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THE ECONOMIC EFFECT OF USING THE NEW METHOD TO IMPLEMENT MEASURES TO REDUCE NOISE BY NOISE INSULATION AND ACOUSTIC BARRIER FOR GAS PIPELINES

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***Abstract**: An important environmental problem is exceeding the current sanitary standards on the territory of thermal power plants (TPP) and in the surrounding residential area. One of the intense sources of noise at the TPP is the gas distribution points (GDP) and the gas pipeline after it. The noise at the exit of the GDP building and along the length of the gas pipeline can be 110 dBA. Effective methods of reducing noise from GDP and gas pipelines are the installation of acoustic barriers and the use of noise insulation materials. The most effective is a set of measures to reduce noise including the joint use of the barrier and noise insulation. The cost of noise reduction measures depends on many factor, including the type of materials, the thickness of the construction as well as the required amount of noise reduction. Earlier in the works of the authors, it was shown that when planning noise reduction measures, it is necessary to achieve equality of the specific reduced costs by using noise insulation and acoustic barriers. This will ensure minimal noise reduction costs. In this paper, the economic effect of using the new method is considered. A new formula is proposed for determining the economic losses in the case of inequality of the specific reduced costs for shielding and noise insulation. It is shown how the economic losses increase in the case of an increase in the ratio between the specific reduced costs of shielding and noise insulation.*

***Keywords:** noise, barrier, noise insulation, noise from gas pipelines*

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1. INTRODUCTION

One of the sources of noise pollution in megacities is energy facilities, such as thermal power plants or district boiler house [1]. Noise at the stations can lead to exceeding the current sanitary standards of the CH 2.2.4./2.1.8.562-96 [2]. A large amount of equipment is installed at the TPP, which is the cause of increased noise in the surrounding area. Gas distribution point and gas pipelines are among the sources of noise both for the territory of the TPP and for the territory of residential development.

Natural gas is transported through the main gas pipeline system under high pressure and it is necessary to reduce the pressure before using it as fuel at the station. In the fracture decreases pressure in the main gas pipeline to the required usually 1-1,2 to 0.05— 0.12 MPa, as a result of lower pressure, there is a strong noise, which extends from the pressure regulators in the building of GDP and gas pipeline after it.

The emission of noise from GDP and gas pipelines from it has its own characteristics. The noise levels from the side surfaces and the end of the building, where the high-pressure gas pipelines enter, are more than 10 dBA less than from the wall of GDP, where the gas pipeline exits. Therefore, GDP can be considered as a point source of noise at the point where the gas pipeline exits the building of GDP. The gas pipeline after GDP has variable noise characteristics along its length. The noise radiation decreases as you move away from the GDP but the first 100-200 m of the gas pipeline has a strong noise radiation. The gas pipeline is considered as a linear source with variable characteristics [3-4].

The maximum value in the spectrum of noise from gas pipelines after GDP occurs at high frequencies especially in the octave bands 1000 and 2000 Hz. The noise from GDP and gas pipelines can reach 110 dBA at the point where the gas pipeline exits the building of GDP, which is a significant excess of the current standards by 25-35 dBA.

Effective ways of reducing noise from the GDP pipeline after it is the use of noise insulation and the installation of acoustic barriers [5, 6]. The efficiency of the barriers depends on its geometry and acoustic properties of the material from which it is made. In addition, the acoustic efficiency is affected by the presence of technological or other openings present in the barrier [7].

The materials used in acoustic barriers also affect its cost. Acoustic barrier panels can be multi-layered structures made of a combination of several materials to increase their acoustic efficiency. It should be noted that the cost of installing the barrier may differ by tens of thousands of rubles, depending on the choice of material. At the same time, the acoustic efficiency of barriers in any octave band is recommended to take no more than 20 dB in the case of diffraction at one edge [8].

To reduce the noise from the gas pipeline at the exit of the building of GDP and along its length, noise-proofing materials are used. The temperature of the gas in the pipeline is constant throughout the year and is 1-6 degrees. In the summer between the wall of the pipeline and insulation condensation may occur, which leads to corrosion of the pipeline and the deterioration of the insulating properties of noise-absorbing material. Therefore, the noise insulation material should be non-hygroscopic, and no condensate should accumulate between the noise-absorbing material and the gas pipeline wall.

For noise insulation of gas pipelines, materials that are a multi-layer structure are often used. The presence of several layers of different types of noised insulation materials allows you to prevent the occurrence of condensation and provide the required noise reduction. The acoustic efficiency and cost depend on the type of noise insulation materials and their thickness.

The cost of noise insulation also significantly depends on the required amount of noise reduction. The effectiveness of the use of noise insulation materials can be several tens of dB. However, it should be borne in mind that it is not always possible to apply noise insulation to all elements of the gas pipeline, for example, to its attachment to the supports. Therefore, it is difficult to provide the required amount of noise reduction only by noise insulation.

To ensure the necessary noise reduction from the GDP and the gas pipeline after GDP a set of measures is required including the joint use of barriers and the use of noise insulation materials.

