Letter to Editor

Occupational Noise in Mines and Its Control – A Case Study

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Abstract

Nowadays, owing to the improvements in technology through greater energy efficiency, higher labour productivity, continuous production methods and operating flexibility, mechanization has also advanced rapidly in open and underground pits together with mineral processing plants. In parallel to this improvement, sources of noise and ambient noise at work in the mining industry have shown a noticable increase.

In this work, the noise sources and levels encountered in mines, the effects of noise on workers and finally suggestions to reduce these effects are given in details, together with a real case study from mining activities in Turkey.

Keywords: noise, sound, equivalent noise level, mining, Turkey

Introduction

Works carried out in order to expand productivity in the mining industry have pointed out the necessity to utilize larger machinery in parallel with improvements in technology. An increase in mechanisation also has resulted in an increase in noise levels, leading underground and open pit mines and mineral processing plants to generate enormous levels of noise. Occupational noise in underground mines has reached unbearable levels due to the reverberant nature of the narrower spaces. Therefore, it is hard to find a relatively low-noise environment for workers. Although the equipment employed in open pits are comparatively larger in size than the ones encountered underground, they may be said to be less significant as the noise emitted from them easily spreads hemi-spherically in the free sound field.

In reality, the noise occurring during extraction works (i.e. drilling-blasting, excavation, loading and transporting) that take place in both open and underground pits is noteworthy when considering labour health and job performance as the highest disease and illness rates in mining continue to be mine worker's permanent or temporary hearing loss [1]. Additionally, it appears that noise can account for quickened pulse rates, increased blood pressure and a narrowing of the blood vessels. Workers exposed to noise sometimes complain of nervousness, sleeplessness and fatigue [2]. Therefore, it is of foremost importance to conduct research on this matter to give suggestions to mine management with respect to the health of workers and maximizing the competence in productiveness. In comparison with the levels of noise exposure in various industries (airport, forest machinery, cement industry, foundry, textile industry, printing, metal plate workshop, ship engine room, riveting workshop), noise levels encountered in the open cast mining industry are second only to that encountered near jet engines at airports [3]. Noise-induced hearing loss usually occurs initially at high frequencies (3k, 4k, or 6k Hz), and then spreads to the low frequencies (0.5k, 1k, or 2k Hz) [4].

Sources of Noise

Noise, defined as undesirable sound, is a by-product in many industries. This is particularly true for mining.

Many miners are exposed not only to loud but sustained noise levels. Most of the large excavation equipment utilized at open pits are not said to be responsible for the excessive noise levels as they are mostly equipped with noise-protected operator cabs. However, excavators with lower capacity and mobile diesel-powered machines have been accepted as the primary noise sources in surface mining activities [5-7].

On the other hand, equipment such as continuous miners, stage loaders, shearers, compressors, fans and pneumatic drilling machines may be counted as the main contributors to excessive noise levels in underground mining.

Additionally, equipment like vibrating screens, rotating breakers and mills which are commonly in use in most of the mineral processing plants may be defined as the important sources of noise.

Effect of Noise on Hearing Mechanism

Upon the receival of an acoustic signal, pressure changes occurring in the auditory canal move the drum membrane (Fig. 1). The bones called hammer, anvil and stirrup, which are located behind the eardrum are connected in a chain between the tympanic membrane and the round window of the cochlea. In the case of these bones being exposed to noise, they start to vibrate.

Therefore, the sound energy caused by this vibration is converted into mechanical energy and then into hydraulic energy in the cochlea. The motion in the cochlea will affect the small hair-like cells in the cochlea depending on the electrical signal frequency. When a cell is stimulated it sends an electrical signal to the brain. The loss of hearing in the inner ear, apart from natural diseases, may be faced in the case of small hair-like cells becoming damaged or weakened due to excessive noise levels for a long period [9]. Noise-induced hearing loss is 100% preventable but once acquired, hearing loss is permanent and unfortunately irreversible.

