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THE NOISE DAMPING IN THE GAS PIPES

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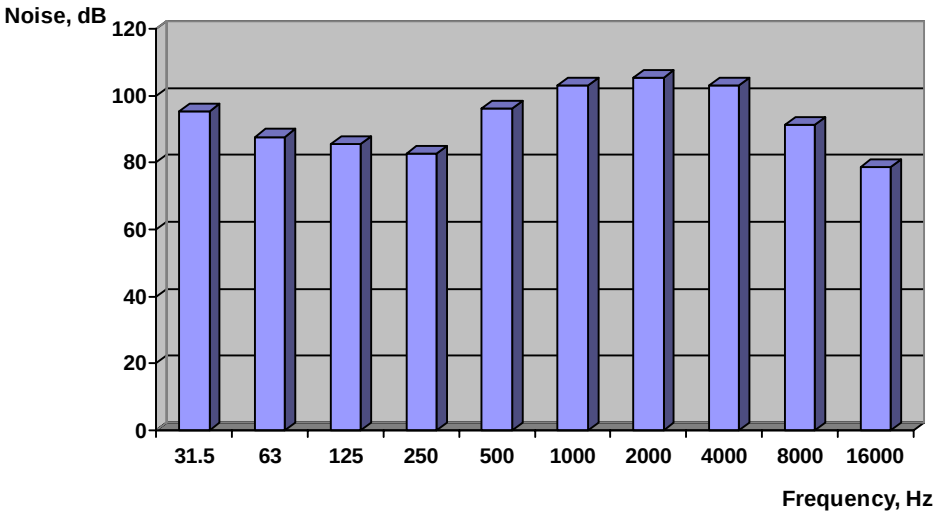
ABSTRACT
An effective noise damping system has been introduced at AB Lietuvos Elektrine Company. Natural gas pipelines were insulated with noise-reducing materials to reduce the noise caused by regulators. Measurements at the pipelines indicated that the produced maximum noise level (2500 Hz) exceeds the standard limit by 24.8 dB. After insulating the pipelines with nose-reducing materials the noise level at the regulators was reduced by 13 dBA and at the insulated pipelines - by 33.5 dBA.
Keyword: noise deafeners, gas pipelines, noise-reducing materials, noise level

1. INTRODUCTION
Gas flow in pipelines generates noise of a certain level. The effect of noise may be dual given the gas supply object. It may be harmful to the health of the operating staff or if there is no operating staff in this environment, it may create uncomfortable conditions for the pipeline service personnel. It has been established that at the noise level of 90dB the work efficiency falls down by 80% whereas the amount of errors increases by 25% [1]. However, insufficient attention has been given to the reduction of noise pollution, especially at thermal power plants. The reason thereof lies in the fact that the service personnel attend these noise-generating zones on a casual basis and with personal protection aids only. Further, the noise level generated at power plants and by other machinery is rather high. To improve working conditions of the personnel attempts are made to reduce the generated noise pollution. The majority of researchers [2, 3, 4, 5, 6] indicate that a gas-supply system generates considerable noise and suggest reduction of sound pressure levels by means of sound insulation. One of the options could be application of ball valves of equal capacity and mounting of noise deafeners on the pressure regulators. Some experts recommend the following noise reduction methods: reducing of gas flow velocity to 28 m/s, insulating of pipes and fixing them reliably. Currently, principal attention is focused on improving of designs of compressor stations, on designing, manufacturing and implementing of valves and pressure regulators with deafeners. Some authors [5, 7, 8] suggest reducing of noise and vibrations by coating the pipe surface with paste and mineral wool layer. However, application of such a means has not been substantiated by experimental tests. Other researchers [7, 8] suggest using of sound-absorbing materials and sound-insulating jackets. For example, reducing of pipe-generated noise by two methods, i.e.: sound insulation and absorption.

