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Original Article

Occupational noise exposure among the workers of Kerman Cement Plant, 2009

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Abstract

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Background: The sound is an environmental and occupational pollutant and can cause a number of reactions in human body, in which hearing loss is one of the most important effects. Cement industry is one of the industries with noise induced hazards. The aim of this study was to evaluate the noise level in different parts of Kerman Cement Plant.

Materials and Methods: This descriptive cross-sectional study was done in Kerman Cement Plant in 2009. The sound level was measured according to the standard ISO 9612:1997 (E) in workers main commuting spots. Noise levels were measured by the testo SLM device (Model CEL-815) in network A and calibrator model IEC942/90 claa2. Data were analyzed by the EXCEL software.

Results: The highest sound pressure level in the Cement Plant (106 db) was recorded in the stone crushing units and the grinding units (mills); 14 units had a mean sound level above the permissible 85 db noise level.

Conclusion: There are specific units with high noise exposure in the Kerman Cement plant. Thus systematic noise evaluation in the working units, worker education, noise control, distributing proper standard noise protection equipment among the workers, performing annual audiometries, and evaluating and updating noise control programs are necessary.

Key Words: Cement Plant, Noise level, Noise Pollution, Kerman

Introduction

High noise levels have been recognized as a threat to the human health for many centuries. In the past only a small group of people were exposed to the harmful effects of noise, but after world war II due to rapid industrialization and the increase in noise producing sources worldwide, ordinary people also became exposed to the harmful effects of high noise levels [1]. High occupational noise exposure is still an essential health hazard worldwide; for example, in the USA more than 30 million workers are exposed to dangerous noise levels. Also in Germany 4 to 5 million people (12 to 15% of the workforce) are exposed to noises which are classified dangerous by the WHO [2]. In America more than 5 million workers are exposed to noises higher than 85 db in their working environments [3]. The negative effects of noise on humans include physiological and psychological effects; the most important physiological effect of noise on the human body is hearing loss [4]. Its physiological effects are more prevalent than the psychological effects which are stress,

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anger, distraction, lack of concentration and decreased cognition [5]. Among the other physiological effects of noise on human is the increased blood pressure [6, 7] and eventually cardiovascular diseases which account for a high percentage of work related diseases [8]. Noise is a factor for inducing stress related reactions. Stress increases the probability of cardiovascular diseases. In some studies, noise has been classified as the second external factor for coronary artery diseases after smoking [9, 10].

The cement plant is one of the noisiest working environments. Several studies in Iran [11-13] and other countries [14, 15] have reported high noise exposure in different industries, however few [14] have focused on cement factories. The harmful effects of noise depend on the type of industry, the plant section and the exposure intensity, and duration of the workers' shifts [7]. Kerman Cement plant is located approximately 15 km, on the south west of Kerman, a city in the south east of Iran [16]. The plant is located on the way to Bandar Abbas and is one of the main cement exporters of the Persian Gulf region. This plant was launched on August 3, 1967 [17].

In this plant raw materials, which consist mainly of lime-stone, silica, alumina and iron materials, after complete grinding and mixing, are heated up to 1600°C in a rotary kiln to produce cement [16]. This factory has three production lines, Which produces more than 3500 tons cement per day. The products of this plant are type 1 cement (natural pozzolan), type 2 (Portland), type 5 (Portland), HSR and G class (used for oil expeditions) [17]. This plant has employed more than 900 people of which less than 400 are working in the noisy units. The cement manufacturing process consists of four processing steps: crushing of raw materials, grinding of raw materials, pyroprocessing, and grinding of clinker and packing. The whole process is associated with high noise levels due to the striking, loading and transportation of the rocks, clinker and steel balls, the traction systems of the mills and the fans and blowers for the transport of gasses and materials [18]. The aim of this study was to measure the average noise pollution in different parts of Kerman Cement Plant. The measurements will help us to estimate the average noise exposure of workers in the different units of this industry. It will also provide the essential data for spatial noise mapping and planning efficient noise control and hearing protection programs in different units of this factory. The data can also be used for forecasting and planning control programs in the newly established cement factorie, in which sufficient data has not yet been accumulated for action.

