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*Full Length Research Paper*

# Analysis of noise levels in corrugated board factories

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**Increasing demand for goods due to population growth, national and international competition and developing technology result in intensive machine usage. Increasing usage of machinery may cause noise pollution in our environment and may adversely affect employees, leading to physiological and psychological problems. Recently, national and international environmental regulations have become widespread, due to increasing environmental awareness. Such laws include the regulation of workplace noise levels and measures necessary to protect employees from the effects of excessive noise. This study examines the noise levels in a plant manufacturing corrugated board. Noise measurements were conducted at production line locations and management departments throughout the plant. A total of 390 measurements were conducted in 13 departments and were evaluated using SPSS. The average noise level was 85.01 ± 2.12 dB(A), the highest noise level was 97.30 dB(A) (within B-wave corrugation section) and the lowest level was 60.60 dB(A) (within Administration Department.**

**Key words:** Turkey, noise, cardboard, ergonomics, health.

## INTRODUCTION

In general, “sound” is defined as the vibration of materials and the conveying of this vibration to the ear through air or water and “noise” is defined as unpleasant and disturbing sounds (Hayta, 2007). Noise has negative effects on individuals and society, and is defined as a group of sounds that is harmful to people. Noise can be measured by determining the pressure created by the sound waves in the human ear. Noise is measured in dB(A), which is used as an international measure of the intensity of sound. The initial loudness level that humans can hear is 0 dB(A), termed the threshold of hearing; 140 dB(A) is the pain threshold, at which the human ear cannot bear additional sound intensity (Oktav, 1996). Individuals may experience noisy environments at different periods of life, but industrial workers are the social group most affected by exposure to noise.

The economic activities of institutions are realized within an economic, social and technological environment shaped by the institutions themselves (Barlı, 1998; Erkan, 1989; Ilıcak, 1998). Noise created by machinery and equipment used in industrial institutions may present significant problems for employees and those in the surrounding area. As part of the working environment, noise affects the hearing of employees and may also have physiological and psychological implications (Şahin, 2003). Workers with physical and mental disorders could not be expected to perform and to be effective at the levels in the workplace (Ataş et al., 1995). Table 1 shows the noise measurements in various paper and cardboard production environments. Table 1 shows that the noise levels of machinery used in the paper making sector is 94 dB(A) for paper guillotine, 95 dB(A) in box gluing machine and 100.5 dB(A) in a paper, rotary press factory.

In comparison, the noise levels in administrative department and offices range between 40 and 60 dB(A); chatting in low voice, quiet office 40 to 50 dB(A); talking voice, typewriter 50 to 60 dB(A); vacuum cleaner 55 to 65 dB(A); noisy office 60 to 65 dB(A); telephone ring, classical music 65 to 70 dB(A) (Demirkale, 2007).

Table 2 shows how different noise levels affect humans. While a noise level of more than 66 dB(A) disturb humans and a level of more than 86 dB(A) has health impacts and causes vocational disorders.

Many studies have attempted to determine worldwide noise level, compare it with legal limits and to develop proposals for reducing the negative effects of noise on human health (Brown and Lam, 1987; Barrigon et al., 2002; Li and Tao, 2004; Öhrström et al., 2006). The International Labor Organization (ILO) accepted an upper noise limit of 85 dB(A) in production companies.

**Table 1.** Noise measurements of papermaking institutions (Ülgen et al., 2002; Anonymous, 2004).

| Machine and equipment/Environment | Sound pressure value of noise source (dB(A)) |
|---|---|
| High speed 4 to 5 units sheet offset press | 102 |
| Grinding-folding machine | 95 |
| Paper guillotine | 94 |
| Boiler box cutting machine | 105 |
| Head replacement machine | 97 |
| Web offset press | 94 |
| Box gluing machine | 95 |
| Cigarette factory | 101 |
| Paper, Rotary press factory | 100.5 |

**Table 2.** The effects of noise levels on human health (Polat and Kırıkkaya, 2004).

| Noise interval (dB(A)) | Its effect on human health |
|---|---|
| 0 - 35 | Harmless noise. |
| 36 - 65 | Disturbing noise disrupting sleep and resting |
| 66 - 85 | Disturbing noise causing mental and hearing disorders |
| 86 - 115 | Noise causing mental, physical and psychosomatic disorders |
| 116 - 130 | Dangerous noise causing deafness or similar disorders |
| 131 - 150 | Hazardous noise requiring protective apparatus. |

**Figure 1.** DELTAOHM HD 2010 noise meter.

Necessary measurements should be taken in order to reduce the effects of noise on laborers working in environments in which noise levels exceed this limit.

The present study examines noise levels in a corrugated board production plant. The results demonstrated the noise conditions within the corrugated board production sector in comparison with previous studies in the cardboard and paper sector.

## MATERIALS AND METHODS

This study was conducted at a corrugated board plant located in the East Anatolian region of Turkey. Corrugated board is a durable and cheap packaging material produced by gluing together one or more layers of corrugated paper and liner board.

