

THE STUDY ON THE EFFECT OF ULTRASONIC NOISE ON HUMAN  
BODY IN THE CASE OF ETUR TEXTILE FACTORY IN ADAMATOWN

BY: DERBE HAILE WEDEBO



A THESIS SUBMITTED TO THE DEPARTMENT OF PHYSICS

SCHOOL OF APPLIED NATURAL SCIENCE

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR  
THE DEGREE OF MASTER'S IN PHYSICS

OFFICE OF GRADUATE STUDIES

ADAMA SCIENCE AND TECHNOLOGY UNIVERSITY

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AUGUST, 2017

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ADVISOR: MESFIN ASFAW (Ph.D)



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## **Declaration**

I hereby declare that this MSc thesis my original work and has not been presented for a degree in any other university, and all sources of material used for this thesis have been duly acknowledged

Derbe Haile Wedebo

Signature\_\_\_\_\_

This MSc Thesis n has been submitted for examination with my approval as thesis advisor.

Mesfin Asfaw(Ph.D)

Signature\_\_\_\_\_

Date of submission

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## **Abstract**

*The study was carried out textile factory at Adama town Ethiopia. We studied ultrasonic noise problem and its effect on the workers. To achieve the goal of this study, noise levels were measured in working environment in five machines which are re-cycling, preparation, carding, knitting and finishing machines. We used sound level meter(model YF-20). The measurement of noise level showed that around the re-cycling, carding and knitting machine, noise level was above permissible limit (85dBA), on the other hand the measurement of noise level in the preparation and finishing machines was blow permissible limit. The measurement of noise level showed that as distance increased from the source of noise, the measurement noise levels have decreased, as we have seen in our measurement of noise level in each machine. The quantity of noise level has not showed a significant at different duration of hour (at different length of time) and at the morning, at the noon and at the night at the same distance (point) in each machine. We recommended them to use ear protection.*

# CHAPTER ONE

## INTRODUCTION

### 1.1. Background of the study

Resilience oscillation in the frequency range from 20 KHz whose propagation takes the form of acoustic waves in the gas, liquid and solid are called ultrasound. The broadband noise containing high audible (10-20 KHz) and low ultrasound frequency (20-40 KHz) is defined as ultrasonic noise [1, 2, 3, 4, 5, 6].the determination of admissible value of ultrasonic noise and recommends limiting noise exposure is different in different countries [1]. France determines admissible value as ultrasonic noise and recommends limiting noise in high audible frequency range (8-20 KHz) and the frequency ultrasonic range (20-50 KHz) [1]. In Poland, ultrasonic noise is assumed for practical reasons, as noise whose spectrum includes high audible and low ultrasonic frequencies range(i.e. 10-40KHz) [1].

Issues concerning occurrence and propagation of ultrasound in two ways; on one hand ultrasounds are produced for purpose. Example streamlines technology process or the useful information carrier in the medical diagnostics. On the other hand ultrasonic are emitted in the machines and devices in the work environment [1]. Ultrasonic Noise is used in many areas of life, especially in the hydro location, underwater telecommunication and industry [1]. Industry, ultrasounds are used in consumer source, such as burglar alarms, dog whistles, humidifiers and inhales. High ultrasound (over, 0.8MHz) used in medicine mainly in therapy and diagnostics [7].

First reports on the negative effect of ultrasonic noise on the human body were published in 1940s and 1950s. In this period, the obsolete term ultrasonic disease described symptoms associated with exposure to noise including low frequency ultrasonic mostly subjective symptoms of exposed workers [1]. Subjective symptoms of exposure to ultrasonic noise however according to Smith, Oxon and Von Gierke, signals, with frequencies over 21 KHz and level exceeding 70dB may cause negative symptoms among exposed workers as excessive fatigue, nausea, ear fullness and headache [1]. Currently, the effect of exposure to ultrasonic noise is classified as effect of hearing, thermal effect, subjective symptoms and functional disorder.

### **i. Effect of noise on hearing (auditory)**

Human hearing covers frequencies between 20 Hz and 20 kHz. With the ageing process, the range narrows in high frequencies. The results of environmental and laboratory studies in the 1960s showed that the temporary threshold shift (TTS) and the permanent threshold shift (PTS) of 0.25–10 kHz resulting from exposure to ultrasonic noise did not exceed 10–15 dB or was not detected at all if sound pressure level did not exceed ~120 dB [1]. However, ultrasonic noise of over 8 kHz may cause noise-induced hearing loss (NIHL).

### **ii. Thermal effect**

First reports, written in 1948, on the thermal effects of ultrasounds on the human body described burns on the hand skin between fingers from accidental exposure to a signal with a frequency of 20 kHz and level of 165 dB [8, 9]. Ultrasounds at level of 159 dB may cause moderate warming of the surface of the human body; according to computational simulations exposure to ultrasounds for ~50min at level of at least 180 dB may be fatal [1]. Par rack & per ret (1962) found that slight heating of the skin could occur when exposed to sound pressure levels of 140-150dB at ultrasonic frequencies. Parrack (1966) has also calculated theoretically that a dose to the skin of more than 180dB would be lethal to human [3]

### **iii. Subjective symptoms**

Many studies confirmed the appearance of subjective symptoms of exposure to noise emitted by ultrasonic devices like dizziness, balance disturbances, tinnitus and fatigue [1]. It is assumed that those symptoms result from the effect of noise on the vestibular system; however, further studies are necessary [1]. According to the results of studies in the 1960s and 1970s, “audible” components of the noise spectrum are, / above all/, responsible for subjective symptoms among workers exposed to noise emitted by ultrasonic devices [1, 2]. In the industrial environment, many workers have complained of subjective symptoms (nausea tinnitus headaches fatigue etc) when operating devices such as ultrasound cleaning tanks [9].

#### **iv. Functional disorders**

In the Workers using ultrasonic devices suffered from functional changes such as neurasthenia, cardiac neurosis, hypotension, heart rhythm disturbances and adrenergic system disturbances [1]. Studies showed that exposure to frequency of 21 kHz and level of 110 dB for 3 h daily for 10-15 days caused functional changes cardiovascular and central nervous systems [1].

Ultrasonic energy is used in wide variety of industrial processes, including cleaning; drilling, mixing and emulsification, most of these processes invariably emit airborne acoustic energy, not only at the ultrasonic operating frequency but also at sub-harmonics noise which, in many cases, are audible [9]. Many industrial applications use high ultrasonic intensities which produce cavitations, observed as a type of boiling action in the liquid, which produce high audible level [9].

