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NOISE SOURCES AND CONTROL IN UNDERGROUND METAL MINING

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ABSTRACT – Application of modern technologies in the mining industry through energy efficiency, higher labour productivity, adopting continuous production methods, operational flexibility, resulted the use of machinery and equipment of high capacity. Parallel to this, the result was a significant increase in the number of noise sources and noise levels in open pit and underground mining. The paper presents noise sources, the impact of noise on labour and suggestions to reduce noise impact in the workplace.

Keywords: Noise, Level, Impact, Mining.

INTRODUCTION

Noise or noise disturbances are caused by excessive noise that can harm the activities or balance of human or animal life [1]. The source of most of the world's external noise is mainly caused by machines and transport systems, motor vehicles, planes and trains [1]. This type of noise is briefly summarized as environmental noise. Poor urban planning can lead to increased noise, as both industrial and residential buildings can lead to noise pollution in populated areas.

External noise can be caused by machines, due to construction activities, and musical performance, especially in some workplaces. Hearing loss due to noise can be caused by external (e.g. trains) or internal (e.g. music) noise.

High noise levels can contribute to cardiovascular effects in humans and increase the incidence of coronary heart disease [2]. In animals, noise can increase the risk of death due to the inability to detect and avoid predators, obstructed reproduction and navigation, and contribute to permanent hearing loss [3].

NOISE IN MINING

Work being carried out to expand productivity in mining has indicated the need to use larger machines in parallel with improvements in technology. The increase in mechanization has led to an increase in noise levels. Professional noise in underground mines has reached unbearable levels of noise due to the natural propagation of sound in narrow spaces. Therefore, it is difficult to find an environment for workers with relatively low noise levels.

In reality, the noise that occurs during exploitation works (drilling-blasting, excavation, loading and transport of excavations) that take place at underground mines is significant when it comes to the health of workers and their performance at work, because noise has the highest rate of disease and illness in mining, which leads to

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permanent or temporary hearing impairment of workers [4].

In addition, noise appears to be the cause of an accelerated heart rate, high blood pressure and narrowing of blood vessels. Workers exposed to noise sometimes complain of nervousness, insomnia and fatigue [5]. Therefore, it is crucial to conduct research on this issue and to make suggestions to the mine management in order to preserve the health of the workers. Compared to the level of noise exposure in different industries (airport, wood industry, cement industry, foundries, textile industry, printing, ship engine room, etc.), the noise levels encountered in mining are second only to the noise generated by jets. engines at airports [6].

Noise-induced hearing loss most commonly occurs at high frequencies (3000, 4000, or 6000 Hz) and then spreads to low frequencies (500, 1000, or 2000 Hz) [7].

Kinds of noise sources depend on the technology applied in an open cast mining. Apart from blasting works, which are the source of short-lived noises, there are also continuous noises. Sources of this kind of noise constitute machines and devices used in the excavation processes, transporting, dumping and crushing of raw materials.

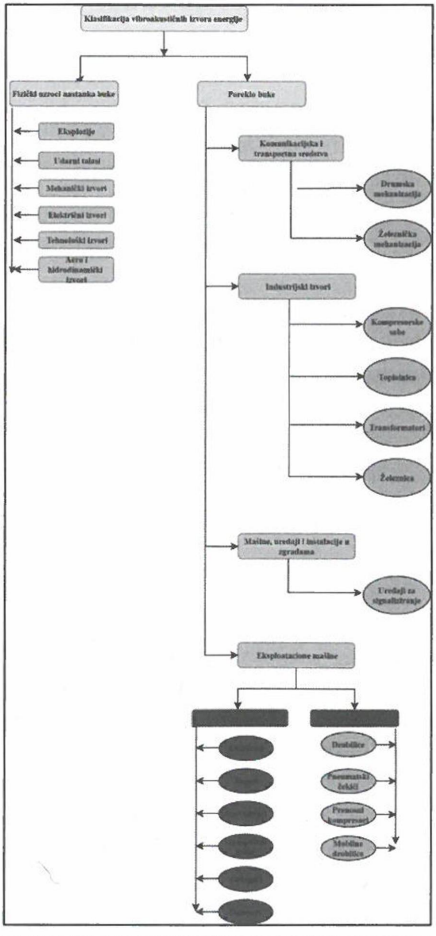

Figure 1 Classification of vibroacoustic energy sources

Each machine, device or means of transportation has many elementary vibroacoustic energy sources. The vibroacoustic energy source is understood as a mechanical or acoustic system generating acoustic vibrations. Properties of such source can be assessed in two ways:

- considering the properties of an acoustic field generated by the source, which provide the so-called external or field characteristics of the source,
- considering the properties of the source itself as the vibroacoustic energy emitter.

The collection of such properties constitutes the so-called internal characteristics of the source. [8].

External characteristics of the source are used for assessment of an acoustic effect generated by the source, while internal characteristics - for assessment of the source itself [8].

Sources can be classified from many points of view. The basic division consists of: theoretical models of radiation, physical reasons of noise generation and the noise origin.

Classification of vibroacoustic energy sources occurring in underground mines of mineral raw materials, performed when taking into account two criteria: physical causes of noise generation and the noise origin - is given in Figure 1. The machines which emit most vibroacoustic energy: are mining machines, especially: Haul Trucks, crushers, pneumatic hammers, drilling rigs, excavators, dumping conveyers and belt conveyers. The most annoying sources of vibroacoustic energy are explosions at blasting works, which are also the sources of shortlived noises.

