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Technical Solutions for Preventing and Reducing Noise Levels During the Processes Involved in the Extraction of Commercial Ores

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Abstract:

Given the current requirements with regards to human protection, the final aim of the work safety activity is that of ensuring the people's life and anatomical and functional integrity during the work process.

The paper presents the own research conducted following the documentation, conception, production and processing of the data obtained over a longer period of time, research that was carried out at the ore mines of REMIN SA Baia Mare.

Among the data presented in the paper there are a series o measures meant to reduce noise levels in the course of the main technological operations involved in the mining of commercial ores.

1. Introduction

One must note that the infrastructure for preventing and fighting illnesses caused by noise falls within the limits of certain technical, technological and organizational means, which aim to reduce noise levels below the maximum accepted limits or the building of a scientific foundation for actions required for understanding the way noise is formed in the course of both underground and surface work, as well as the aspects related to it.

The paper presents own research conducted following the documentation, conception, achievement, and processing of the data obtained in the course of over two and a half decades of activity in the field of Work Safety.

To this aim the paper describes briefly the documentary research related to the issue of noise with regards to the way it forms, its physical and physiological properties, the general principles and solutions for fighting it in the technological processes involved in the mining and processing of commercial ores, applied both in our country and abroad, as well as the contributions to improving the procedures for reducing noise in the course of underground and surface processes, and an evaluation of their efficiency.

2. Particularities of noise in the underground

Noise is defined as an unwanted sound, an undesirable by-product of the company's normal daily activity. From a physical point of view a sound is the mechanical vibration of an elastic environment, whether in gas, liquid or solid form, which allows energy to be transferred from

the source through progressive sound waves. Every time that an object moves or vibrates, a small proportion of the energy involved is lost in the environment in the form of sound.

In the mining industry, more than in other industrial branches, because of the special working conditions in the underground, the noise produced during various procedures involved in the mining of mineral substances, which utilize machines and tools, is an increased hazard.

The process of fighting noise in mining plants has two aspects:

- first, it is required that the staff that was exposed be protected against the harmful effects of noise, which are dangerous from a physiological point of view.
- secondly, it must be ensured that the staff that was exposed have the capacity to perceive the noise produced by mining pressure, by the eruptions of small material and gases, etc.

The noise level during the processes involved in the mining of mineral substances is so high that it produces an effect of hiding the other noises that announce danger, which shows that fighting noise in the mining process is required not only in order to avoid auditory problems and extra-auditory effects, but also, to a large extent, in order to ensure work safety.

It is general knowledge that the noise produced during the mining of the commercial ores results from the chaotic overlapping of sounds of various frequency and intensity, which creates on the auditory analyzer the effect of an unpleasant sensation.

3. Means for fighting noise in the course of processes involved in the mining and processing of commercial ores, as applied abroad and in our country

3.1 The drilling operation

The drilling of the mine holes is one of the main operations in the process of cutting ore with explosives, both when conducting the preparatory drivings and when carrying out the face works.

The use of modern drilling methods has led to an increase in the rate of advancing but, at the same time, has caused an increase of the noise level.

The noise level produced by pneumatic picks and drills has values that cover the noise produced by the movement of rocks or supports. The increased hardness of the rock results in an increased noise level, especially when using pneumatic drills.

The research conducted to reduce noise levels at the drilling operation carried out with light drills and heavy air-feed drills have outlined the existence of the following sources: the air exhaustion from the pneumatic drill; the mechanic noise produced by the piston's knocking against the auger bit, the movement of the air distribution device, the working of the drill rotation ratchet; the process noise.

An analysis of the noise origins indicated that 87.5% of it was created at the air exhaustion and 12.5 % is of mechanical origin.

The research carried out in order to reduce noise at pneumatic picks resulted in the creation of a sound insulation system formed of a 4 chambers silencer, tried on a PR-20 V drill, which has a noise level of 120 dB and after incorporating the special filters in the drill, the noise level was reduced to 100 dB.

The drill and the device mentioned above can be seen in figure 1, which indicated the track of the exhausted air from the annular chamber I through the pipe I 1, chamber II, through the two pipes 2, chamber III, through the two pipes 3, chamber 4 and the exhaust vents 4.

