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NOISE CONTROL FOR A BETTER ENVIRONMENT

Noise reduction from the boiler houses of various capacities

Tupov, Vladimir[1]
National Research University "Moscow Power Engineering Institute"
111250, Russia, Moscow, Krasnokazarmennaya st., 14

Taratorin, Andrey[2]
National Research University "Moscow Power Engineering Institute"
111250, Russia, Moscow, Krasnokazarmennaya st., 14

ABSTRACT

Noise from the boiler houses are a serious problem for surrounding residential area. The excess of noise sanitary code could be registered at the distance of hundreds of meters. This problem becomes very urgent in cities where residential area can be situated very close to such boiler houses. The results of the acoustic examinations of boiler houses with boilers of different heat capacities are given. Separately, a boiler house with gas turbines installations is considered. The main sources of noise for various boiler houses are identified. Noise reduction for boilers of different power is required not only by a value, but also in a different part of the noise spectrum. It is especially important to take into account the low-frequency noise radiation from mouths of boiler chimneys. The influence of the layout, composition and power of the equipment on the excess of sanitary standards is shown. Reducing noise from boiler houses is a complex task. Normally, noise reduction is required from several sources of boiler houses. The designed systems of noise control measures for complex noise reduction from various boiler houses are described in detail. The results of acoustic measurements after the implementation of measures to reduce noise are shown.

Keywords: Noise, Boiler house
I-INCE Classification of Subject Number: 12

1. INTRODUCTION

In some cases, boiler rooms could be a source of exceeding sanitary standards [1] in the surrounding area due to the noise factor.

Noise emissions from the boiler room depends on many factors: the type, capacity, number of boilers, boiler equipment layout, other installed equipment in the boiler room, the distance to a residential area, etc.

In accordance with the existing classification of hot water boilers are divided according to the power of the boiler:

Low power— up to 2 MW;
Average power— 4-30 MW;
High power —50-210 MW.

[1] Tupovvb@mail.ru [2] Taratorinaa@rambler.ru

Boiler rooms with low power boilers are often located in the basements of residential buildings, sometimes in separate buildings, some may be located on the surface of the ground or be buried. The fuel for low power boiler rooms in large cities is most often gas. Such boilers are equipped with boilers of the type UN-6 (up to 0.6 MW), HP-18 (0.76 MW), etc. Only in Moscow there are about 106 such boiler rooms.

Usually, boilers of medium and high power are located in separate buildings.

The article discusses boiler houses with hot-water boilers of average power– WOLF DKS-Dynatherm 3200 (heat capacity of boiler is 3.2 MW), WOLF DKS-Dynatherm 4000 (heat capacity of boiler is 4 MW), KVGM-20 (heat capacity of the boiler is 23.26 MW) (Fig. 1), as well as with high power boilers from 50 up to 120 Gcal (from 58.15 to 209.34 MW) (boilers PTVM-50, PTVM-60, PTVM-100, PTVM-120, KVGM-180) (Fig.2).

Boiler houses with medium power boilers are often located at a distance of 25-35 m from residential area.

The location of the boiler house with high power boilers is determined in accordance with existing regulations [2]. Here the width of the sanitary protection zone is determined by the class of the enterprise. Boiler houses of 200 Gcal (232.6 MW) and above using coal and fuel oil belongs to class III enterprises, and those running on gas and black oil fuel (the latter as reserve), belong to class IV enterprises. Sanitary protective width zone for class III enterprises is 500 m, for class IV enterprises — 300 m.

Often, boiler houses with high power boilers are located at a much closer distance to residential area.

Excess sanitary standards for noise in the surrounding area may be due, on the one hand, to the very close of boiler houses to residential buildings, and on the other hand, due to incorrect consideration of the noise characteristics of both existing and newly installed equipment. All these factors can lead to excess noise sanitary standards.

