THE EVALUATION OF NOISE LEVEL IN HAND-HELD PNEUMATIC TOOLS (ROCK DRILL) BY "PNEUROP CAGI TEST CODE" METHOD

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1. INTRODUCTION

The objective of this study is evaluation of noise in hand–held pneumatic tools (Rock drills) used in Lashotor stone mines in Isfahan by the method of PNEUROP CAGI TEST CODE specifies the procedures which can be applied to certain items of construction equipment.

Extremely loud noise damages hearing. In rare cases, the damage is momentary and caused by shock waves from, for instance, an explosion [1]. Damage to hearing normally occurs after many years of exposure to loud noise. Such damage is not sudden and total, but a gradual deterioration of the hearing which is most pronounced around the frequency of 4000 Hz [2]. Compressed air driven hand-tools are often used as examples of noisy machines. This is not surprising considering that air tools are extremely common and many old, compressed air tools are noisy [3].

This method is designed to evaluate noise and vibration propagated by the hand–held pneumatic tools [4]. Rock drill is one of the four product categories specially identified as a major source noise and vibration in the federal noise control Act of 1972 [5]. There are three different types of noise sources including: 1. Process noise, produced by contact between the machine and a surface, 2. Exhaust air noise, partly caused by the flow variation as the compressed air passes the motor, partly by the aerodynamic sound generated in the exhaust air channel, and 3. Vibration radiated noise, from the surface of the machine produced by the moving parts of machine and the flow of air inside the machine [6, 7].

In this study the rock drill produced noise in above specify test method, its control procedures are also recommended.

2. METHOD

2.1 PNEUROP CAGI TEST

The method is based on ANSI (1971) for measuring hand-held pneumatic tools overall noise such as rock drill, paving breaker, and is also famous to "PNEUROP CAGI TEST CODE" [8, 9]. This paper will deal with the methods required for determining the amount of noise produced by a rock drill. The aim of these measurements is either to obtain a value of the overall noise emitted by the tool, or to understand why a tool emits noise and therefore provide a basic for making noise reducing modifications.

2.2 The equivalent value and noise dose

High sound levels over long periods of time damage hearing. For this reason, major efforts are being made to reduce sound at workplaces to harmless levels. In the first step it is possible to deal with methods and criteria for determining the amount of noise a worker is exposed to. Rock drill produced a continuous noise based on ISO standard and therefore we can calculate the total dose in regarding to duration and level of the various noises which the worker is exposed with the aid of the following formula:

$$Leq = 10 . Log\left[\frac{1}{T}\sum t_i . 10^{0.1 . L_{pi}}\right]$$

2.3 measurement conditions

In the second step, the measurements shall be performed with the center of the machine, 1 meter above a reflecting floor [10]. In fact, the noise assessment will be done on the spherical area so that geometric center of drill should be located in the spherical center and also in a 1 meter distance of land. All values are measured in terms of sound pressure level in a situation of "A" for frequency weighting and "slow" for time weighting by B&K 2230 sound level meter and 1625 analyzer. Table 1 shows the allowable noise levels of construction equipment including rock drill given by ANSI S5.1-1971.

Table 1. Allowable values of construction equipment sound level, ANSI S5.1-1971.

Equipment	A-Weighted Sound Level, dB(A)
Earthmoving :	
front loader	75
backhoes	75
dozer	75
tractor	75
scraper	80
grader	75
truck	75
paver	80
Material handling:	
concrete mixer	75
concrete pump	75
crane	75
derrick	75
Stationary:	
Pumps	75
generators	75
compressors	75
Impact:	
pile drivers	95
jack hammers	75
rock drills	80

2.4 Sound power level

In order to calculate the sound power level of a drill by use of sound pressure level [11] so that the drill is located in the center of a hypothetical sphere with the surface of 'S' and the reference surface of 1square meter, the following formula can be used:

$$Lw_A = L_p + 10Log_{10}(S/S_0)$$

3. RESULTS

As can be seen, SPL values are shown in Table 2. The background values are defined for two situations while compressor was turned on or off. The overall sound pressure level based on ANSI S5.1-1971 has been equal to 94.63 dB (A).

Table 2. Exposure levels of measured SPL in a rock drill

Sound pressure levels(dB)	Max sound levels(dB)	Background sound levels(dB)
95.5	105	55.7*
94.5	103	37.3**
94	101	
93.8	102	
95.5	104	
$SPL_{(f)}$=94.63	$Max_{(f)}$=103	Leq=88 (dB)
*The compressor turned on **The compressor turned off		

The graph below shows an increase gradually in sound pressure level generated by the rock drill from frequency of 31.5 Hz to 4000 Hz with a fall in 1000 Hz frequency gotten by sound level meter in a frequency analysis of 1/1band octave.

