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SOLUTIONS TO CREATING A LOW-NOISE POWER FACILITY

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Creating a low-noise power facility (boilers, thermal power plants, transformer substations and other) is an actual problem for many cities. The opportunities to create low noise object considered. The creating a low-noise power facility has a number of theoretical limitations. It is possible to create a low-noise power facility, if there are no theoretical limits to the implementation of measures for sound reduction. Type of energy facility and its capacity are important characteristics for the creation of a low-noise power facility. Each type of energy facility characterized by a certain group of sources. For each group of sources used certain measures to reduce noise. There are considered well-known and original activities to reduce noise. It was stressed that an important point to create low-noise power facility is a complex application of measures to reduce noise. Determination of the value the required noise reduction by each source at the energy facility, considering the cost of reduction 1 dB noise can achieve the sanitary standards at the lowest cost.
Keywords: noise reduction, silencer, acoustic barrier

1. Introduction

Creation of a low-noise power facility is connected to reduction of noise from the working energetic equipment. It is known that exceeding of sanitary norms from permanently operating energetic equipment can reach for the residential zones 20-30 dB, and from temporal sources — 35-45 dB [1, 2].

These values are correct if Heating and Power Plant (HPP) and district boiler with a thermal power of 200 Gcal and above, using coal and fuel oil, according to standards are at distance at least 500 m, using gas and fuel oil (last — as reserve) — at least 300 m.

The laws "On Protection of Atmospheric Air " and "Concerning the Protection of the Natural Environment" oblige implementation of actions for lowering from noise sources to sanitary standards which are set by Sanitary norms 2.2.4/2.1.8.562-96 [1] for jobs and the residential area.

Noise reduction from the power equipment urgent not only for big and small-scale power generation, but also power facilities in metallurgical, chemical, construction and other industries. Noise reduction from the power equipment urgent not only for big and small-scale power generation, but also power facilities in metallurgical, chemical, construction and other industries.

Noise from the group of sources is radiated from a power facility, as a rule.

In the analysis of noise sources consider the following factors:

- placement of sources (in locations or in the open air);
- level of emitting sound power;
- nature of noise (tone or broadband);
- time response characteristic of emitted noise (temporal, constant or discontinuous);
- the index of directivity from a source;
- the location over earth level for the sources which are in the open air.

It is important to mark that there is an increase in level of sound energy in case of a deviation

from the rated mode by operation of fans, smoke exhausters, gas turbine.

2. Noise sources of power facility and methods of noise reduction

In the present manuscript is considered such power facilities as thermal power plants, district boilers, transformer substations. Separately is considered thermal power plant with set gas turbine plant (GTP). The main noise sources from these power facilities are given in table 1.

The combination of noise sources and their quantity is characteristic of each power facility. For example, a large number of the equipment is characteristic of thermal power plant. The total quantity of noise sources could be more than one hundred units. The constant noise source which is strongly influencing the environmental region is noise radiated from gas turbines, the fans, smoke exhausters or is connected with burning processes. Noise sources are also gas distribution substation (GDS) and gas conduits after it, the casing of fans, power transformers and coolers. Noise penetrates also from different locations. The compressor station, GDS and gas conduits after it are the strong noise sources.

The noise penetrating from power facilities locations is caused by the most intensive noise sources which are there. Such sources are turbines (especially gas turbines), the reduction and cooling installations (RCI), the pulverizing equipment, boilers, compressors, different pumps, steam conduits, the synchronous compensators, forced-air and exhaust fans.

The strongest noise source is steam emission. The sound level in case of steam emission in certain cases reaches nearly 140 dBA at distance of 15 m from emission.

It is important to note that there is an increase in level of sound energy at a deviation from the nominal mode during the operation of fans, smoke exhausters, GTP.

For a boiler room, it is necessary to consider the noise radiated from a mouth of a chimney, air intakes the fans, GDS, the noise getting from a boiler room.