2. NOISE SOURCES OF BOILER HOUSES

Until now, it was believed that gas boiler rooms with low power boilers are not sources of intense noise for the surrounding area. The results of an acoustic survey of 106 boiler rooms showed that 15% of the total number are sources of noise for the surrounding area. Indoor sound levels range from 77 to 91 dBA, and sound pressure levels are exceeded sanitary norms by 5–15 dB at octave band center frequencies of 500–4,000 Hz. The excess of sanitary night standards for the residential area takes place within a radius of 20 to 150 m from the boiler rooms.

Sources of noise of low-power boiler houses inside the boiler rooms are pumps, and for the surrounding area noise coming from window or ventilation openings.

Boiler rooms with medium power boilers are often located at a distance of several tens of meters from residential buildings. A complex of acoustic measurements near the boiler houses of average power was carried out and showed the excess of noise night sanitary norms for all points of residential areas.

The excess of sanitary night standards for the residential area takes place within a radius of 100 to 250 m from the boiler houses.

The analysis of the obtained results made it possible to determine that the main sources of noise emission considered for boiler houses of average power are chimney mouths and ventilation openings in boiler houses (Fig. 1). The noise emitted through the walls of the boiler of average power is insignificant.

Gas boiler houses with high power boilers should be located at a distance of at least 300 m from residential area.

Sources of noise from boiler houses with high power boilers are the noises emitted from the mouths of chimneys and from air intakes. The noise from the mouths of chimneys of the PTVM boilers is due to the burning noise, and from the KVGM boilers - the noises from of draft fans. The noise from the air intakes is due to the noise of the blower fans. In some cases, the noise source is the noise from gas distribution station (Fig. 2). The noise from gas distribution stations is due to the noise from control valves [3].

The width of the sanitary protection zone R, m, for a boiler house with boilers of medium and high power depending on the heat output of the boiler and its mode of operation, can be estimated with a semi-empirical formula

$$R = K_1 K_2 \sqrt{N}, \qquad (1)$$

where N — is the installed thermal capacity of the same type of equipment, MW; K_1 — coefficient taking into account the type of boiler and its power (Table 1); K_2 — coefficient taking into account the mode of operation (Table 2).

To determine the coefficients K_1 , K_2 numerous measurements were carried out near the boiler houses. The coefficient K_2 =1 for boilers with boilers of the type PTVM.

Table 1. K_1 values for boilers

Boilers	K_1
PTVM-50	46
PTVM -100	41
KVGM-20	42

Table 2. K_2 values to the mode of operation

N_f/N	1	0,9-1	0,8-0,9	0,8
K_2	1	1,25	1,6	1,8

In contrast to the PTVM boilers, the noise from the KVGM boilers increases when the load deviates from the nominal one due to an increase in the level of the radiated sound power of draft fan. If the mode deviates from the nominal one, a correction coefficient K_2 should be used.

The values of the coefficient K_1 are valid with the standard layout, when the decrease in sound power level in the gas paths is: for boilers of the PTVM type — 2–3 dB, and for boilers of the KVGM type — 5-6 dB.

In case of deviation from the nominal load, the coefficient K_2 increases, and, consequently, the width of the sanitary protection zone increases in 1.8 times. This result is explained by an increase in the radiated sound energy by draft fans with a deviation from the maximum efficiency mode. The coefficient K_2 has a minimum value when the equipment is operating at rated load. From this point of view, it is expedient to distribute the partial load of the station by a small number of blocks, but at nominal load.

The width of the sanitary protection zone for boiler houses without noise suppression measures will be about 600 m for a boiler house with 3 boilers PTVM-50, and about 900 m for a boiler house with 4 PTVM-100 boilers.

A special case is the boiler with gas turbines (Fig. 4 *a*). It is necessary to consider additional sources of noise and the possibility of using silencers to reduce them [4-5]. The boundary of the sanitary protection zone of such a boiler room is determined from the acoustic calculation.

3. NOISE REDUCTION FROM BOILER HOUSES

Technological methods (change of burner operation modes, their placement) were implemented at all the boiler houses considered. Therefore, here to further reduce the noise from the boiler can be used as theoretical data [6-7], which are implemented in various silencers [8-10].