In the industrial environment, many workers have complained of subjective symptoms (nausea, tinnitus, headaches, fatigue etc), when operating devices such as ultrasound cleaning tanks. Some data indicate hearing loss from exposure to very high intensities or airborne ultrasound [9]. Noise is one of the physical environmental factors affecting our health in today's world. Noise is generally defined as the unpleasant sounds which disturb the human being physically and physiologically and cause environmental pollution by destroying environmental properties [11]. The general effect of industrial noise on the health of workers has been a topic of debate among scientists for a number of years.

Continuous hearing loss differs from person to person with the level, frequency and duration of the noise exposed [11]. Negative effects of noise on human beings are generally of a physiological and psychological nature. Hearing losses are the most common effects among the physiological ones. It is possible to classify the effects of noise on ears in three groups: acoustic trauma, temporary hearing losses and permanent hearing loss [10, 11].

The blood pressure may be considered among the other physiological effects. The psychological effects of noise are more common compared to the physiological ones and they can be seen in the forms of annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception [11]. The noise level generated depends mainly on the type of the noise source

such as the kinds of machines, distance from the source to the employee or receiver and the nature of the working environment.

High noise exposure in industries not only affects the communication among the workers, but also leads to the other psychological and physiological effects on the workers. Due to industrial technological progress there appear more and more of the ultrasonic noise source at the workplaces producing high frequency noise in the range of one third octave band of center frequencies 10, 12.5-40 KHz[12]. Harmful effects of loud noise on human health are known for many years. With industrialization, more people are exposed to noise [13]. At the recent past ten years the overall loudness of environmental noise is doubled, so that serious attention must be given to control this growing problem [3]. Hence scientists attempt to discuss and study occupational noise exposure in different fields and the effects of noise pollution on human's health.

Most of these researches have been concentrated with the effect of noise on the auditory system, such as temporary or permanent hearing loss [3], and it is now well established that exposure to noise levels of relatively high degrees can lead to direct hearing loss and / or hearing impairment [3]. However, more recent researches have concentrated on the relationship between noise and non-auditory impacts [3]. Social survey data has shown that annoyance, speech interference, sleep disturbance or insomnia and cardiovascular problems are considered to be the most important noise effect.

This research focused to know the awareness of the workers who know the effect of noise in ETUR textile factory at Adama town. Moreover to measure the noise level and compared measurement value with permissible limit (85dB), this research is important in the textile industry where many people are employed that comprises an important part of economy.

### **Statement of the problem of the study**

The main question that thesis was rose including the following

- How was the awareness of society on the effect of ultrasonic noise on human body?

- What was the effect of ultrasonic noise on ETUR textile factory workers and in environment?
- How did we measure the intensity of ultrasonic noise at workstation in environment?
- Which sources were the main causes for ultrasonic noise?

## **1.2. Objective**

### **General objective**

- To study the effect of ultrasonic noise on human body the case of ETUR textile factory

### **Specific objectives**

- To identify the awareness of the workers that ETUR textile factory workers have on effect of ultrasonic noise.
- To measure the intensity of ultrasonic noise this came from ETUR textile factory during working hours.
- To identify the source of ultrasonic noise which the main cause in ETUR textile factory.
- To create awareness on the effect of ultrasonic noise in textile factory workers.

### **Significant of the study**

This thesis was expected to have some advantage such as

- It gives information about effect of ultrasonic noise in textile factory workers for next generation and workers
- Disseminate information about effect of ultrasonic noise from textile factory
- It becomes reference for other research.

## CHAPTER TWO

### Literature Review

Noise is defined as excessive or unwanted sound which potentially results in annoyance and/or hearing loss and it can be from occupational and/or non-occupational source. In other words, noise is a sound sources disturbance as well as a nuisance which results in health problems and adverse social consequences [14]. The problem of noise can be combated when there are means of measuring noise levels and a system of classification decibel is dimensionless number which relates sound intensity or sound pressure levels to some reference point.

Most people use the term of decibel or discuss noise level in decibels, they referring to decibels related to the A-weight scale dBA. A-Weight scale parallels the sensitivity of human ear and uses the lowest audible sound that the human ear and detect as the reference point for determining the decibel level of noise.

Any noise rating above 80dB produce physiological effect and a long exposure at 90-100dB produce permanent damage to a person's hearing [4]. Ultrasound and ultrasonic noise are high frequency range of noise. Some data indicate the effect of ultrasonic noise on human body as follows:

In their environment studies, Grzesik and Pluta observed noise induced hearing loss at 13-17 KHz in workers exposed to ultrasonic noise over several years of work with washers and welding machine at level exceeding 80dB [1] they also reported that high-frequency hearing loss would aggravate at a rate of 1 dB per year of work in workers exposed to noise emitted by those machines. There are several reports on studies on hearing perception of sounds with frequencies over 20 kHz. According to Henry and Fast, most listeners in their study registered sounds with sound pressure Level of 124 dB and a frequency of 24 kHz [1] ..Results of environmental studies on 20 workers working with ultrasonic sources showed that, after a day of work, body temperature of 40% of workers increased by 0.5 °C and in some cases even by 1–2 °C [1].

According to the results of studies in the 1960s and 1970s, “audible” components of the noise according to Smith, Nixon and von Gierke, signals with frequencies over ~17kHz and level exceeding 70dB may cause negative symptoms among exposed workers success has excessive

fatigue, nausea, ear fullness and headache [1, 3]. Holmberg, Landstrom and Nordstrom exposed 10 workers for 2 min to noise of an ultrasonic washer, and then the workers assessed discomfort and irritation. They concluded that noise emitted by ultrasonic washers with level over 75 dB (A) caused annoyance and discomfort [1].

Workers exposed to noise emitted by ultrasound sources suffered from increased neural excitability irritation, memory problems and difficulties with concentration and learning [1]. Rosh chin and Dobroserdov indicated that levels of 90–110 dB within the range of lower frequencies (21 kHz) and 110–115 dB within the range of higher frequencies (40 kHz) constituted the limit of occurrence of functional changes [1]. As the population grows, there is increasing exposure to noise pollution, which has profound public health implications. Noise pollution creates a need for action at the local level, as well as for improved legislation and management. Urban noise pollution produces direct and cumulative adverse health effects by degrading residential, social, working, and learning environments with corresponding real(economic) and intangible (well-being) losses.

The World Health Organization has documented seven categories of adverse health effects of noise pollution on humans [15].