NOISE LEVELS

The noise levels emitted by haul trucks, load-haul-dump vehicles (LHD) and jumbo drills and bolters are presented in this paper.

Haul trucks are constructed with various sound absorbing materials, such as vinyl-covered material installed in the area in front of the operator; Also, engine enclosures and sealing gaps are having more – less absorbing role.

Performed testing on haul trucks represents results in table 1.

Table 1 Sound level at the haul truck operator's position, underground measurement [9]

	Without vinyl-covered material (dB[A])	With vinyl-covered material in canopy only (dB[A])	With all vinyl-covered material (dB[A])	Noise reduction with vinyl-covered material in canopy (dB[A])	Noise reduction with all vinyl-covered material (dB[A])
Low idle	83.2	82.4	82.6	0.8	0.6
High idle	100.6	100.0	99.6	0.6	1.0

Load-haul-dump vehicles (LHD) similar like haul trucks are constructed with various sound absorbing materials. The engineering noise controls on the machine consisted of

a partial engine enclosure and sound-absorbing material in the engine compartment and in the cab. The used materials are thick steel panels, thick fiberglass sound-absorbing material, thick rubber.

Comparing the surface and underground measurements, the underground environment adds about 3 to 4 dB(A) to the sound level at the operator's ear. The table 2 shows the application of all controls in the underground environment resulted in an attenuation of 1.5 dB(A) at the operator position.

Table 2 Sound level for LHD at the operator's position, high idle [9]

	Surface measurement			Underground measurement		
	Without enclosure (dB[A])	With enclosure (dB[A])	Noise reduction (dB[A])	Without enclosure (dB[A])	With enclosure (dB[A])	Noise reduction (dB[A])
Both sides on or off	91.9	90.8	1.1	95.8	94.3	1.5
Right side off, Left side on or off	91.6	90.8	0.8	95.1	94.3	0.8

Noise controls for jumbo drills and bolters consisted of several motor covers or barriers, treatments applied inside the cabs, and different cab windshield designs.

Table 3 shows the sound levels without and with noise controls applied to the electric-motor-powered hydraulic pumps. It should be noted that the sound levels generated with only the electric motors on were less than 85 dB(A). Sound levels during drilling and bolting can exceed 100 dB(A).

Table 3 Sound level for jumbo drills and bolters at the operator's position, underground [9]

Motors	Noise control	Without control (dB[A])	With control (dB[A])	Noise reduction (dB[A])
Bolter	0.25-inch-thick heavy conveyor belt	84.9	83.2	1.7
Bolter	1.5-inch-thick fiberglass blanket	77.3	76.9	0.4
Face drill	0.5-inch-thick heavy conveyor belt	79.4	77.2	2.2
Face drill	1.5-inch-thick quilted fiberglass absorptive material	79.9	79.5	0.4
Face drill	0.25-inch-thick Plexiglas	84.3	81.9	2.4

Table 4 shows the sound levels without and with the material and the resulting noise reduction achieved by applying it to the canopy. The face drill measurements were taken

underground during the drilling cycle, and the bolter results were measured above ground with the percussive hammer operating. The data show the sound-absorbing material did not significantly change the sound levels at the operator's position in this case.

Table 4 Sound level of jumbo drills and bolters at the operator's position [9]

Motors	Without absorptive material (dB[A])	With absorptive material (dB[A])	Noise reduction (dB[A])
Bolter	97.4	97.3	0.1
Face drill (with windshield)	99.6	99.6	0.0
Face drill (without windshield)	100.3	100.1	0.2

Table 5 shows the sound levels with and without the absorptive material placed around the operator and the resulting noise reduction. The data indicate that the absorption around the operator has essentially no effect on the sound level during the drilling process.

Table 5 Sound level of jumbo drills and bolters at the operator's position, absorptive material around operator [9]

	Without quilted material around operator area (dB[A])	With quilted material around operator area (dB[A])	Noise reduction (dB[A])
Bolter (drilling)	97.5	97.6	-0.1
Bolter (bolting)	98.4	98.7	-0.3
Face drill (motor)	78.1	77.2	0.9

CONCLUSION

Basic noise controls include barriers and sound-absorbing materials. A barrier is a solid obstacle that is somewhat impervious to sound and that interrupts the direct path from the sound source to the receiver. For the best reduction in sound level, the barrier should be:

- placed as close as possible to either the source or receiver;
- assembled to be as tall and wide as practical so it extends well beyond the direct source-receiver path; and
- constructed of a material that is solid and airtight.

Sound-absorbing treatments reduce reflections and the resulting echoes and reverberation. Usually, these materials are porous. Compared to high frequency sounds, low frequency sounds are more difficult to absorb with materials and to block with barriers. Therefore, it is important to know the frequency content for a particular noise problem.

Based ol noise levels shown at tables 1-5, we can concluded that usage of sound absorbing materials is good for noise control. Mainly because they are inexpensive and simple to attach to existing surfaces.

Also, windshields and environmental cabs can be highly effective noise controls, especially for high frequency noise.

For the noise reduction benefits of existing barriers plugging gaps in machine panels and windshields with a material that creates an airtight seal can greatly enhance.

Noise levels survey sampling is necessary to determine any overexposure in order to effectively eliminate or reduce them [1]. Additionally, reduction of occupational noise in mines is an effective factor to ensure adequate and productive working conditions [1].

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