Usually transformer substations are in the open air. In this case radiation, actually from transformers and systems of their cooling, and also from air switches can be essential.

Excess of sound level sanitary norms for working zones on during the operation of various power facilities by measurements results at distance of 1 m the following:

- Emergency steam dumps into the atmosphere - 36-58 dBA;
- Gas turbines - 18-32 dBA;
- Steam turbines - 20 dBA;
- Fans - 5-15 dBA;
- GDS - 20-25 dBA;
- RCI - 28-32 dBA;
- The cooling towers - 7 dBA;
- Transformers - 5 dBA;
- Pulverizing equipment - 7-21 dBA;
- Pumps - 9-17 dBA;
- Compressor - 6-15 dBA.

Considering big excess of sanitary norms, implementation of measures for noise reduction from the equipment for low-noise power facility creation is necessary.

3. Noise reduction measures from the equipment for low-noise power facility creation

The next ways of noise reduction by the environment were distinguish:

• noise reduction in the source;
• noise reduction on the ways of his distribution.

For real power facilities, the package plan for noise reduction in all directions is held. The choice of plan is carried out based on technical and economic calculation. The basic is noise reduction on the ways of his distribution.

Also, main ways of noise reduction from power facilities which allow to provide sanitary norms are given in table 1.

Table 1: Classification of the main noise sources of the power facilities influencing the surrounding area and ways of noise reduction

	Name	Sources of noise	Primary way to noise reduction
1	Thermal power plant	1.Steam emissions 2. Fans (air intakes and case); 3. Smoke exhausters (mouth of a chimney and case) 4. Equipment for fuel burning preparation (GDS and gas pipelines or pulverizing equipment) 5. Transformers 6. Cooling towers 7. Compressor 8. Systems of local ventilation 9. The noise getting from the boiler room	Package plan: 1. The silencers providing a low-noise pressure reduction (steam mufflers, GDS mufflers) 2. Silencers for noise reduction in channels from the fans, smoke exhausters, compressors 3. Acoustic barriers for noise reduction of cooling towers and transformers 4. Sound insulation of fans cases, pulverizing equipment, walls of rooms 5. Sound absorption of the building walls
2	Thermal power plant with GTP	1. GTP air intakes 2. Noise from a chimney 3. See item 1	Package plan: 1. Silencers on air intakes and exhausts of GTP 2. See item 1
3	Boiler room	1. Noise from mouth of chimney 2. Noise from air intakes of the fans 3. GDS 4. The noise getting from the boiler room	Package plan: 1. The silencers providing a low noise pressure reduction (GDS silencers) 2. Absorbing type silencers for noise reduction in channels from the fans, smoke exhausters or burning noise. 3. Sound insulation of fans cases, walls 4. Sound absorption of building walls
4	Transformer substations	1. Transformers 2. Switches	Acoustic barriers for noise reduction of transformers and it's switches

The developments by authors allowing to reduce noise effectively from the power facility are given below, providing low-noise power facility creation.

In figure 1 the original steam silencers [3] is shown.

In figure 2 *a* silencer for noise reduction in channels from smoke exhausters, and in figure 2 *b*— from fans [4-6] are shown.

In figure 3 *a* the acoustic barrier for noise reduction of cooling tower, and in figure 3 *b*— the barrier for noise decrease from compressor are shown [7].

Sound insulation of fans cases, the pulverizing equipment, the sound absorption of power facility buildings walls also allows to reduce noise.

Creation of a low-noise power facility is possible only at complex applying of noise reduction various means for ensuring sanitary norms in the residential area on border of the sanitary protection zone (SPZ). Determination of the value the required noise reduction by each source at the energy facility, considering the cost of reduction 1 dB noise can achieve the sanitary standards at the lowest cost [8].