1. **Hearing Impairment:** Hearing damage is related to duration and intensity of noise exposure and occurs at levels of 80 dB or greater, which is equivalent to the noise of heavy truck traffic. Children seem to be more vulnerable than adults.
2. **Interference with Spoken Communication:** Noise pollution interferes with the ability to comprehend normal speech and may lead to a number of personal disabilities, handicaps, and behavioral changes. These include problems with concentration, fatigue, uncertainty, lack of self confidence, irritation, misunderstandings, decreased working capacity, disturbed interpersonal relationships, and stress reactions.
3. **Sleep Disturbances:** Uninterrupted sleep is known to be a prerequisite for good physiological and mental functioning in healthy persons. Noise pollution is a major cause of sleep disturbances. Apart from various effects on sleep itself, noise pollution during sleep causes increased blood pressure, increased heart rate, increased pulse amplitude, vasoconstriction,

cardiac arrhythmias, and increased body movement. These effects do not decrease over time. Secondary effects include fatigue, depressed mood and well-being, and decreased performance. Combinations of noise and vibration have a significant detrimental effect on health, even at low sound pressure levels.

4. Cardiovascular Disturbances: A growing body of evidence suggests that noise pollution may be a risk factor for cardiovascular disease. Acute exposure to noise activates nervous and hormonal responses, leading to increased blood pressure and heart rate and to vasoconstriction. If the exposure is of sufficient intensity, there is an increase in heart rate and peripheral resistance; an increase in blood pressure, and increased levels of stress hormones (epinephrine, nor epinephrine, and cortisol [15].
5. Disturbances in Mental Health: Noise pollution is not believed to be a cause of mental illness, but it is assumed to accelerate and intensify the development of latent mental disorders. Noise pollution may cause or contribute to the following adverse effects: anxiety, stress, nervousness, nausea, headache, emotional instability, argumentativeness, and sexual impotence, changes in mood, increase in social conflicts, neurosis, hysteria, and psychosis. Children, the elderly, and those with underlying depression are particularly susceptible to these effects.
6. Impaired Task Performance: The effects of noise pollution on task performance have been well-studied. Noise pollution impairs task performance, increases errors, and decreases motivation. Reading attention, problem solving, and memory are most strongly affected by noise. Noise produces negative after-effects on performance, particularly in children; it appears that the longer the exposure, the greater the damage [15].
7. Negative Social Behavior and Annoyance Reactions: Annoyance is defined as feeling of displeasure associated with any agent or condition believed by an individual to adversely affect him or her. Annoyance increases significantly when noise is accompanied by vibration or by low frequency components. The term annoyance does not begin to cover the wide range of negative reactions associated with noise pollution; these include anger, disappointment, dissatisfaction, withdrawal, helplessness, depression, anxiety, distraction, agitation, or exhaustion. Social and behavioral effects are complex, subtle, and indirect.

These effects include changes in everyday behavior (closing windows and doors to eliminate outside noises), changes in social behavior (aggressiveness or disengagement), and changes in social indicators (residential mobility, hospital admissions, drug consumption, and accident rates), and changes in mood (increased reports of depression). Noise above 80 dB is consistently associated with decreased helping behavior and increased aggressiveness. Effects of Multiple Sources of Noise Pollution: Most environments contain a combination of sounds from more than one source (e.g., trains, boom-box cars, car horns and alarms, and heavy trucks). Adverse health effects are related to total noise exposure from all sources [15].

In residential populations, combined sources of noise pollution will lead to a combination of adverse effects, such as sleep disturbances; cardiovascular disturbances; interference at work, school, and home; and annoyance; among others. Groups vulnerable to the effects of noise pollution: Although everyone may be adversely affected by noise pollution, groups that are particularly vulnerable include infants, children, those with mental or physical illnesses, and the elderly. Because children are particularly vulnerable to noise induced abnormalities, they need special protection. The adverse health effects of noise pollution are numerous, pervasive, persistent, and medically and socially significant. These adverse effects represent a significant public health problem that can lead to social handicaps, reduced productivity, impaired learning, absenteeism, increased drug use, and accidents. The aim of enlightened governmental controls should be to protect the population from these adverse effects of noise [15].

The threshold limit value has been set and allowed by the International Standards Organization (ISO), and other developed countries. NIOSH estimates that there is an excess risk of 8% for a 25 dB average hearing loss at 1, 2, 3 and 4 kHz at an occupational LA2000hn of 85 dBA and 25% excess risk at a level of 90 dBA recommended by National Institute for Occupational Safety and Health (1998). The World Health Organization reported that 16% of disabling hearing loss in adults is attributable to occupational noise exposure [16]. The association between noise and noise-induced hearing loss (NIHL) has been known since the 18th century. Noise induced hearing loss remains among the 10 leading occupational diseases [16]. Low frequency noise is common as background noise in urban environments and as emission from many artificial sources [16]. Most national and international occupational and environmental health agencies use [16]. Workers are at risk of hearing loss if they are exposed, without hearing protection, to more

than 85 decibels averaged over an eight-hour day [16]. Occupational hearing loss resulting from exposure to high noise level depends not only on exposure time but also on the frequency, intensity and type of noise (continuous or impact) [16].

### 2.1. Spherical and plane waves

The wave move outward from source at the constant speed because all points on the vibrating sphere behave in the someway. We conclude that the energy in the spherical have propagates equally in all directions. If average power emitted by source, then at any distance r from source, the power must be distributed over a spherical surfaces of area  $4\pi r^2$  assuming no observation in the medium. The average of power distributed over a spherical surfaces of area is called intensity of sound and its equation is

$$I = \frac{P}{A} \text{----- eq. (1) [19]}$$

#### Intensity level in decibels

The loudest tolerable sounds have intensity about  $1 \times 10^{-12}$  times greater than the faintest detectable sound. The most intense sound, however is not perceived as being  $10^{12}$  times louder than the faintest sound because the sensation of loudness is approximately logarithmic in human ear. The relative intensity of a sound is called the intensity level or decibel level [17].

The equation of the intensity level is

$$B = 10 \log \frac{I}{I_0} \text{----- eq(2)}$$

Where  $I_0 = 1 \times 10^{-12} \frac{w}{m^2}$  -is the reference.

## 2.2. Physical properties of noise

Noise is one of the physical environmental factors affecting our health in today's world. Noise is generally defined as the unpleasant sounds which disturb the human being physically and physiologically and cause environmental pollution by destroying environmental properties [9]. The general effect of noise on the hearing of workers has been a topic of debate among scientists for a number of years [6, 19]. Regulations limiting noise exposure of industrial workers have been instituted in many places. For example, in the U.S., the Occupational Noise Exposure Regulation states that industrial employers must limit noise exposure of their employees to 90 dBA for one 8-h period [11]. This permitted maximum noise exposure dose is similar to the Turkey Standard, which is less than 75 dBA for one 7.5 h period [11]. Exposure to continuous and extensive noise at a level higher than 85 dBA may lead to hearing loss. Continuous hearing loss differs from person to person with the level, frequency and duration of the noise exposed [11].