Miners have to put up with a variety of noise sources during their daily working environment. Contrary to popular thought, hearing loss arising from instant high levels of noise rarely happen; however, the main cause is prolonged levels of sound.

The length of period during which workers are exposed to excessive noise is rather important as it takes a foremost role in distinguishing the type of hearing loss being either temporary or permanent. In Fig. 2, the hearing loss percentage of underground colliery workers can be seen [10].

The parameters which are effective for hearing loss due to noise are exposure period, noise level, age of workers and physical condition of workers (existence of other illness etc.). For most effects of noise, there is no cure. However, prevention of excessive noise exposure is the only way to avoid health damage.

Noise Abatement Methods

Efforts made to reduce excessive noises from any source to tolerable levels by changing acoustic features and decreasing the period of exposure may be covered as the principles of noise control [11]. It should be noted that noise controls and administrative actions should be the first line of defence [12]. These methods may be classified into three groups [13]:

a) Equipment practice: This practice relates directly to the selection and utilization of mining machinery to obtain reduced noise levels.
b) Operational and administrative practice: This practice is also related to the design and execution of the mining operation to obtain reduced noise exposure.
c) Engineering noise controls: Removing hazardous noise from the workplace by means of engineering controls is the most effective way to prevent noise-induced hearing loss. For this purpose, equipment hardware changes are implemented, especially to reduce machine noise emission levels.

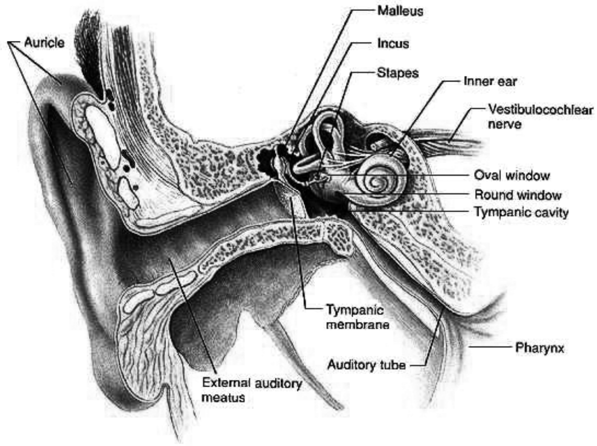

Fig. 1. Anatomical layout of ear [8].

Fig. 2. Hearing loss percentages of underground workers.

Fig. 3. The location of the Tuncbilek Colliery (WLC).

Industrial Noise Measured from a Real Mine – A Case Study

In the open and underground mines of WLC located in the western part of Turkey (Figure 3), mining activities include overburden stripping and coal winning for surface workings and mechanized longwall excavation for subsurface workings. For overburden removal, an excavator, truck and dragline are employed, whereas for coal winning, a hydraulic excavator and truck combination is used. However, double drum shearer is utilized for coal excavation in mechanized longwall of underground pit.

A survey of industrial noise was carried out in the Western Lignite Corporation (WLC) of the Turkish Coal Board. All the data were taken 5 m from the rear of each machine while it was working. Additionally, in situ measurements were taken 1.2-1.5 m above the floor level and 3.5 m away from sound-reflecting structures in the work site [14]. An ANSI S1.4 Type 2 digital sound level meter complying with Turkish Standards 2711 [15] – 2604 [16] was used. The survey results were transformed to the equivalent noise levels [17]:

$$L_{eq} = 10\log\left(\left(1/n\right)\left(10^{L_1/10} + 10^{L_2/10} + \ldots + 10^{L_n/10}\right)\right) \qquad (1)$$

where n is the number of measurement (it is taken 60 for 1 minute), L_1-L_n is the measurement value (dBA) and L_{eq} is the equivalent noise level (a measure of the average sound pressure level during a period of time) (dBA). An average of 100 measurements was taken from each station.