Materials and Methods

This study was a descriptive cross-sectional study done in Kerman Cement Plant in 2009. The map of different parts of the plant was inquired and the stations for noise measurement were selected from the places which workers used to stop or commute more than other places. the selection and measurement of noise in all units of the cement plant was done according to ISO 9612:1997(E).

The level of noise was measured by an occupational health specialist who was familiar with the measuring device instructions and the study protocol. All measurements were done during morning work hours (from 6 am to 2 pm) in which the maximum number of workers were working, and all of the noise producing equipment were operating. The noise produced in different units was different and depended on the unit's surface (m^2), number of operating

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equipment, number of people working and the type of work. The number of our measurements depended on the unit's surface, and more measurements were done in larger halls. The factory units, number of people working and the db in each measuring station was recorded. Noise was measured in a sum of 224 measurement stations. In each station at least 3 measurements were done and the logarithmic mean for each station was determined. In this Factory, workers work in 8 hour shifts and the sum of noise exposure in each shift is about 6 hours. In order to measure noise levels, the testo SLM devise (model CEL-815) in the A network was used and for calibrating it the calibrator model Testo IEC942/90 claa2 was used.

For measuring noise, the noise meter microphone had at least one meter distance from reflective surfaces such as walls or machinery and its distance from the floor was about 5 feet or 1.5 meters. Data about noise levels were gathered in each unit, and the logarithmic means were calculated for each unit. The statistical analysis was done by EXCEL software and the units that had noise levels higher than the standard threshold (85db) were determined.

Results

The map and the measurements in one of the working halls as a sample has been shown in figure 1.

Figure1: the noise measurement stations of one working hall

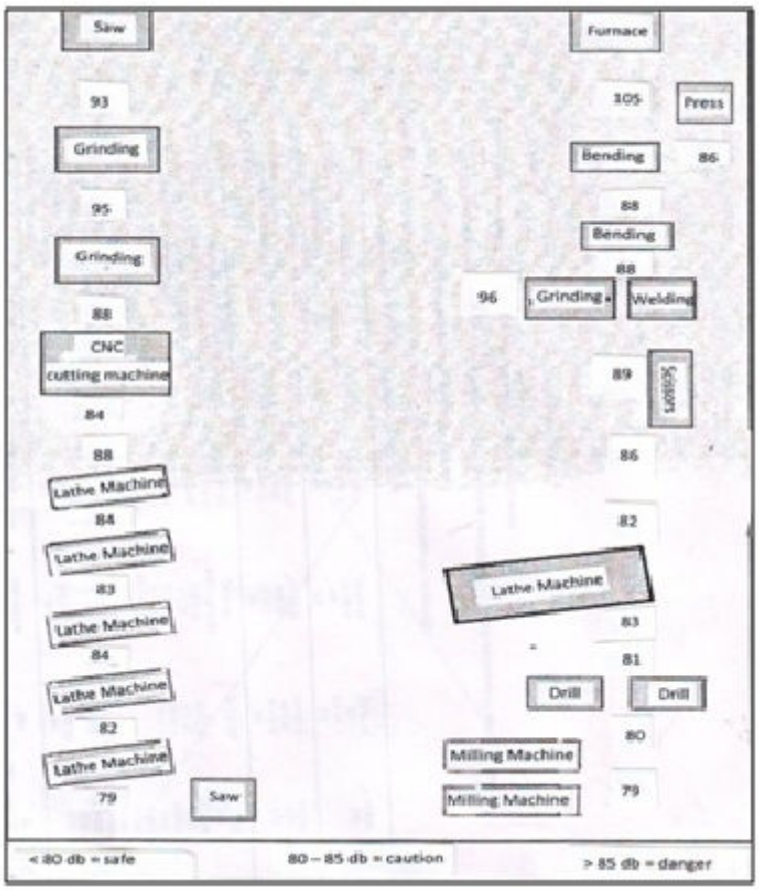

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Table 1: The noisy units of Kerman Cement Factory, the mean, maximum and minimum of noise measured (db) and number of workers in each unit.