Measurements were conducted throughout the production line, beginning from raw material department, to control rooms, product storage, facility room and administration offices, covering all of the environments in which employees work (Table 3).

A Delta-Ohm HD 2010 (URL1, 2011) noise meter was used for noise measurements (Figure 1). The noise meter was placed on a tripod at a 45° angle and was programmed to measure noise at 5 s intervals. Measurements were made for 3 min in each department. In order to prevent any kind of reflection of sound, the noise meter was placed at 1.5 m above ground and away from walls; and 1 m away from the person conducting measurement. In addition, measurements were made within the operational temperature range of the device (Muluk et al., 1995; Serin and Tutuş, 2008). A total of 390 noise level measurements were made in 13 departments of the organization. The noise level data were evaluated using the SPSS statistics program. Descriptive statistics, simple variance analysis and Duncan test were applied.

**Table 3.** Descriptive statistics (dB(A)).

| Plant section | N | Change | Minimum | Maximum | Mean | Std. deviation |
|---|---|---|---|---|---|---|
| B Wave corrugating | 30 | 05.20 | 92.10 | 97.30 | 94.89 | 1.65 |
| C Wave corrugating | 30 | 05.30 | 87.10 | 92.40 | 90.51 | 1.55 |
| Administrative Building | 30 | 16.40 | 60.60 | 77.00 | 66.85 | 3.56 |
| Boiler | 30 | 03.80 | 84.00 | 87.80 | 85.48 | 1.01 |
| Inline printing | 30 | 13.10 | 83.10 | 96.20 | 91.35 | 3.59 |
| Rotary cutting | 30 | 04.80 | 84.80 | 89.60 | 86.43 | 1.35 |
| Ear gluing | 30 | 03.80 | 80.70 | 84.50 | 83.05 | 1.30 |
| Stock of finished products | 30 | 06.80 | 68.50 | 75.30 | 70.66 | 1.54 |
| Stoter print | 30 | 15.20 | 79.50 | 94.70 | 87.80 | 5.16 |
| Dryers | 30 | 05.20 | 90.20 | 95.40 | 92.60 | 1.48 |
| Scissors and Riley | 30 | 03.80 | 91.50 | 95.30 | 93.35 | 1.13 |
| Finished goods storage area | 30 | 06.60 | 82.80 | 89.40 | 85.89 | 2.13 |
| Semi-finished storage area | 30 | 07.40 | 73.30 | 80.70 | 76.19 | 2.08 |
| Average | 30 | 07.49 | 81.40 | 88.89 | 85.01 | 2.12 |