For the silencers of gas paths and devices to reduce the noise of the ventilation openings of boiler houses, as well as sound insulation of channels after gas distribution station, the following requirements have been developed, namely:

1. the necessary noise reduction;

2. moderate aerodynamic resistance of the devices, which do not reduce the heat output of the boilers (for silencers) or do not interfere with the implementation of ventilation (for noise reduction devices);

3. moderate weight and overall dimensions, allowing to place them in the place of installation;

4. to be convenient for installation and operational inspection;

5. sound insulation of gas pipelines should not lead to condensation of moisture on the surface of the channel;

5. silencers and sound attenuation measures should have moderate capital costs.

For boiler houses with low-power boilers, the well-known recommendations for reducing noise from pump noise and window openings are used.

To reduce the noise penetrating through the ventilation openings for boiler houses of low and medium power, special sound-absorbing devices have been developed [11].

To reduce the noise of gas paths of medium and high power boiler houses, original silencers for horizontal and vertical gas ducts have been developed [12–16].

For example, for the boiler house which is shown in Fig. 3 *a*, it was necessary to reduce the noise from the gas paths at low frequencies. Using the technique of [14], such a silencer was developed. The test results of 2018 at the point at 50 m from the boiler house are shown in Figure 3 *b*. The silencers reduce noise from the boiler house by 10 dB at an octave band center frequency of 63 Hz and by 13.8 dB at an octave band center frequency of 250 Hz.

To reduce the noise of the air paths of high-power boiler houses, silencers have been developed [16-17]. It is important to note here that noise reduction must come from all sources [18].

In some cases, to reduce noise, it is advisable to use screens [19].

A special task is to reduce the noise from boiler houses with gas turbines (Fig. 4 *a*). Here, in addition to measures to reduce the noise of boilers, it is necessary to take special measures to further reduce the noise of gas turbines. Standard measures for noise suppression of GTU are insufficient here. Figure 4 *a* shows a boiler house with gas turbines, where measures have been taken to reduce the noise of the ventilation system of the housing of the gas turbine casing and to further increase the noise reduction by the silencers of the air intakes of the gas turbine. Figure 4 *b* shows noise silencers to reduce the noise of the supply and exhaust ventilation of a 5.3 MW GTU and installation sites for silencers to further reduce the noise of the air intakes.

The silencer of exhaust emissions from forced ventilation of gas turbine enclosures consists of two parts: a baffle silencer and a straight turn of the outer duct lined with sound-absorbing material (Fig.4 *b*). The baffle silencer consists of 4 plates with a thickness of 200 mm and a length of 2500 mm, placed evenly in the channel of the outer duct. The distance between the plates is 212 mm. The round fairings are installed at the inlet and outlet of the baffle's silencer to reduce the aerodynamic drag of the silencer. The silencer plates are assembled from individual cassettes. The silencer

box is installed at an angle of 45 ° to the roof surface (Fig. 4 b), which ensures that no snow accumulates on the silencer box surface and precipitation falls into the exhaust section of the outer duct.

The installation of an additional silencer in the air intake system made it possible to reduce the noise level from 7.1 dB at the octave band center frequency of 31.5 up to 18.9 dB at the octave band center frequency of 1000 Hz.

The installation of silencers in the gas turbine ventilation systems and additional silencers in the air intake system ensured sanitary standards in the surrounding boiler house area.

4. CONCLUSIONS

1. Boiler houses with boilers of any capacity can be a source of exceeding noise sanitary standards in the surrounding area. This is especially typical for boilers with medium and high power boilers and boiler houses with gas turbines.

2. The width of the sanitary protection zone of the boiler house is determined by the type of boiler, its heating capacity, operating mode, number of operating boilers and other factors.

3. Silencers must be installed in gas paths for boiler houses with medium and high power boilers; in air paths — for boiler houses with high power boilers. For boilers with high power boilers, it is often necessary to reduce the noise from gas distribution station by sound insulation and the use of special acoustic screens.