Unit name	Mean±SD (db)	Min - Max (db)	Number of workers	No. of noise measurement stations
Raw material mill	100.1 ± 1.3 *	98 - 102	22	16
Cement mill	99.4 ± 1.6 *	96 - 102	30	16
Gypsum mill	99.4 ± 1.6 *	96 - 102	3	16
Iron ore mill	100.1 ± 1.3 *	98 - 102	3	16
Crusher	103.5 ± 1.3 *	102 - 106	8	10
Preheater	80 ± 0.9	79-81	6	6
Furnaces	94 ± 8.8 *	84 - 106	31	8
Prefurnace group repair	84.3 ± 4.7	77 - 92	18	6
Soil silo	80.8 ± 1.3	79 - 82	5	4
Klinger storage	84.1 ± 3.5	79 - 88	3	4
Tonnage house	82 ± 3.7	78 - 88	3	4
Repair of tonnage house	93 ± 5.8 *	86 - 105	14	6
Operations group	76.6 ± 3.4	72 - 82	26	6
Building Department	81 ± 4.2	75 - 86	15	6
Laboratory group	74.4 ± 3	70 - 78	21	8
Power (Electricity)	81 ± 6	72 - 88	68	6
Electrostatic Filter	98.4 ± 1.5 *	97 - 101	12	4
Casting	89.7 ± 3.9 *	85 - 95	2	12
Technical Service Group	91.8 ± 5 *	86 - 100	13	6
Technical Project Office	73.2 ± 2.7	70 - 77	15	6
Technical Workshop	88.3 ± 6.5 *	79 - 105	38	22
Furnace repair group	78.2 ± 6.1	75 - 89	13	6
Mechanics	86.8 ± 7.7 *	77 - 101	22	5
Vehicle repair shop	88.5 ± 7.3 *	77 - 102	8	12
Power plant	91.2 ± 6.3 *	84 - 106	12	13

* Noise above national recommended level

After collecting the measurements, in all of these halls the logarithmic average and the standard deviation of noise intensity were calculated. The results of noise measurement, the number of people working in each unit and the number of noise measurements done in each unit have been shown in table 1.

Kerman Cement Plant has a total of 29 units and the units that have a higher noise level have been shown in table 1. The results showed that from a total of 29 units operating in the Kerman Cement Factory, 14 units have noise levels above 85 db which noise control programs should be executed in them. The range of noise level in different parts of the plant was from 39 to 106 dBA. As it has been shown in the table 1, among the units with noise levels, more than 85 db, the iron ore mill, crushing and the raw material mills had the highest average noise levels.

Discussion

The present study showed that the Cement Plant due to its high noise exposure is among the hazardous industries and noise exposure in some parts of Kerman plant has reached dangerous levels of up to 106 db. According to the safety standards in this high noise intensity, the exposure time should be shortened (Table 2).

Also the necessity of frequent noise evaluation, machinery control and maintenance in the working environments should be highlighted. It has been mentioned in numerous sources that noise intensities

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similar to the ones measured in this plant can lead to hearing loss [19]. According to the estimates of the American Occupational Health and Safety Institute, from every four workers aged above 55 years and exposed to noise levels above 90 db, one has hearing difficulties. This institute describes noise induced hearing loss as one of the 10 important occupation related diseases [19].

A study from a cement plant in Holcin, Croatia reported that most of the machinery produce noise levels between 67 to 112 db in one meter distance [18].