The measurements were taken from various work places of WLC and given in Table 1.

Detailed examination of Table 1 reveals the fact that in almost all of the stations both surface and subsurface from which the measurements were obtained are undesired sources of noise. The sound pressure levels in certain stations of both surface and subsurface workplaces are above the limit of 87 dBA for the exposure period of 8 hours which is defined in Noise Control Regulations of Turkey [11]. The findings of the present work also prove that the labour force is affected very much from occupational noise as approximately 60% of the workers complain from hearing problems.

Table1. Equivalent noise levels for various workplaces of WLC.

Noise measurements from underground pits of WLC	
STATION	Sound Pressure Level (dBA)
Compressor house (between two compressors)	89-90
Main belt conveyor (beside the engine)	83-84
Monorail house	93-94
Central water drainage pumping station	78-79
Double ended ranging drum shearer	94-95
Transfer point of face armoured conveyor	91-92
Transfer point of belt conveyor	78-79
Noise measurements from open pits of WLC	
85 tonnes truck (dumping in progress)	99-100
85 tonnes truck (full speed, window closed)	83-84
Dozing operation (inside cab)	95-96
Pneumatic drilling machine (window closed)	91-92
Marion dragline (inside cab, window closed)	72-73
Marion dragline (5 m away)	81-82
10 yd^3 excavator (inside cab, window closed)	73-74
10 yd^3 excavator (inside cab, window open)	83-84
Noise measurements from coal preparation plants of WLC	
Rotary breaker	91-92
Belt conveyor for run-off mine coal	83-84
+18-50 mm sorting screens for coal	94-95
+18-50 mm sorting screens for tailing	97-98
+18-50 mm screens for run-off mine coal	95-96
-18 mm jigging system	92-93
Sheltered dumping station	92-93
Controlling panel room	73-74
Roberts & Schaffer heavy media cyclone system	90-91
Hand sorting conveyor	85-86
Noise measurements from manufacturing workshop of WLC	
Circular saw (1 m away)	97-98
Line saw (1 m away)	98-99
Planing machine (1 m away)	98-99
Guillotine machine (1 m away)	96-97
Pipe-cutting machine (1 m away)	97-98
Battering-ram (1 m away)	96-97
Grinding machine (1 m away)	87-88
Noise measurements from maintenance workshop of WLC	
Engine test hall (by the engine)	102-103
Engine test personal cab	77-78
Noise measurements from timber yard of WLC	
Small line saw (sawing in progress)	90-91
Big line saw (sawing in progress)	77-78

Conclusions and Suggestions

Noise survey sampling is necessary to determine any overexposure in order to effectively eliminate or reduce them. Additionally, reduction of occupational noise in mines is an effective factor to ensure adequate and productive working conditions. Thus, the measures categorized as administrative and engineering noise controls to remedy noisy environment in mines are given below:

A) Administrative
- supplying the workers being exposed to occupational noise exceeding 87 dBA with earplugs, semi-insert plugs, muffs and helmets,
- reducing hours of work where excessive sound pressure levels are experienced,
- task rotation of workers,
- training the workers about the use of personal protectors and explaining their advantages,
- having the mine workers undergo periodic medical inspections to check hearing.

B) Engineering noise controls
- selecting the processes with lower sound pressure levels,
- locating the mine-related plants in noiseless places,
- enclosing the source of noise and preventing the noise from being transmitted,
- isolating the operators' cab,
- moving the noisy machine to a little-used section of a mine.

However, the effectiveness of hearing protection programs may be hindered sometimes by poor compliance in the use of hearing protection devices due to communication difficulties, comfort issues, individuals' attitudes about protecting themselves from noise-induced hearing loss, and individuals' perceptions about how others who do not use hearing protection will view them if they choose to use hearing protection [18].

Finally, a comprehensive programme of hearing conservation in Turkish coal mines should be initiated to identify those activities that carry most risk and to minimize noise exposure.

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