4. Designed silencers and noise suppression measures made it possible to reduce noise to sanitary standards from boilers of various capacities.

5. ACKNOWLEDGEMENTS

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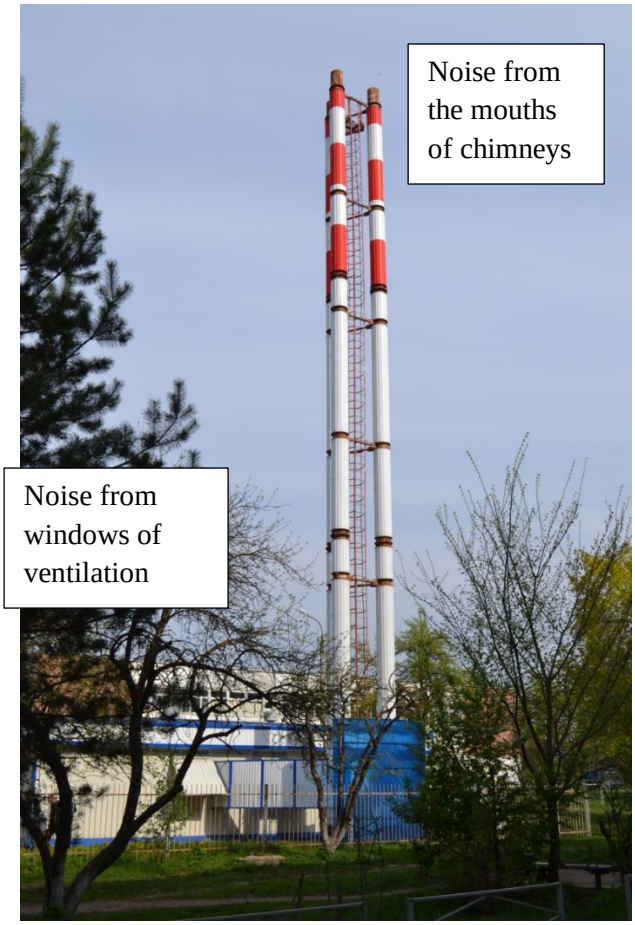