The average noise reduction at the PR-20 V drill was of 20 dB.

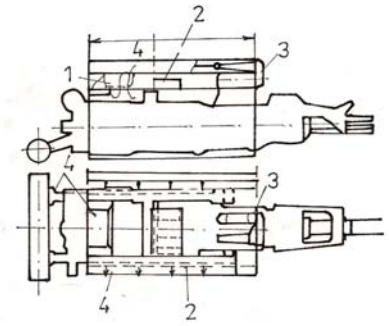


Fig. 1. Scheme of the 4-chamber silencer, assembled on the PR-20 V drill.

In the mining field of Baia Mare, researchers have improved the "Jumbo" drill by reducing the noise levels caused by: the vibration of the steel in the drill; the vibration of the drill's body; the air exhaustion.

A metallic collar was made to reduce the vibration of the steel in the drill, anchored with viscid tubular material with thin walls (figure 2).

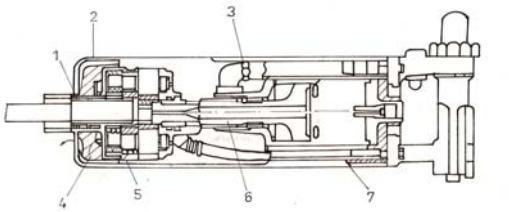


Fig. 2. Scheme of the "Jumbo" drill.

Composing elements: 1. front outlet opening; 2. outer aluminium shell; 3. separation walls; 4. replaceable chuck; 5. independent rotation; 6. valveless piston; 7. flexible lining to prevent ice accumulation. To reduce the noise level produced by the body of the "Jumbo" drill, the latter was acoustically insulated with rubber sleeves and the front outlet opening was equipped with hoses and the drill's exhaust system was divided into an acoustically treated exhaust box.

The average noise reduction was of 15 dB(A).

3.2 The mechanical loading operation for commercial ores

Specialized literature keeps records of existing concerns towards the mechanization of loading operations, on one hand, and the insurance of a certain level of work safety and comfort.

In Romania, the efforts of the researchers aiming to fight noise resulted in the creation of a reduction system for the noise of aerodynamic nature produced by pneumatically-powered loading machines, for which the sound power takes values between 90-114 dB and while operating creates an area of acoustic pressure that extends on a distance of 40 m, during mining works.

The system consists of a silencer made of 3 expansion chambers that are actually the technological cavities of the pneumatically-powered loading machine, connected through joints (figure 3).

The main parts of the system are: the silencer, 1; the bucket carriage mechanism, 2; the discharge outlet of the start-up valve, 3; collecting chamber, 4; the discharge outlet of the lifting mechanism, 5; the 6, 7, and 8 couplings; the machine's technological chamber, 9; the connecting pipe, 10; the pneumatic actuation system, 11.

The three chambers of the silencer are represented by the technological chamber 9 and the chamber of the bucket moving mechanism, 2, as well as the silencer itself, 1.

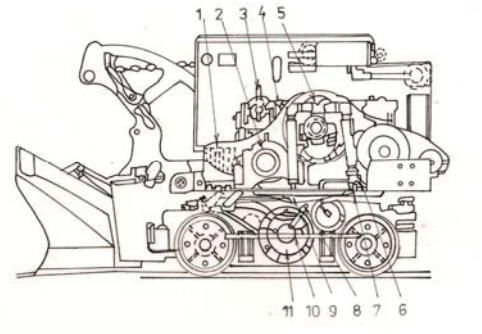


Fig. 3. Pneumatic loading machine with a silencing system for aerodynamic noise.

The system allowed a reduction of the aerodynamic noise level of the carriage mechanism by 10-20 dB, and of the lifting mechanism by 5-22 dB, which ensured a reduction of the noise when loading the ore by the 6-20 dB, in the frequency range of 63-8000 Hz.

