

# The problems of reducing the noise level on open sites of machine building plants and living areas

**V.V. Bulkin and M.V. Kalinichenko**

Murom Institute of Vladimir state University, Orlovskaya, str., 23, Murom, 602264, Russia

E-mail vvbulkin@mail.ru and marinakali@mail.ru

**Abstract.** In this article there is an analysis of using noise-absorbing screens on the basis Helmholtz resonator to reduce the level of acoustic noise on open industrial sites of machine-building plants and adjacent living areas. A design realization of this screen was considered, the characteristic of which is a variable depth of the resonator chamber and the change of the clearance of the resonator throat. The evaluation of the efficiency of using the screen was performed using experimental modeling with an acoustic chamber and a screen model. It was shown that in the majority of the cases there is some attenuation of the acoustic signal in the zone in front of the screen. A conclusion was made about the possibility of reducing noise level in industrial and living zone

## 1. Introduction

The problems of any modern machine building plant are determined by a complicated combination of different processes and tasks. The systematization of those processes was done in the standard GOST R 15288-2005 “Information technology. System engineering. System life cycle processes” (ISO/IEC 15288:2002 “System engineering — System life cycle processes”). The main processes connected with the production consist in the agreement processes, the plant processes, the project processes and technical processes.

Among the hazards of the developed machine-building production, not the least is the acoustic noise that is present typically in indoor areas with active process of mechanical production. However, depending on the intensity of work of the enterprise, the vastitude of the territory and the availability of open areas with active construction and traffic, the acoustic noise may be a very influencing factor on open spaces too. If the enterprise is located in urban realm and not equipped with good protection against the propagation of noise into the urban area, this can be a problem for the entire urban agglomeration. Thus, from the problem of worker safety and health within the enterprise, the noise may become an environmental problem of a big urban land.

The questions of labor protection are included in the group of processes of the plant and they are connected with the media control. The provision of the labor safety provides researching harmful factors, determining the degree of their danger for the personnel of the plants or the inhabitants of the houses in vicinity, measures to reduce the danger level and the implementation of the safety system of the life activity and labor protection.

Until recently special attention was paid to the noise registration and the analysis of its characteristics in the urban areas [1]. Of late the task of reducing noise becomes more and more actual. And because the sources of noise are different and there is no single way of reducing their influence this problem is complicated requiring huge efforts and without simple solutions.



## 2. Means and methods of noise absorption

Having analyzed the existing methods of reducing noise and it is possible to single out four main groups [2]:

- a. Reducing the noise of the source.

In practice this method is realized using design and technological measures, which give an opportunity to create the mechanism and units with a low noise level.

- b. Sound insulation.

It is a complex of measures having the purpose of decreasing noise level penetrating from outside so reducing the noise using adsorbing materials.

- c. Building and planning measures.

We mean decreasing the distance between the noise source and the protected object using acoustically nontransparent screening elements (slopes, walls and screening buildings), creating special noise-protecting special green zones, using noise adsorbing covers by means of different methods of planning, rational positioning of industrial and living zones. Besides, to the building and planning measures belong rational building system of the main streets, the maximum possible planting of greenery and separating lines, using the relief of the terrain.

- d. Engineering and technical means.

Primarily acoustic screens and resonance absorbers of other types are meant, other noise protecting facilities.

In this article special attention is paid to researching and developing engineering and technical means. The use of such means gives an opportunity to struggle against noise in the existing conditions of the enterprise or city and the existing stationary and moving noise sources.

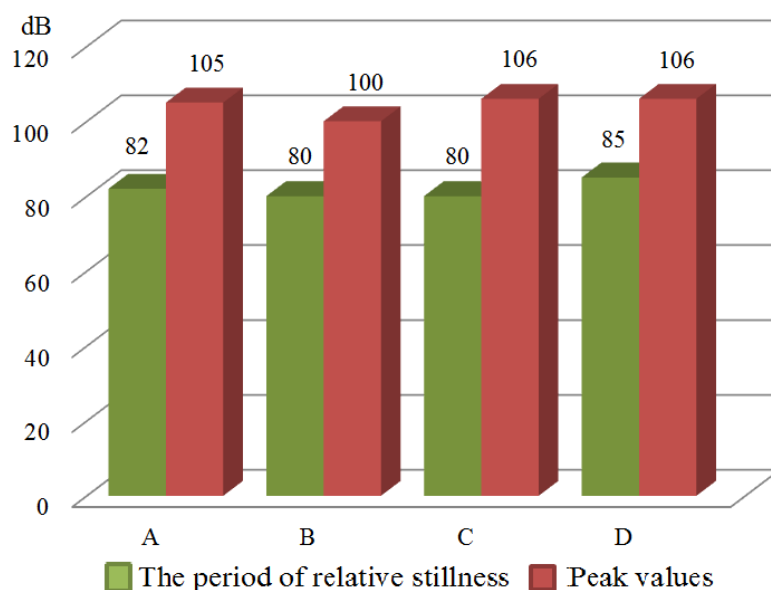
The most effective engineering and technical means are acoustic (noise protecting screens) and resonant absorbers of different types. Upon the whole noise protecting screens are divided into several types: noise absorbing, noise-reflecting and combined. The choice of the concrete type of the screen is performed using the concrete condition of the considered territory and the characteristics of the noise pollution.