Fig.1 Boiler house with medium power boilers

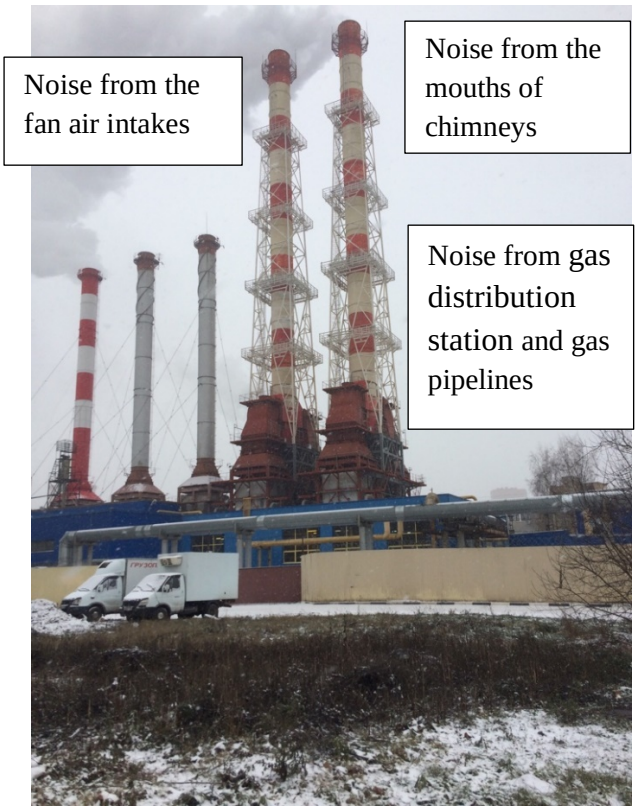
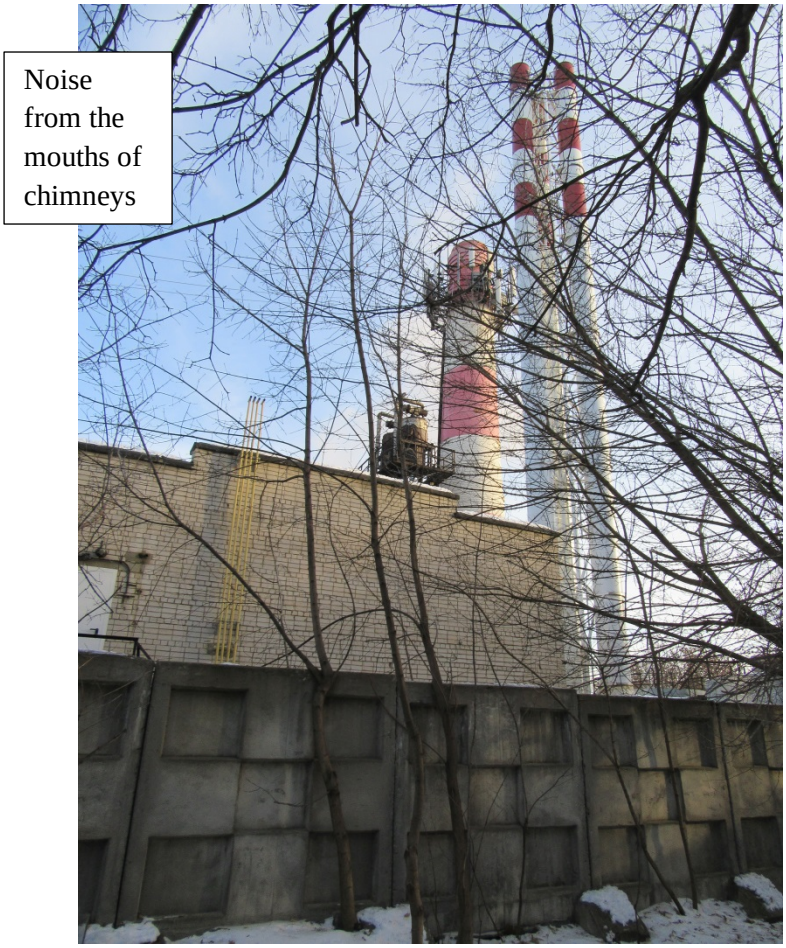
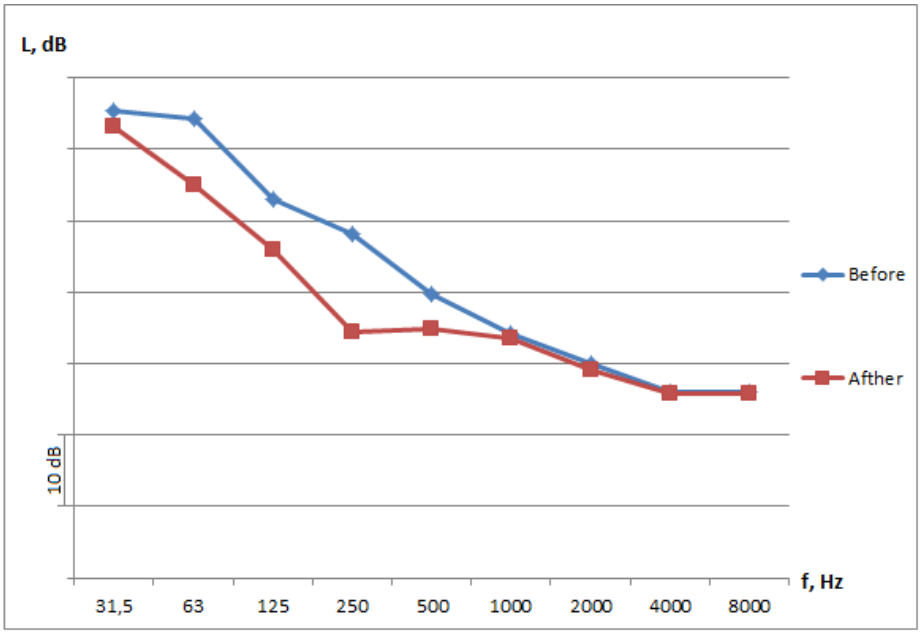