Another study conducted by the Workers' Health Center of one cement plant in Brazil, showed that noise and temperature were the most important hazardous exposures in these workers and the noise levels were up to about 120 db [20]. In our study, the minimum measured noise level was 39 db and the maximum was 106 db. This higher noise level at the cement industry in comparison to other industries is probably related to the work structure and type of operations performed at these factories. Similar studies from other researchers, such as the study done by Golmohammadi et al showed that environmental noise levels at the Isfahan Iron Melting Plant were between 75 to 105 dBA [12].

In another study of construction industry the average measured noise levels in a cement mason were 79.3 dBA and more than half of the measurements were above the 85 dBA standard threshold and in 10 cases it was more than 90 db [21]. Bostani et al studies done in 23 functional units of the Abadan Oil Refinery showed that the minimum average noise exposure in these units was 83 db and the maximum was 102.1 db [11] and Jahangiri and Adl's study in the Imax Unit of the Tehran Oil Refinery showed that the noise level in this unit is higher than the standard recommended level (85 db) [22]. In another study about the noise exposure of construction workers, results showed that the noise exposure in this occupation is also at a level that can cause harmful effects for the workers hearing and had reached about 87 db. In this study out of 60 construction workers whom did an audiometery, 45 workers used ear muffs during work, but the hearing loss detected in workers showed that the hearing protection program was not efficient [23].

There are also studies that show the hearing protection gear used in some industries is not efficient either [11]. Therefore, it is essential to have occupational hygienists' supervision over choosing and correct using of hearing protection equipments in different industries. Other studies measuring noise levels in cement factories and evaluating the workers hearing loss in these factories have shown that 55% of the workers had levels of noise induced hearing loss [14]. In our study among the units with noise levels more than 85 db, the iron ore mill, crushing and the raw material mill had the highest average noise levels. Because of the high number of workers that operate in units with high noise pollution (table 1); noise control, the use of personal hearing protection equipment, reduction in working times and other preventive strategies are necessary in Kerman Cement Plant.

The time restrains that should be applied accordingly in case of high noise levels based on international standards has been shown in table 2. Kerman Cement Factory is one of the major Iranian industries with high industrial hygiene standards. All of the workers in the noisy industrial units are equipped with ear plugs, and are screened annually for work related disease and hearing loss. Nevertheless, the factory's privacy regulations did not allow us to access workers' health files.

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Table2: The standard duration of noise exposure according to National and ACGIH Standards

Noise Intensity	Duration of Exposure
82 db	16 hours
85 db	8 hours
88 db	4 hours
91 db	2 hours
94 db	1 hour
97 db	30 min
100 db	15 min
103 db	7.5 min
106 db	3.75 min

Another study stated that among the units in a cement factory the coal mill, Kiln/Raw mill, packers of cement plant and DG sets had the highest noise production [24].

The noise pollution control measures proposed for cement plants are provision of acoustic dampeners in foundations and insulators in the interiors, encasement of noise generating equipment, development of a thick greenbelt all around the plant boundary to act as a noise attenuator, providing ear muffs to personnel working near high noise levels, providing suitable acoustic barriers around areas generating high noise, and effective preventive maintenance and vibration measurements of all rotating equipments [24]. Application of noise mapping techniques in complex industrial environments such as the cement plant shows that with reliable acoustic and spatial data, proper noise map and action planning can be calculated. Obviously, without acoustic measurements or reliable databases it is not possible to noise map the industrial source [18].

All hearing protection devices should be labeled with a Noise Reduction Rating, which is an estimate of how much noise the protector will block. Typically, this level should be about two times higher than the protection most workers experience in actual use [21].

Conclusion

According to the results of this study and other studies, the cement plant is one of the industries with high noise exposure and a multiple step noise control program including noise evaluation, worker education, engineering strategies for noise reduction, determining the hazardous zones, distributing standard hearing protection devices, annual audiometries and evaluation and revision of noise control programs should be implemented.

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Conflict of interest: Non declared

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