refracted is based on the angle of refraction reported to virtual height of the screen. The refracted waves may have important effects only at low frequencies; hence the effectiveness of the acoustic screen is significant at mid and high frequencies. The most important quota of the acoustic energy in the protected area is given by the reverberated waves and to reduce this effect, the ceiling room and part of the walls it necessary be covered with sound absorbing structures. In such conditions the reverberated component reaches the same order of magnitude with the one refracted [5, 6, 11, 24, 25].

2.3. Ways to combat noise at receiver
To combat noise at the receiver is recommended in addition to individual means of protection, its protection in soundproof cabin. this thing is possible only in case of technological processes that can be operated, controlled and monitored from a distance, thus reducing to a minimum the period of noise exposure of workers (less, the maintenance operations on equipment) [7, 10, 26].

The personal protection on noise pollution in industrial environments is achieved by using special systems called earplugs, divided into two categories [5, 7, 27]:
- on intern type: stoppers or tampons, made by cotton, rubber, plastics. They are introduced and adapted for the external auditory canal;
- on external type: the headphone which covers the entire pavilion of the ear, used usually for the most intense noise, because they have a great capacity for sound insulation.

Studies of the issues related to protection against the harmful effects of noise, using the individual means for protection at receptors have revealed two trends [7, 10, 27]:
- the use of selective earplugs, noise depending on the nature of work performed and the duration of exposure, the particular receptor, so if high noise levels and reduced demand for certain work with attention, it is recommended ear type external, in the case of the low exceeding of the levels of permissible limits is recommended intern earplugs;
- the development of the earplugs to allow a normal conversation and to neutralize the high frequency noise.

The greatest attenuations are made earplugs of external type which performs better at high frequencies where the ear is more sensitive. These earplugs require no maintenance demanding. The variation of attenuation is about 45 dB than 30 dB for intern earplugs. However the internal type are lighter and can be worn longer, require a much simpler technology of implementation, low cost price and can be worn in environments with higher temperatures (not prevent breathing and perspiration), the worker can use in the same time other equipment or devices or protective work [5, 7, 27, 28].

The negative characteristic is given by means of individual protection that defends only the auditory organ and excessive noise can disturb the general condition of the body exposed, even if the ears are protected [5, 7, 27].

Such personal protective equipment such as ear plugs can reduce or block selectively the perception of noise and enable the speech perception. They are considered suitable and adequate when worn correctly and the noise level is under 80 dB(A) for the employee's ear [7, 28].

Complementary measures of protection against noise are [7, 23]:
- limit time of the exposure to noise of the operator;
- change periodic the job;
- ensuring the silence on during breaks.

CONCLUSION

Concerns about reducing noise pollution in the industry are multiple and directed to problems aimed the noise in the three directions: at source, on the propagation paths and at receiver. The researches in this domain aimed specifically the use of silencers for treating noise at source and the use the absorbing materials for the treating of noise on the propagation pathways. Regarding treating noise at receiver are analyzed the effects of noise level on the health of workers [10, 19, 27, 28].

Noise control methods are effective when were studied all the factors related to: the nature of noise, the device which produces noise, the propagation pathways and the environment in which it propagates [29].

The treating of the noise issue is different depending on the sources power to generating noise, the size of the industrial hall and materials used at the walls of the industrial hall [30].

Reduce noise in a specific point can be achieved by interposing a sound absorbing panel and Soundproofing. By its location is obtained a noise level reduction on almost all frequency ranges (highest attenuation is obtained for frequencies above 2400 Hz) [6, 11, 19, 29].

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