For the loading machines of the PKU-A kind (fig. 4) and LHD kind, Eimco and Wagner (fig. 5), noise adjustments were applied to improve the performances of the acoustics obtained. For the PKU-A loader the noise was reduced from 102 dB(A) to 94 dB (A). For the loading machines of the Eimco and Wagner kind, equipped with Diesel engines, the following solutions were applied in order to reduce noise levels: encapsulating the Diesel engine; insulating the engine with rubber dampers and elastomers; applying a silencer for the discharge of burnt gases;

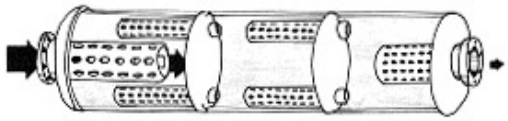
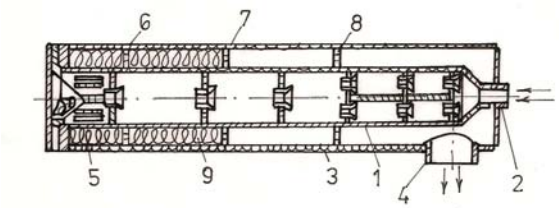


Figure 4. Silencer for the P.K.U.A loader



- **Fig. 5.** Three-phased reaction silencer for LHD, Eimco and Wagner.

For the three types of loading machines to which the researchers applied the silencer illustrated in figure 5, the noise level was reduced from 140 dB (A) to 95 dB (A). In Romania, the maximum level accepted for noise in the underground is of 98 dB (A), as per the current regulations under effect.

4. Conclusions and proposals

The particularities of noise in the underground are characterized by two aspects: first it is required that the exposed staff be protected against the harmful physiological effects of noise; secondly, it must be ensured that the exposed staff maintain their capacity to discriminate between the noise caused by minimum pressure and the sound of gas or small material eruptions.

The measures aimed at achieving a noise reduction are applied directly to the producing source, as well as to the receiver, or to the way of transmission from the source to the receiver.

The analysis of the noise sources in the underground pointed out that the solutions for fighting noise are those that reduce acoustic pressure by applying active and reactive silencers specific to each machine, through the following measures: replacing the machine with a new, silent kind; mounting sound insulating screens close to the noise source, and replacing the control elements; mounting the machine on vibro-insulating elements; acoustic treatment of the rooms' ceiling or walls; using individual ear protection; reducing the exposure time.

For the loading machines of the LHD-65 ud³ EIMCO -915 D – 2 ud³ type, of the Wagner ST – 5A-5ud³ type, and of the EIMCO 918-8-ud³ from the USA, the application of acoustic treatment consisting of absorbent materials for the lateral walls of the block, protected by insulating material and sound-insulating combines of the operator, and at the exhausting system a three-phased reaction silencer, has resulted in a reduction of noise by 10-15 dB (A), which has lead to doubling the working time with these machines.
In Romania, the exhaust box-like silencer was used, mounted on MIS-1P machines, which resulted in a reduction of the noise level by 8-10 dB.
During the process of drilling with PG-80 and PG-125 carriage-mounted rotary percussive drills for long holes, when using the sub-level mining method, the level of the noise produced reaches up to 115 dB(A).
To reduce the noise levels for these drills, the author used silencers that had a series of advantages: they reduce noise levels regardless of the type of drill; they maintain the energetic characteristics; they reduce the propagation distance of the noise level; they reduce the level of oil and water aerosols from the pressured air.
The specific work safety norms related to the mining of coal, schists, bituminous sands and ores have introduced the obligation of reducing noise levels in the operations involved in the extraction of commercial ores.

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Soluţii tehnice pentru prevenirea şi reducerea nivelelor de zgomot la procesele de exploatare a substanţelor minerale utile

Rezumat

În condiţiile cerinţelor actuale privind protecţia oamenilor, obiectivul final al activităţii de protecţie a muncii este de a asigura viaţa şi integritatea anatomică şi funcţională a oamenilor în timpul procesului de muncă.

Lucrarea prezintă cercetările proprii realizate în urma documentării, conceperii, producerii şi prelucrării datelor obţinute pe parcursul unei lungi perioade de timp, efectuată la minele de minereu ale REMIN SA Baia Mare.

Printre datele prezentate în lucrare se numără şi o serie de măsuri menite să reducă nivelele de zgomot din cursul principalelor operaţii tehnologice de exploatare a substanţelor minerale utile.