Fig.2 Boiler house with high power boilers

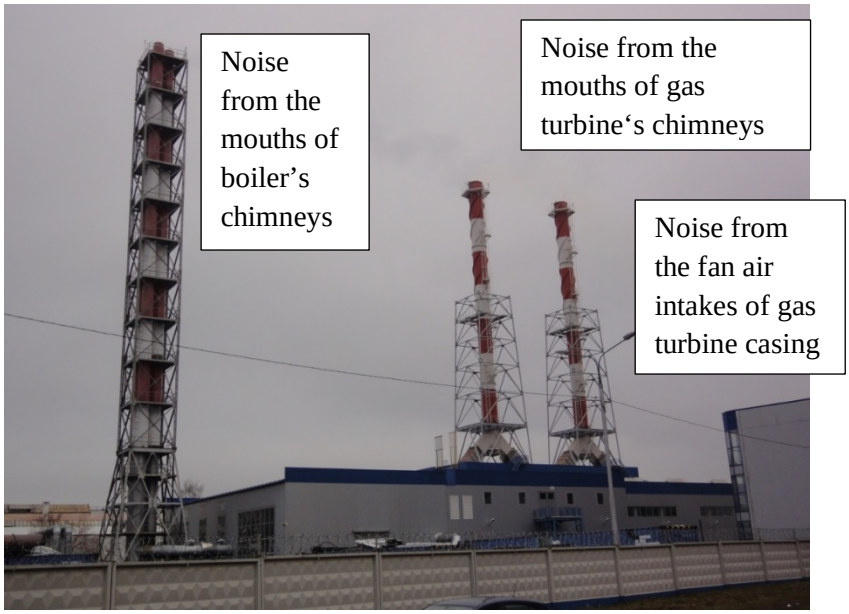


a)



b)

Fig. 3 Boiler house with medium power boilers: a— general view of the boiler room; b— noise levels before and after measures for noise reduction for boiler house



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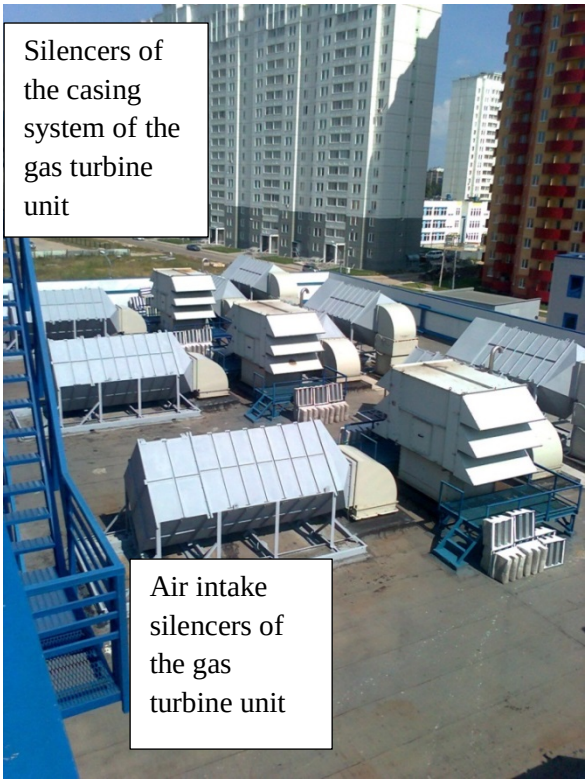

b)

Fig.4 Boiler house with boilers and 4 gas turbines: a— general view; b— roof of the boiler house: 1—gas turbine air intakes with silencers; 2— silencers on the ventilation system of gas turbine casing