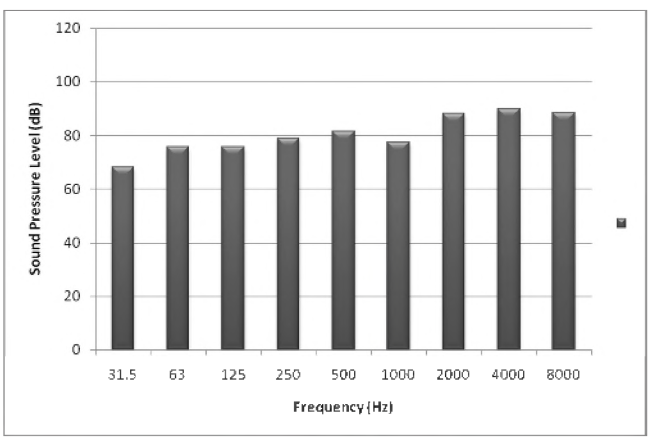

Fig. 1. 1/1 octave band frequency distribution of the rock drill radiated noise from 31.5 Hz to 8000 Hz using by miners in stone mines.

The critical frequency was 4000 Hz with a value of 90 dB to 105 dB depending largely on the design of the work piece and given load to drill. Figure 1 shows the values of a rock drill SPL applied in the stone mine measured in a distance of two meter of rock drill.

A wide range of noise frequencies produced by the rock drill are shown in Figure 2. There is a slightly rise from 20 Hz to 8000 Hz frequencies with a peak of 90.1 dB at 4000 Hz. The graph shows higher levels of noise in high frequency limits. It can be important while using sound absorbing material to control noise emitted from the exhaust system of pneumatic tools. Perhaps achieving control approaches look complicated but the above assessment can help us to apply one or more of control methods given below.

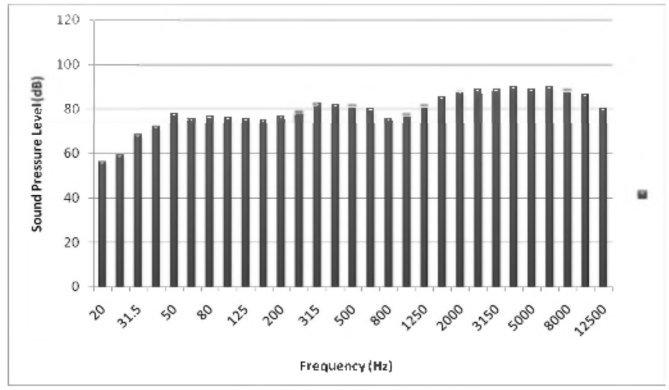

Fig. 2. 1/3 octave band frequency distribution of the rock drill radiated noise using by miners in stone mines from 20 Hz to 12500 Hz.

4. DISCUSSION

The overall SPL will get from the values and evaluated levels around the drill so that we can find the sound power level of drill. This is necessary factor to apply control approaches on machine.

However, there are three different methods for control of a rock drill noise applied in stone mines [12, 13].

- Reduction of process noise
- Exhaust air noise reduction
- Reducing vibration-induced noise

The machine casing of hand-held pneumatic tools is a source of noise although the levels are usually not large compared with, for instance, exhaust air noise.

REFERENCES

[1] Handbook of noise and vibration control, *Malcolm J. Crocker*, 2007.
[2] Industrial health, *M Takamatsu*, Journal, 1982.
[3] Measurement of airborne noise emitted by construction equipment intended for outdoor use, *ISO*, 1976.
[4] Handbook of noise and vibration control, *Antony Barber*, 1992.
[5] Surface rock drills, *Atlas Copco*, 1991.
[6] Handbook of noise control Chap 13-construction equipment *M C. GrawHill* – Book company, *Harris* .C 1973.
[7] Sound and vibration, VOL 10, page 6-33, Purcell, 1976.
[8] Test code for the measurement of sound from pneumatic equipment *ANSI*, 1971.
[9] Test – site measurement of maximum noise emitted by engine powered equipment, *ASA*, 3, 1975.
[10] Ergonomic tools in our time, *Atlas Copco tools*, 1988.
[11] Method for designation of sound power emitted by machinery and equipment by machinery and equipment, *ASA*, 5, 1976 *ANSI*, 1976.
[12] Sound and vibration, Vol5. Page 4, *Anonymous*, 1991.
[13] Noise control foundation, *LEPOR – M*, 1983.