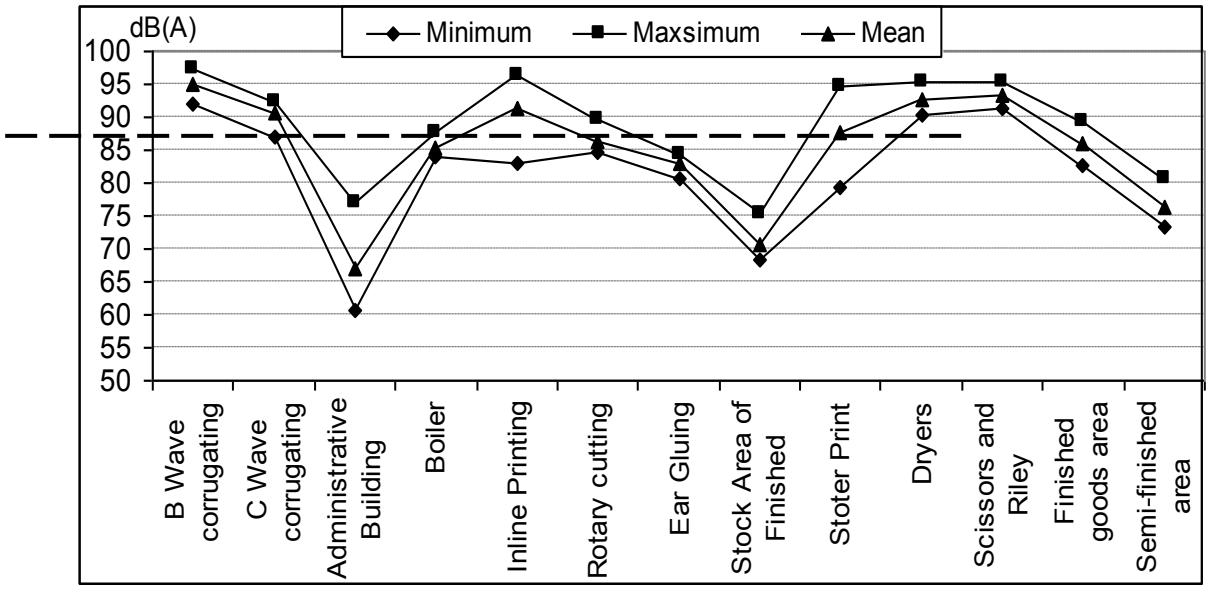


**Figure 2.** Corrugated board plant noise level.

## FINDINGS

Noise measurements at 13 locations within a cardboard production plant were evaluated using SPSS and the results are as shown in Table 3 and Figure 2. When the change interval was examined in the data obtained from the measurements, it was found out that change interval in the administrative building is greater than that in the management building (Table 3). The source of noise from machines in Management Departments, always perform the same function and operate in the same rotation, which results in the low change interval. In contrast, the operation of the sources of noise (talking, telephone, typewriter, etc) within the Administrative Department varies over time, which results in a high change interval. Table 3 and Figure 2 show that average noise level in the corrugated board plant was 85.01 ± 2.12 dB(A). This 85 decibel level is within the noise limit for workplaces accepted by the International Labor Organization (ILO). The maximum noise level was recorded in the B wave corrugating department as 97.30 dB(A), and the minimum level in administrative department as 60.60 dB(A). When average noise level was examined according to departments, the B wave corrugating department (94.82 ± 1.65 dB(A)), scissors and Riley department (93.35 ± 1.13 dB(A)) and drying department (92.60 ± 1.48 dB(A)) showed the highest noise levels. However, these noise levels were relatively low as compared to those recorded

**Table 4.** Duncan's test.

| Duncan(a) | | Subset for alpha = 0.05 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Factor** | **N** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| Administrative building | 30 | 66.8567 | | | | | | | | |
| Stock of finished products | 30 | | 70.6567 | | | | | | | |
| Semi-finished course | 30 | | | 76.1933 | | | | | | |
| Ear adhesion | 30 | | | | 83.0467 | | | | | |
| Boiler | 30 | | | | | 85.4833 | | | | |
| Product area | 30 | | | | | 85.8900 | | | | |
| Rotary cutting | 30 | | | | | 86.4367 | | | | |
| Stoter printing | 30 | | | | | | 87.7967 | | | |
| C Wave corrugating | 30 | | | | | | | 90.5100 | | |
| Inline printing | 30 | | | | | | | 91.3533 | | |
| Dryers | 30 | | | | | | | | 92.5967 | |
| Scissors and Riley | 30 | | | | | | | | 93.3500 | |
| B Wave corrugating | 30 | | | | | | | | | 94.8967 |

Means for groups in homogeneous subsets are displayed. [a]Uses harmonic mean sample size = 30.000.

in various industrial institutions, as shown in Table 1. The departments with the lowest noise levels are the administrative departments (66.85 ± 3.56 dB(A)), finished product storage (70.66 ± 1.54 dB(A)) and storage of semi-finished products (76.19 ± 2.08 dB(A)).

Significant differences (P = 0.00 < 0.05) were found between departments when compared using analysis of variance (ANOVA) at 95% reliability level. Comparison of the noise levels within the 13 departments according to Duncan (a) test showed 9 groups (Table 4). The Administrative Department had the lowest noise level and the B wave Corrugating Department had the highest level. While the Boiler, Product Area and Cutting Rotary Departments were in the same group; C wave Corrugating, 7th section of Inline Printing, Dryers, Scissors and Riley Departments were in another group.

## CONCLUSION AND SUGGESTIONS

Excessive noise is a form of environmental pollution, which negatively affects the perception and hearing health, disturbs the physiological and psychological balance, reduces working performance and changes the quality of the environment by destroying its space and serenity.

Average noise level within the study organization was 85.01 ± 2.12 dB(A). This level was less than the upper limit (85 dB(A)) set by the ILO and was achieved by nearly 50% of the institution. The working environment within the corrugated board factory studies was much less noisy than the vocational branches as shown in Table 1 (Ülgen et al., 2002; Anonymous, 2004). On the other hand, according to Polat and Kırıkkaya (2004), the production departments with more than 90 dB noise level (B Wave Corrugating, C Wave Corrugating, Scissors and Riley, Drying and Inline Printing) have the potential to cause mental, physical and psychosomatic disorders. According to Erkan (1988), working in a noisy environment negatively affects the attention and elaborated working habits of people and thus increases the risk of occupational accidents. Oktav (1996) state that loss of hearing is the most common form of occupational disease.

Noise levels in some departments (A and B wave corrugating) exceeded statutory levels because the machines and systems used were obsolete. This situation could be improved through timely maintenance and repair of these machines. Also, the machines most creating noise should be covered with sound-absorbing material. On the other hand, in order to prevent employees within these departments being affected by excessive noise levels, they should be given earplugs, earflaps or head-dress according to the noise level; appropriate working schedules should be developed for employees exposed to intensive noise, and they should be periodically examined; workers in departments at the noise limit should be supported with orientation programs and their places should be shifted occasionally. In addition, walls should be covered with materials that absorb noise or reduce its effects, and departments should be separated with noise abatement panels.

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