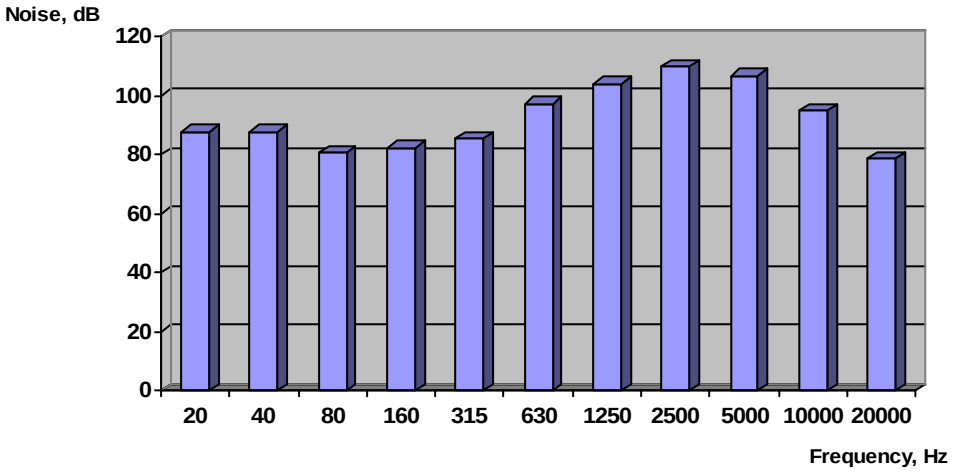
2. NOISE TESTS

The Briuel and Kjaer equipment was used for the tests. Noise levels were measured by the 3533 set comprising the 2230 precision noise-level meter, the 1625 filter and the 4155 microphone.

The graph of noise measuring results is presented in Fig. 1a. The noise level reaches 108.2 dB at the frequency of 1000-4000 Hz, at other frequencies noise levels are up to 95 dB. Results of measurement show that two noise-generating mechanisms may be singled out. One of them is related to gas reduction in the regulator connected in series to reduce the output pressure. The reduction process in the regulator causes turbulence of the gas flow. This turbulent flow generates mechanical vibrations of the regulator's components causing intensive irradiation of noise and vibrations. The turbulent-flow-generated forces acting on the regulator are variable in the value and direction. The second mechanism is related to gas flow pulsation in the gas pipeline. Sound pulsations of gas pressure are generated in the pressure regulator. The pulsation frequency corresponds to the high-frequency segment in the continuous spectrum within the range from 1000 to 7000 Hz (Fig. 1b). Gas pulsation is caused by vibrations of parts resulting from gas and high-velocity gas flow in the regulator. Furthermore, noise is also generated by operation of other boilers and equipment.



a)



b)

Fig. 1. Noise levels when a 500 mm diameter gas pipeline is not insulated:
a) at 270 MW boiler output capacity
b) at 284 MW boiler output capacity

3. PIPELINE NOISE INSULATION TESTS

To the research analysis enables to maintain that the best insulation jacket for gas pipelines would be from 1 to 1.5 mm thick. It can be made from steel or aluminum. The best clearance between the pipe and jacket would be vary 25 to l00 mm. The optimum clearance would be approx. 60 mm. Calculations of such jackets according to formula (1) are presented in Table 1.

$$R = 20\lg\left|1 - \frac{z_{G2}}{\Delta z_{20}}\left[H_1^{(1)}(\mu_2 a_2)H_1^{(2)}(\mu_2 a_2)\right]\left[\frac{H_1^{(1)}(\mu_2 a_2)H_1^{(2)}(\mu_2 a_2)}{H_1^{(2)}(\mu_2 a_2)H_1^{(1)}(\mu_2 a_2)}\right]\right|; \quad (1)$$

here $\frac{z_{G2}}{\Delta z_{20}} = -\frac{z_{G2}\mu_2^2 a_2 \pi}{4\rho_2 \varpi}$; $H_1^{(1)}(\mu_2 a_2)H_1^{(2)}(\mu_2 a_2)$ - Henkel functions; a_2 – radius of jacket;

$\mu_2 \approx k_2\sqrt{1-n^2}$; $k_2 = \varpi / c_2$.