Negative effects of noise on human beings are generally of a physiological and psychological nature. Hearing losses are the most common effects among the physiological ones. It is possible to classify the effects of noise on ears in three groups: acoustic trauma, temporary hearing losses and permanent hearing loss [11]. Blood pressure increases, heart beat accelerations, appearance of muscle reflexes, sleeping disorders may be considered among the other physiological effects. The psychological effects of noise are more common compared to the physiological ones and they can be seen in the forms of annoyance, stress, anger and concentration disorders as well as difficulties in resting and perception [11].

A great majority of people working in industry are exposed to noise [11]. Air born sound refers to rapid pressure variation. One complete vibration of the object results in complete cycle of pressure variation. The number of cycles per second is measured in unit used Hertz. The variation in atmospheric pressure propagates as waves which measured in dynes per square centimeter. The range to which human ear response is between 0.0002 to 200 dynes/ cm<sup>2</sup>, or A logarithmic scale is used to define sound pressure level the unit which is used is the decibel, which is equal to 20 times the logarithm to the base 10 of the ratio of the root means square sound pressure to the threshold of audibility for 1000 Hz pure tone. The equation of sound pressure level (S.P.L) is

$$S.P.L=dBA=20\log\frac{pa}{p0}-----eq. (3)$$

where pa: root mean square pressure of sound. P0: threshold of audibility =0.0002dynes/cm<sup>2</sup>. [14]. Sound is disturbance that propagates through an elastic medium (air, water, etc...) at speed characteristic of that medium. When sound source (in air) vibrates it causes air to oscillate producing extremely small change in the pressure [15.].

### 2.3. Sound Pressures

Sound wave produces change in the density of the medium, e.g. As they travel through air change in air density causes pressure fluctuation around the ambient static pressure. The disturbances created in air pressure cannot easily be expressed mathematically in time and space. From this result the fact that disturbances over an extended portion are compressing surrounding air while for other portion they are causing rarefaction. This result in phase in both time and space differences in pressure. The wave is defined as any disturbances from an equilibrium condition that travels or propagates from one point to another. The fundamental aspect of work, energy and motion is that to provide a machine for the transfer of energy and momentum from one point to another without transportation of matter between the points [14].use the decibel scale to express the ratio between any two sound pressures. Sound pressure is usually proportional to the square root of the sound power. The sound pressure can be expressed as a sound –pressure level with respect to a reference sound pressure. Reference a sound pressure is generally 20µpa.

### 2.4. Quantification of Noise

When approaching noise measurement the various feature of noise that is likely to be considered these include:

1. Type of noise: it is of continuous constant level, continuous but fluctuating or is it intermittent.
2. The frequency content of noise it is in broad band or it is of a prominent frequency.

3. The time of day it occurs. The acoustical environment in a room depends greatly upon the size, shape, and the other properties of the confining walls, floor, and ceiling which act as reflecting surface. The sound wave from a source will travel through the atmosphere from the source to the listener. The sound wave arrives at the time  $t=R/C$ . Where R is the distance in (m) between the source and the receiver and the C is the speed of the sound m/s etc.

A reflected sound wave is weaker than the direct sound wave for the following reasons

1. It might travel further than the direct sound and hence sound intensity decreases within distance.
2. Some sound energy will be lost in the process of turning the sound wave around (absorption) urban noise levels are combination of background noises from transportation, industries

## **2.5. The human response to noise**

The problem of response to noise is complex and individual judgment with respect to loudness or noisiness tends to vary over a relatively wide range ,so in recent years the A\_ weighted sound level has become a widely used major of the effect of noise on man, both psychological and physiological, and a reasonably good indicator of noisiness or loudness provide that the frequency spectrum of noise covers several octaves when a single frequency or octave band dominate the spectrum, the A weighted level tend to over estimates the loudness or the noisiness of a particular sound [14]. the disturbance that is evoked by noise depend on various components including nature of noise itself and the situation that suffers are looking for. The most important factors are intensity of sound, noise level, the duration of the separate sound impulses, the frequency of sound impulse and the subjective reaction to noise to individual [14].

# CHAPTER THREE

## Method of study

The main objective of this research was to study the effect ultrasonic noises (noise) on human body. To achieve this study, ETUR textile factory in Adama town has been selected randomly. The data was gathered for this study from the Textile factory in two ways.

### 3.1. Interview

For some workers, Administer and supervisor of ETUR textile factory were provided some oral questions about their awareness in the effect of noise on the textile factory workers and information have been gathered from them about the effect of noise on the workers including the section, number of workers, number of working hours, the hazards or the risk that the workers are exposed to and whether they are using factor means's.

### 3.2. Measurement

To measure the noise of the textile factory, a location workplace has been chosen which it placed at three arbitrary points and a distance of 1m, 1.5m and 3m from operator machine or noise source of machine and measured by repeating three times per day for three days in a week and to measure the distance a meter stick was used.

The measurement was taken three times per day for three days in a week such as; in the morning, in the afternoon and in the night and for a duration hour of 1hour, 2hours and 3hours on the time of working.. The instrument used to measure noise level is sound level meter (Model YF-20). It is analog display with quick and accurate measurement. It is easy for operation by one hand.

Before using the instrument it has been calibrated by install battery and microphone. Install microphone and battery by connected one 9vol battery (type 216, 006p622 or similar) connected the battery to matching snap connector and fit the battery to the battery compartment so that the bottom of the battery is below the 'CAL ADJ' marking and the battery wires are concealed behind the battery. Rotate the control knob to 'BATT' position to test the battery do not leave the control knob in the battery position as this could quickly flatten the battery. The measurements

were taken in re-cycling machinery, Fiber preparation, carding and spinning, circular knitting machine and finishing machine



Figure (3.1): Sound level meter

### 3.3 Study area

This study was conducted at ETUR textile factory. This factory found in Ethiopia, oroma region, and east shew zone Adama town. The Factory started in 2010 and continued till 2017. The number of workers of this factory is 750.

The factory building: factory buildings include the followings; administration, car shelter, guards room, dining room, cotton store, pumping room, workers changed room. .Factory has five sections which are re-cycling machine, preparation machine, carding machine, knitting machine and finishing machine.



Figure(3.2): ETUR textile factory

# CHAPTER FOUR

## Results and Discussion

### 4.1 Results

Data was gathered by two methods, interview and measurement.

#### A. Interview

Some workers and supervisors responded oral questions provided in the form of interview as the following.

Some workers exposed to the effect of noise of factory such as hearing ability loss, hearing induced loss, headache, ringing in ear has shown after employment. Most workers did not use the ear protection due to the fact that the factory did not provide ear protection and there was not awareness on use of ear protection.

#### B. Measurement at arbitrary points and at the distances

The equipment which was used in the noise measurement in dBA is the sound level meter. Noise level measurement at arbitrary points in each machine: the measurements of noise level were taken in each machine at three arbitrary points, three times per day for three days in a week and then the data of measurements were presented in tables (4.1.1-4.1.6) from re-cycling, fiber preparation, carding, circular knitting and finishing in dBA arbitrary points.