## 3. Measuring the average noise equivalent in the industrial noise zone in Murom

To evaluate the possibility of using noise protecting screens in territory of industrial zones or city areas situated near industrial sites the research of the noise levels was made in the characteristic zone of the city of Murom. To illustrate the level of acoustic pollution the results of the measurements are given in Fig. 1, which were made during the spring (A, B) and autumn (C, D), periods, in the morning (A, C) and in the evening (B, D). This zone was deliberately selected because the border of the factory territory is near the pedestrian zone of a lively road passing through the city center and connecting several regions of Russia. This road is actively used by heavy trucks including the transportation of the commodities produced by the city plants. The other side of the road is the border of the living zone. Apart from this there is another access point in the zone for heavy trucks performing the import of ready products. So in this zone the industrial and living areas are connected together and there is an intensive traffic of cars, public transportation and heavy trucks.

In Fig. 1 there are the results of measurements in the moments of the most efficient load on this territory (peak values) and during the most quiet moments (the periods of relative stillness). The measurements were performed using the sound intensity meter BIIIB-003 (VShV-003) in the regime of controlling the average level without using octave analysis. This regime of the measurement is permitted during the total hygienic evaluation of the noise level.

The analysis of the presented results shows that the excess of the level of sanitary norms in the considered zone must be considered to be significant (more than 20 dB). On the other side it is necessary to note the similarity of the acquired results differing not only during different day parts but during different seasons, which underlines the presence of a stable acoustic pollution in the considered area.



**Figure 1.** The results of analyzing noise level

#### 4. The possibilities of using noise protection means

On the basis of the obtained information about the level of the acoustic and noise pollution evaluation calculations were performed with respect to the use of noise-protecting screens in the treated area. To provide a required level of the protection the screens must have the height of more than nine meters and they must be installed not only from the side of the plant but from the side of the residential area, which not permissible in city areas.

One of the possible variants of solving partially the task of reducing the noise level is the installation of noise-adsorbing screens representing the combination of usual noise-protecting structure with resonance absorbers of different types.

One of those decisions is provided using the combination of the screen with Helmholtz resonators, which are formed due to the internal volume of the screen. The constructive peculiarity of this screen is the presence of a internal capacity changing by height (on account of changing the profile of the internal cavity depth by height) and the possibility of changing the clearance of the slot-type throats of the resonator. On account of this decision the authors propose the possibility of adjusting the resonators for the required frequencies [3].

It is known that noise absorbers on account of Helmholtz resonator provide some reduction of the acoustic level of the signal in the zone of the resonator position at the frequency corresponding to its own resonance frequency. In case of broadband noise, which usually happens at a plant or when the noise created by vehicles is present this resonator must have polyharmonic characteristics. A practical realization of this noise absorber is possible when resonators adjusted at different frequencies are used. Another variant is the decision proposed by the authors with a variable depth of the internal volume, which provides the acquisition of the combination of different volumes of the internal resonator cavity and getting a combination of the resonant frequencies.