Table 1. Calculating sound insulation R, dB

Pipe diameter, mm	* Jacket material	Mean geometric frequencies of an octal tape, Hz							
		63	125	250	5000	1000	2000	4000	8000
273	Steel	54	54	54	54	54	51	26	47
	Aluminum	45	45	45	45	45	42	17	38
530	Steel	41	41	41	41	39	14	41	50
	Aluminum	32	32	32	32	30	5	32	41

* jacket thickness: 1 mm, clearance between the pipe and jacket: 60 mm.

A steel jacket is obviously more effective than an aluminum one. At frequency of 2000 Hz (Table 1) the efficiency of the jacket drops markedly. To increase the efficiency of the jacket a sound absorption process can be used, i.e. by placing a sound-absorbing material between the jacket and pipe. Such material can be rubber, rock wool or mineral wool. After using a 1 mm thick jacket with sound-absorbing material (Fig. 2) noise level was measured in a similar manner, with the same 3533 set.

Fig. 2. A pipe insulated with noise-reducing materials

Effective results (Fig. 3) that meet the permissible noise levels in the working environment established by ISO1996-2:1987 were obtained. The largest noise levels of approx. 82 dB and 78 dB are registered within low frequency bands of 31.5 Hz and 125 Hz, respectively. Noise levels are markedly reduced in the high-frequency area. Noise level reaches 80 dBA according to scale A.

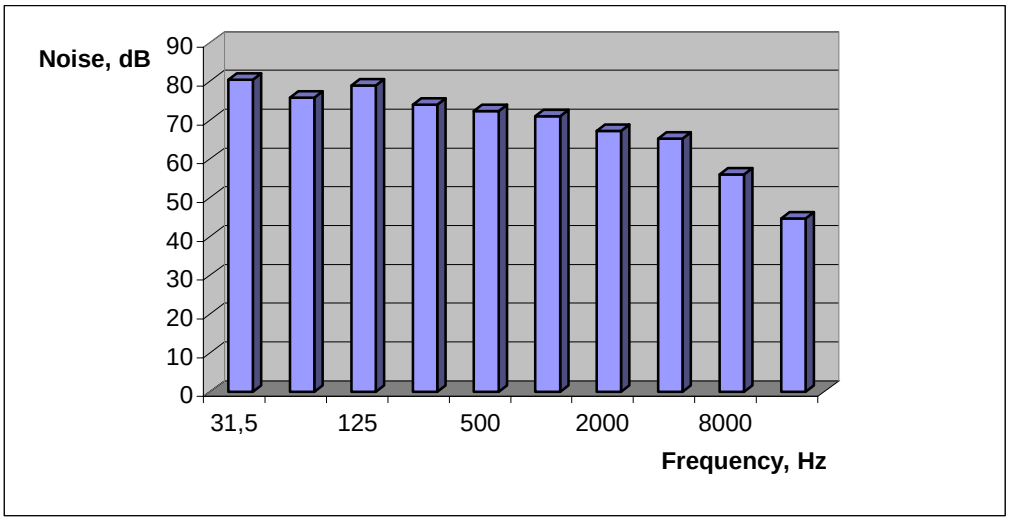


Fig. 3. Noise level recorded in an insulated pipeline. Noise level reaches 80 dBA under scale A.

4. CONCLUSIONS

1. Gas pipeline-generated noise can be reduced by means of sound-absorbing materials and sound-insulating jackets.
2. After measuring noise and vibration levels in a pipeline that was neither coated with insulating materials nor insulated with a jacket the noise level exceeded the sanitary norms reaching the levels from 100 to 119 dB.
3. After insulating the boiler gas pipeline the noise level was reduced to the values specified in the sanitary norms.

5. REFERENCES

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