Table (4.1.1): Shows noise level measurements in re-cycling machine at arbitrary points. The measurements were taken from three points every day and then the mean value was calculated for every day. In the first day the reading was varying from 95-92dBA, in second day was from 95-93dBA and third day was from 95dBA - 93dBA.

Frequency	Re-cycling1	Re-cycling2	Re-cycling3	Mean
Day1	95	94	92	93.7
Day2	95	93	94	94
Day3	94	95	93	94

Table (4.1.1): Noise level measurement in dBA in re-cycling machine at arbitrary points

Figure (4.1.3): shows the measurement of noise level in re-cycling machine at arbitrary points.

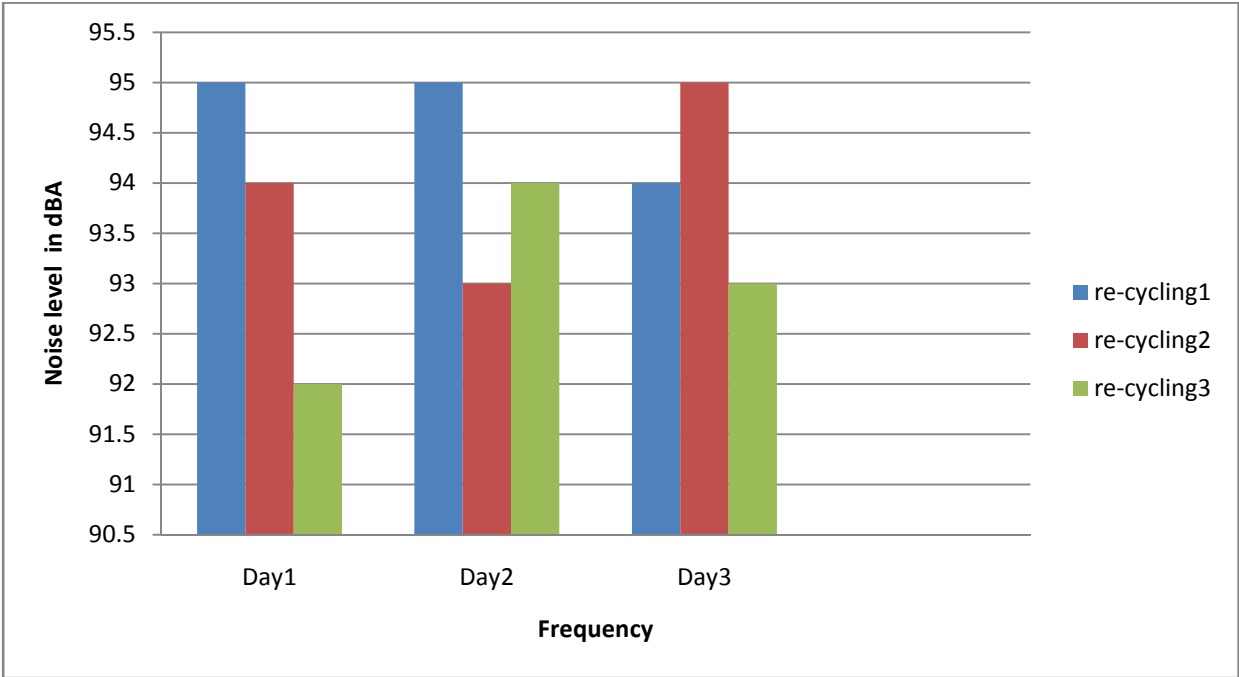


Figure (4.1.3): measurements of noise level in dBA in re-cycling machine at arbitrary points.

Table (4.1.2): clarifies the noise levels measurement in the fiber preparation. The measurements of noise level were taken from three points for every day and then the mean value was calculated. In first day the measurements were 75-72dBA, in second day the measurements were 75dBA and 72dBA and in the third day the measurement was 75-73dBA.

Frequency	Preparation1	Preparation2	Preparation3	Mean
Day1	75	73	72	73.3
Day2	75	72	72	73
Day3	73	75	74	74

Table (4.1.2): Measurement of noise level in dBA in preparation machine at arbitrary points.

Figure (4.1.4): shows the measurement of noise level in dBA in preparation machine at arbitrary points.

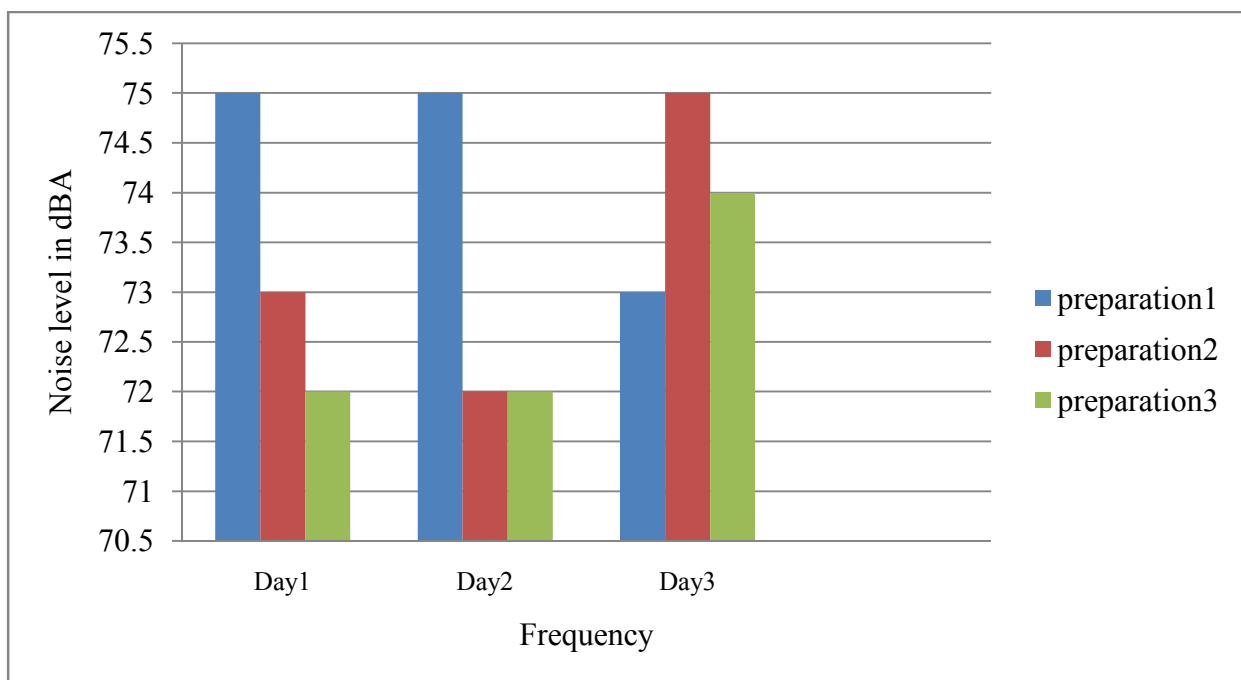


Figure (4.1.4): Noise level measurement in fiber preparation machine at arbitrary points.