2. THE ECONOMIC EFFECT OF USING THE NEW METHOD TO IMPLEMENT MEASURES TO REDUCE NOISE

The implementation of noise reduction measures requires significant funds. The analysis of noise insulation materials has shown that not all materials used in the insulation of industrial pipelines have the necessary characteristics. To reduce the noise level along the length of the gas pipeline, it is sometimes necessary to remove the already installed thermal insulation and use insulation that has both heat and noise insulation properties. Similar problems are encountered when installing acoustic barriers. All these questions justify the relevance of technical and economic calculations.

In [10] it was shown that the minimum discounted cost of attenuation when using measures of noise insulation of pipeline and acoustic barrier with equal increments of the specific costs per unit of noise reduction using the barrier and noise insulation of the pipeline

$$r_{bar} = r_{isol}, \tag{1}$$

where

r_{bar} and r_{isol} – the specific increments of the reduced costs per unit of noise reduction using the barrier and noise insulation of the gas pipeline, respectively, rubles/ (1 dB year)

Let´s discuss the question when the specific cost consider when the specific cost increases per unit of noise reduction from the barrier and noise insulation will not be equal. Using the results of [1, 9], we obtain the following formula for determining the economic losses depending on the specific increments of the reduced costs per unit of noise reduction using the barrier and noise insulation of the gas pipeline

$$\Delta C = 10lg\left[\left(\frac{2r_{bar}}{r_{bar}+r_{isol}}\right)^{r_{bar}} * \left(\frac{2r_{isol}}{r_{bar}+r_{isol}}\right)^{r_{isol}}\right] \tag{2}$$

Economic losses in accordance with formula (2) will be provided that $r_{bar} \neq r_{isol}$. In the case when $r_{bar} = r_{isol}$, formula (2) takes the form

$$\Delta C = 0 \tag{3}$$

Thus, with equal specific cost increases per unit of noise reduction from the barrier and noise insulation, the economic effect of the implementation of measures will be maximum, and the losses are equal to ***ΔC=0***.

To estimate the economic losses using the formula (2) we consider the case when the specific reduced costs per unit of noise reduction for the installation of a barrier and noise insulation differ by 5 – 50 %. The data obtained are shown in Fig. 1.

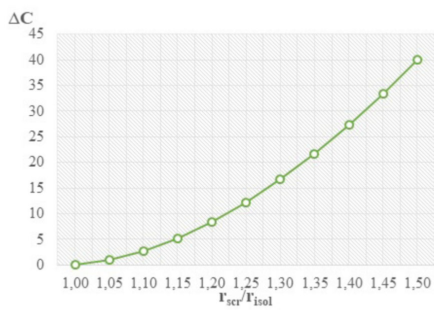

Fig. 1: Economic losses depending on the growth of the ratio between the unit cost per 1 dB of noise reduction for the installation of the barrier and sound insulation

Fig. 1 shows that as the ratio between the unit cost per unit of noise reduction for barrier installation and noise insulation increases, the economic losses increase. So, with a ratio of 5% of the specific reduced costs for shielding and insulation *ΔC=0.99* r_{isol} with a ratio of 15% - *ΔC=5.15* r_{isol}, with a ratio of 30% *ΔC=16.62* r_{isol}, and with an increase a ratio to 50% - *ΔC=40.1* r_{isol} rubles/ (1 dB year).

An analysis of the data obtained during the implementation of measures from the joint installation of an acoustic barrier and the use of noise insulation materials on one of the district boiler house showed that the specific cost of reducing 1 dBA was approximately 160 000 rubles (2 182 $) pear year. Thus, with the relation r_{bar}/r_{isol}=1.3 *ΔC*=2 659 200 rubles/ (1 dB year) (36 258 $/(1 dB year)), and with the relation r_{bar}/r_{isol}=1.5 *ΔC*=6 416 000 rubles/ (1 dB year) (87 483 $/ (1 dB year).

Based on the data obtained, it can be concluded that an increase in the ratio between the specific reduced costs per unit of noise reduction for the installation of a barrier and noise insulation significantly increases the cost of implementing noise reduction measures.

3. CONCLUSION

Effective ways to reduce noise from the GDP pipeline after it are joint events, consisting of the use of barriers and noise insulation materials, a minimum given the discounted cost with equal specific costs.

The formula (2) is obtained, which makes it possible to determine the economic losses in the case when the specific reduced costs for reducing the noise unit when using the barrier and noise insulation materials will differ.

The dependence of the economic losses depending on the growth of the relationship between the specific given the cost of 1 dB noise reduction on the installation barrier and noise insulation (Fig.1). Increase in the ratio between the specific given by the unit cost of reducing noise on the installation barrier and noise insulation leads to an increase in the cost of implementing a complex of measures to noise reduction.

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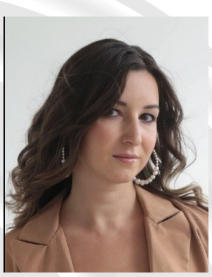

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