Figure 1: Steam silencers by MPEI

a)

b)

Figure 2: Plate-type silencers for noise reduction;
a- exhausters*; b*- intake fans

a)

b)

Figure 3: Acoustic barriers for noise reduction: *a*- cooling tower;
b- compressors

Example of an integrated approach is noise reduction work from the largest steelmaker NLMK where authors in 2014 — 2015 have developed a package plan for noise reduction from the most powerful twenty-two sound sources. In 2015-2016 introduction of a complex of the specified equipment has been complete, and in February-March of 2016 guarantee acoustic tests of noise reduction devices, and measurements in the surrounding area on border of the sanitary protection zone have been carried out [9].

For the noise reduction radiated from mouth of chimney and air intakes various absorbing (dissipative) silencers have been used. Plate-type silencers have been installed in square or rectangular section channels, link-cylindrical type silencers in round section channels. In complicated type channels silencers in combination with sound-absorbing elements special placement has allowed to improve channels aerodynamic characteristics as much as possible have been used. Plate-type silencers installation for air intakes the agglomerative plant fans has allowed not only to reduce the radiated noise, but also to improve air intakes aerodynamic characteristics. It has positively affected on technical characteristics of the fans.

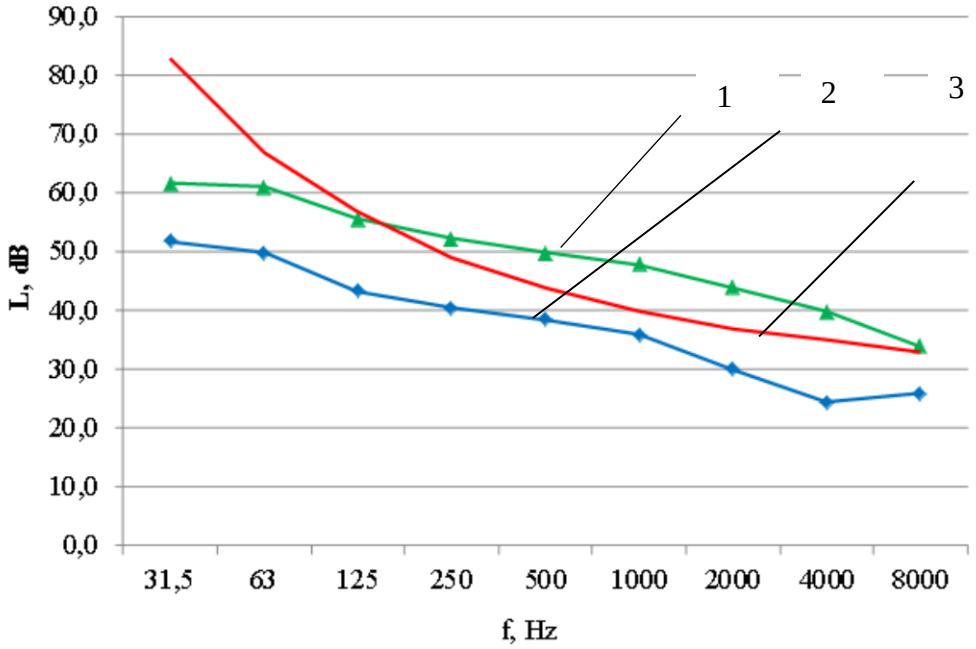

Figure 4: Results of acoustic measurements in a reference point on border of the sanitary protection zone of NLMK at night (from 23 to 7 o'clock): 1 – the levels of sound pressure (LSP) before noise reduction plan, dB; 2 – LSP after noise reduction plan, dB; 3 – sanitary norms [1]

For the noise reduction radiated from land-based sources various acoustic barriers have been apply. After realization of noise reduction package for all 22 sources acoustic measurements have been taken. Results of night acoustic measurements in one of reference point before and after noise reduction plan package are given in figure 4 [9]. It is visible that sound pressure levels in reference point after the noise reduction package have significantly decreased also their values below of night sanitary norms. The noise reduction package on NLMK was recognized the best in the national competition of ecology area in 2017.

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