Table (4.1.3): shows the noise levels measurement in carding machine in dBA. The measurements were taken from three points every day and then the mean value was calculated. In the first day the reading was 87dBA and 86dBA, in the second day was 88-85dBA m and in the third day was 87dBA and 90dBA

Frequency	Carding1	Carding2	Carding3	mean
Day1	87	86	86	86.3
Day2	88	86	85	86.3
Day3	90	90	87	89

Table (4.1.3): Measurement of noise level in dBA in carding machine.

Figure (4.1.5): shows the measurement of noise level in dBA in carding machine at arbitrary points.

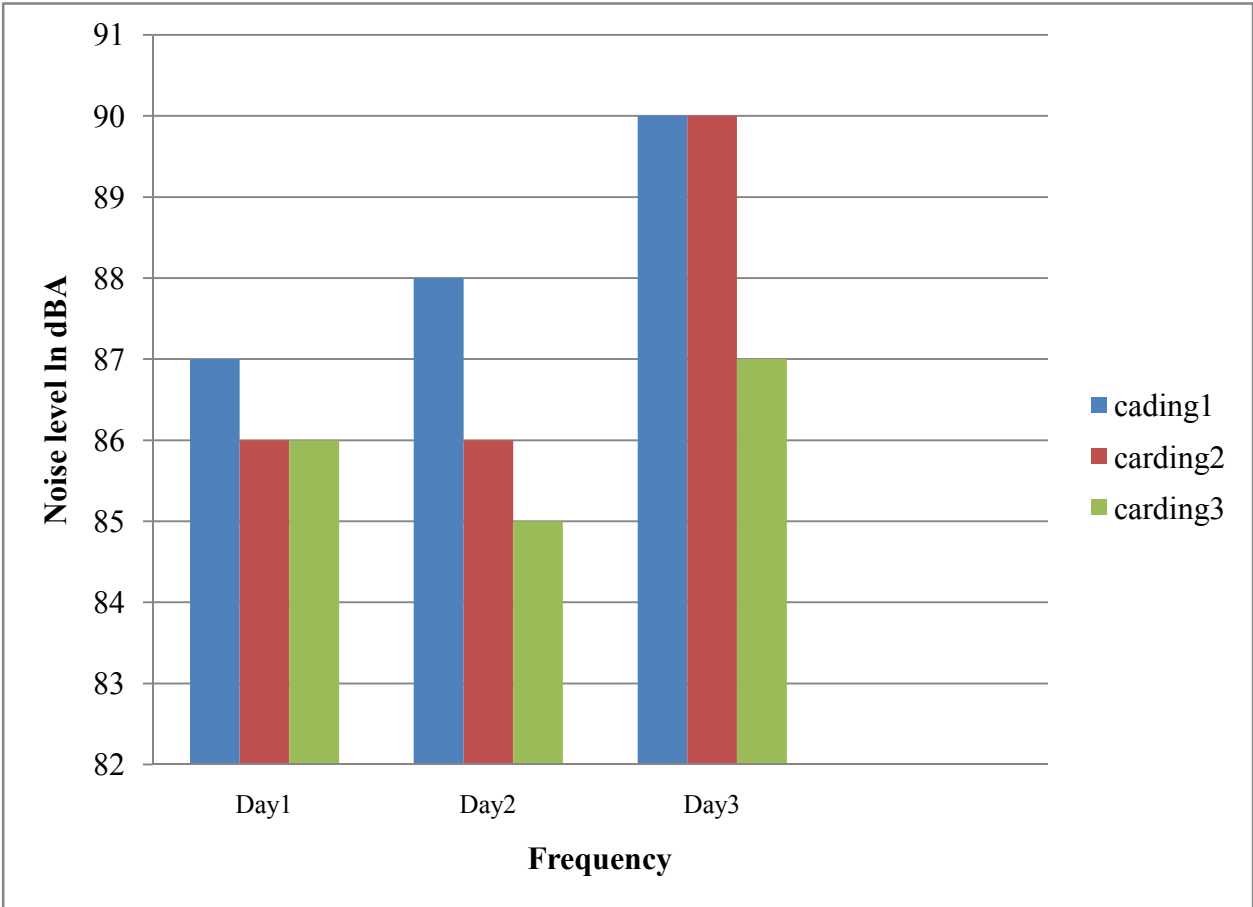


Figure (4.1.5): Measurements of noise level in dBA in carding machine at arbitrary points.

Table (4.1.4): indicate the noise level measurement in circular knitting machine. The measurements were taken from three points every day and then the mean value was calculated. In the first day the reading was 90-86dBA, in the second day was 91-88dBA and in the third 92-89dBA.

Frequency	Knitting1	Knitting2	Knitting3	Mean
Day1	89	90	91	90
Day2	90	91	88	89.7
Day3	92	89	90	90.3

Table (4.1.4): Measurements of noise level in dBA in knitting machine at arbitrary points.

Figure (4.1.6): shows the measurement of noise level in dBA in knitting machine at arbitrary points.