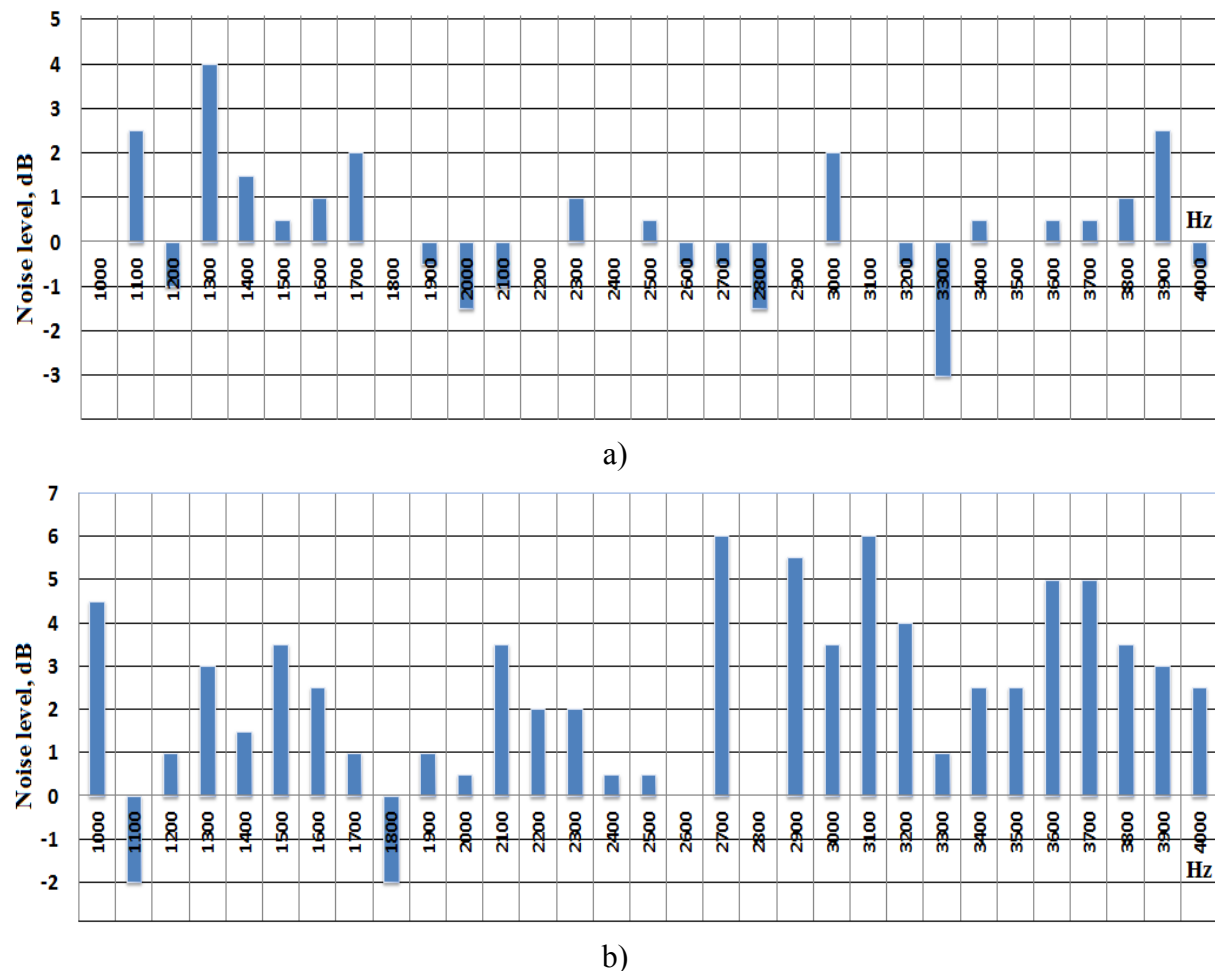
It is evident that the presence of any obstacle in the way of the acoustic signal causes its attenuation. But because of the fact it is known that screens constructed using resonance absorbers are more effective from the point of view of acoustic absorption, it is interesting to evaluate efficiency from the point of view of absorbing the sound in front of the screen.

The experimental check was performed by modeling the signal reflection in the presence of screen model in a small laboratory acoustic chamber using the BIIIB-003 (VShV-003) sound level meter. The

measurements were performed within the range of the maximum sensitivity of the human ear so within the interval from 1000 to 4000 Hz. Deviating from the requirements of standard measurement methods, the analysis was performed not using the weight average of octave and part-octave ranges but in all the specified range with the step of 100 Hz. Also some damping material was used inside the case of the screen model to improve the acoustic absorption.

Some results of the experiments are used in Fig.2. The measurements were used for different sizes of the clearances in the slot throats of the resonators, using series by 10 measurements each with a following evaluation of the average statistic value at each frequency. To compare and to evaluate the efficiency of the screen a group of measurements was performed with a control screen representing the same structure but with a closed front wall. In Fig. 2 along the axis of ordinates the values of the noise level reduction are shown in the zone in front of the resonator model calculated in front of the control screen.

The specified information shows that upon the whole there is a real reduction of the noise level in front of the screen. The attenuation value is different at different frequencies and in some cases there is some signal amplification (resonance).



**Figure 2.** The results of the experiments with a noise protecting screen

## 5. Summary

The acquired results give an opportunity to make the following conclusions. The method used in this paper cannot provide absolutely precise results. But its use gives an opportunity to evaluate the principal possibility of getting some effect using such structures. In this case it is possible to consider

that the statement is correct that in case of using this variant of the noise absorption screen it will be possible to prove a certain reduction of the acoustic noise in the zone in front of the screen which will provide a certain increase of the acoustic and noise pollution of the environment in case of using such structures as the protective facilities of the 1st echelon, for example as the fencing of open industrial sites or near private living houses in vicinity of technological zones, which will provide a certain reduction of the general acoustic and noise pollution of the city environment.

*The work was supported by the grant of Russian Foundation for basic research №14-08-00186.*

*The work was supported by the municipality of the city Murom.*

## References

- [1] Kalinichenko M. (2012) Some aspects of the problem of pollution in urban areas by road (using the example of Murom), *Ecology and industry of Russia*, **12**, 54-59.
- [2] Bulkin V., Kalinichenko M., Shtykov E. and Fil'kov D. (2014) To the question of using noise absorbing means in industrial areas, *Bulletin of Tambov State University*, **19**, 1388-1392.
- [3] Bulkin V., Kalinichenko M., Shtykov E. and Fil'kov D. (2014) Noise reducing screen, *Patent RF (utility patent) № 139581*, Published: 20.04.2014.