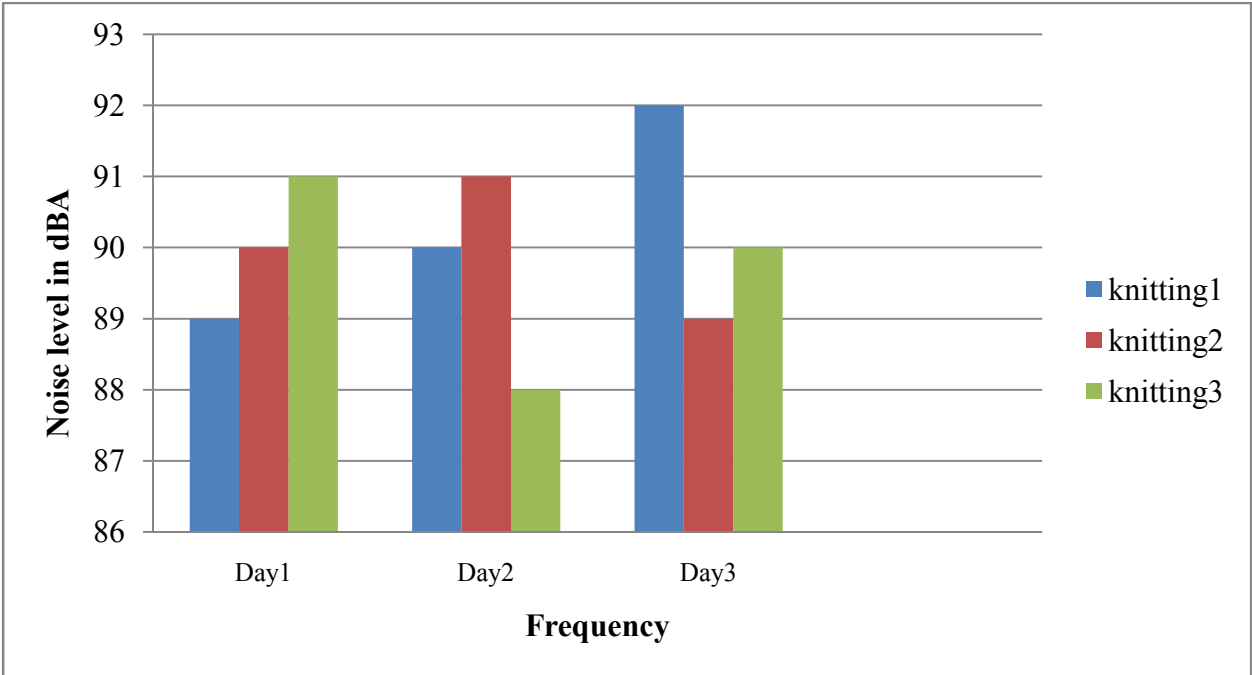


Figure (4.1.6): Measurements of noise level in dBA in knitting machine at arbitrary points.

Table (4.1.5): shows the noise level measurement in finishing machine. The measurement was taken from three points every day and then the mean value was calculated. In the first day there Reading was 83-81dBA, in the second day was 84-81dBA and the third day was 83dBA.m

Frequency	Finishig1	Finishing2	Finishing3	Mean
Day1	82	81	83	82
Day2	82	81	84	82.3
Day3	83	83	83	83

Table (4.1.5): Measurement of noise level in finishing machine.

Figure (4.1.7): shows the measurement of noise level in dBA in finishing machine.

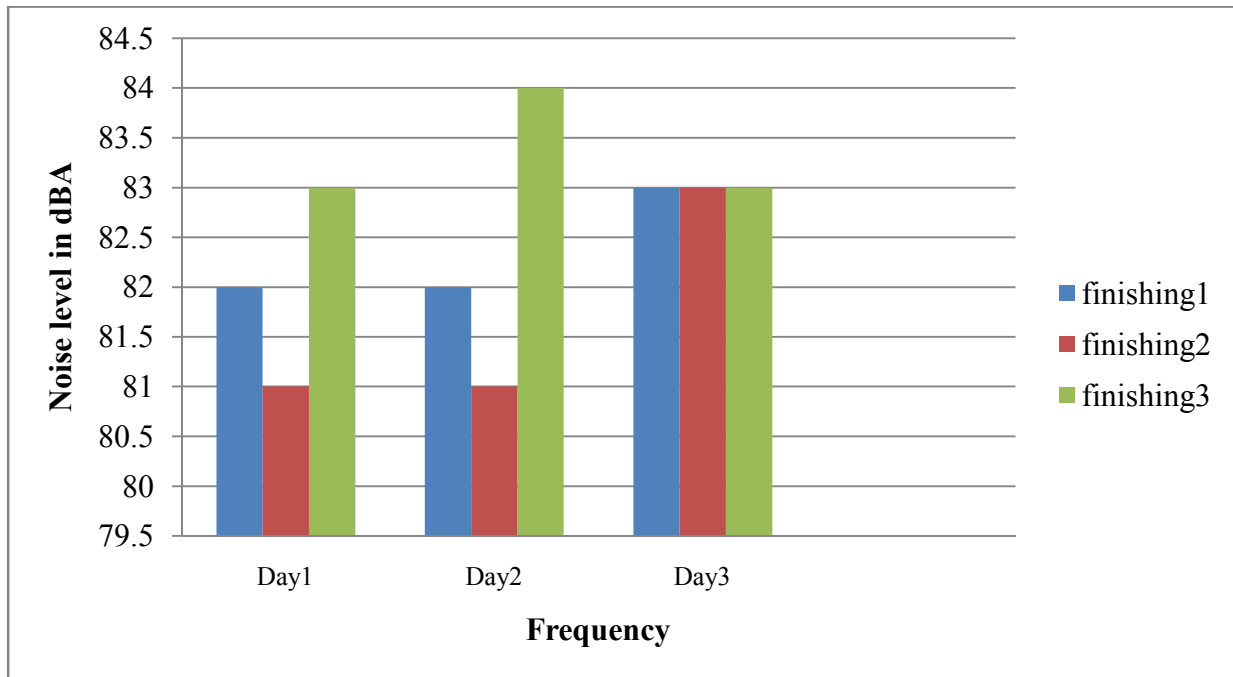


Figure (4.1.7): Noise level measurements in dBA within finishing machine at arbitrary poin

Table (4.1.6): illustrates the noise levels measurement among re-cycling, fiber preparation, Carding, knitting and finishing.

Frequency	Re-cycling	preparation	carding	Knitting	Finishing
Day1	93.7	73.3	86.3	90	82
Day2	93	73	86.3	89.7	82.3
Day3	94	74	89	91.3	83
Mean	93.56	73.4	87.2	90.3	82.43

Table (4.1.6): Measurement mean value of noise level in dBA in five machines

Figure (4.1.8): shows measurement of noise level in dBA in five machines.

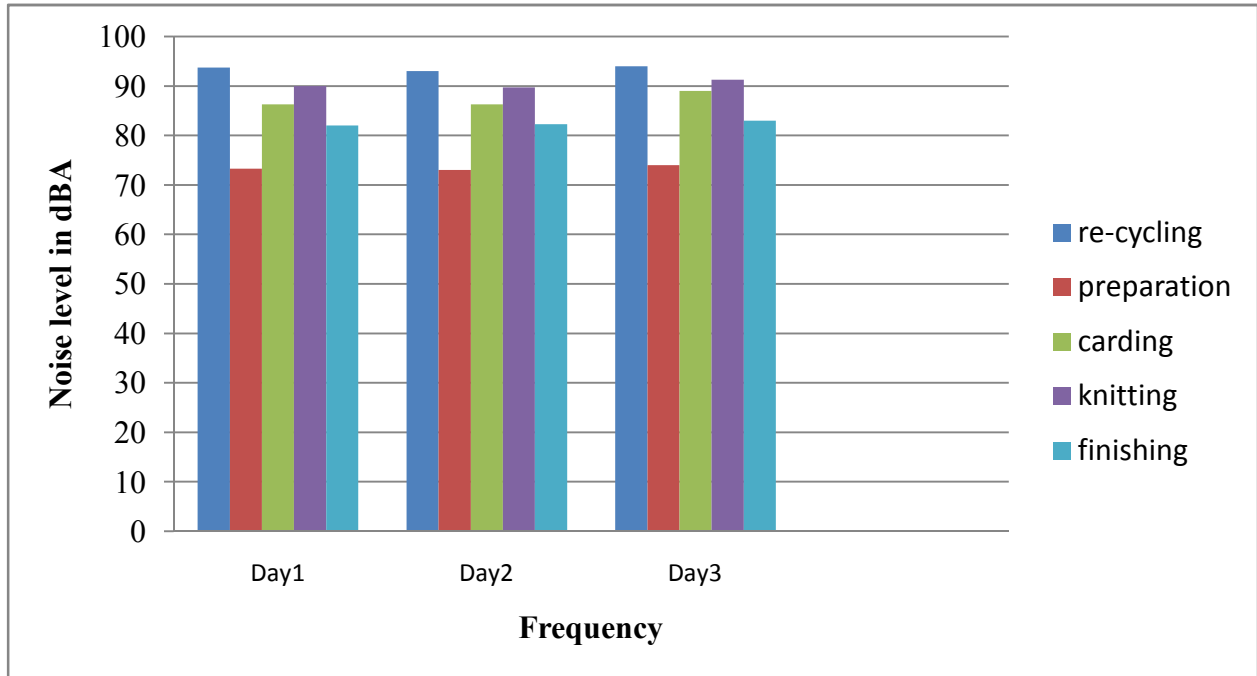


Figure (4.1.8): mean measurement value noise level among five machines at arbitrary points

Noise level measurements at the distances: noise levels were measured at the distances of 1m, 1.5m and 3 m in re-cycling, preparation, carding, knitting and finishing a from the source of noise of machine and the measurements were presented in tables (4.1.7- 4.1.11) in each machine.

Table (4.1.7): shows the noise level measurements in re-cycling machine in dBA. The measurements were taken from distance of 1m, 1.5m and 3m every day and then the mean value was calculated. In the first day the readings, at the distance of 1m, 1.5m and 3m were 93dBA, 91dBA and 87dBA respectively, in the second day the readings, at distance of 1m, 1.5m and 3m were 92dBA, 90dBA and 86dBA respectively and in the third day the readings, at distance of 1m, 1.5m and 3m were 93dBA, 91dBA and 87dBA respectively.

Frequency	1m	1.5m	3m
Day1	93	91	87
Day2	92	90	86
Day3	92	91	87
Mean	92.3	90.7	86.7

Table (4.1.7): Measurement of noise level in dBA at distance of 1m, 1.5m and 3m in re-cycling machine

Figure (4.1.9): Shows noise level measurement at the distance of 1m, 1.5m and 3m in re-cycling machine.

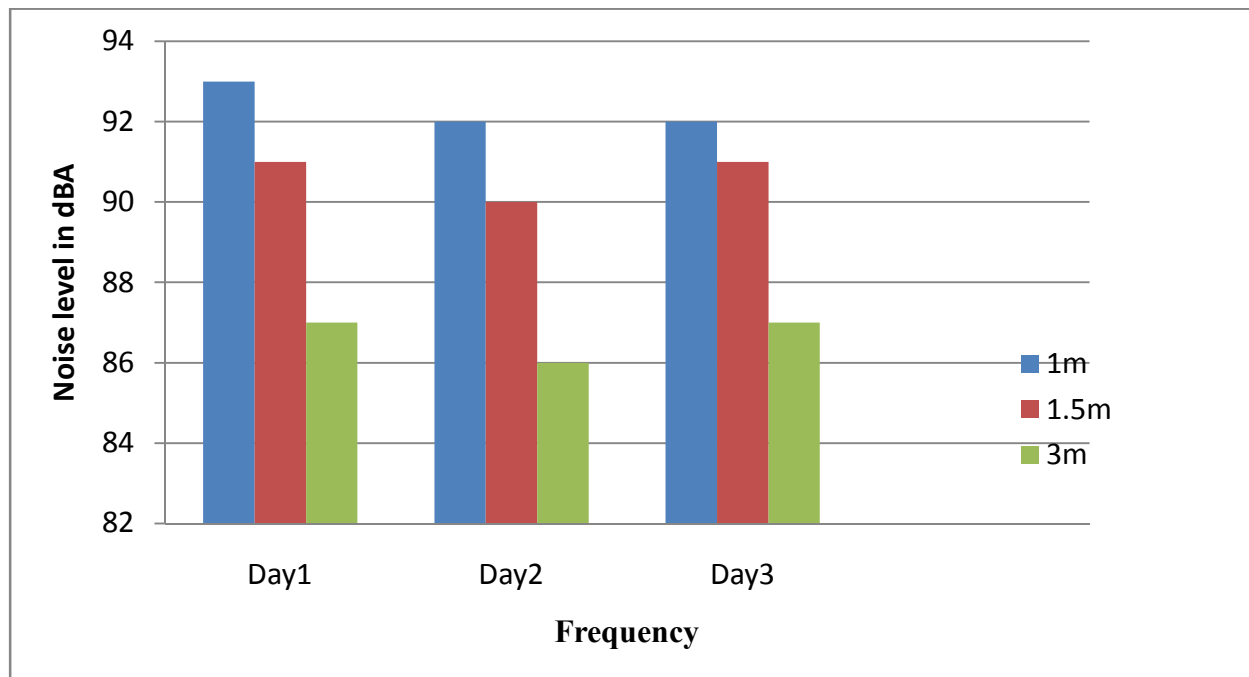


Figure (4.1.9): Noise level measurement at the distances of 1m, 1.5m and 3m in re-cycling machine.

Table(4.1.8): indicates the noise level measurements in preparation in machine dBA the measurements were taken from the distance of 1m, 1.5m and 3m every day and then the mean value was calculated .in the first the day the readings, at distance of 1m,1.5 and 3m were 76dBA ,74dBA and 70dBA respectively, in the second day the readings, at distance of 1m, 1.5m and

3m were 75dBA,73dBA and 69dBA respectively and in third day the readings , at distance of 1m,1.5m and 3m were75dBA ,73dBA and 68dBA respectively.

Frequency	1m	1.5m	3m
Day1	75	74	70
Day2	75	73	69
Day3	75	73	68
mean	75	73.3	69

Table (4.1.8): Measurement of noise level in dBA at the distances of 1m, 1.5m and 3m in preparation.

Figure (4.1.10): shows the measurement of noise in dBA in preparation machine at the distances of 1m, 1.5m and 3m.

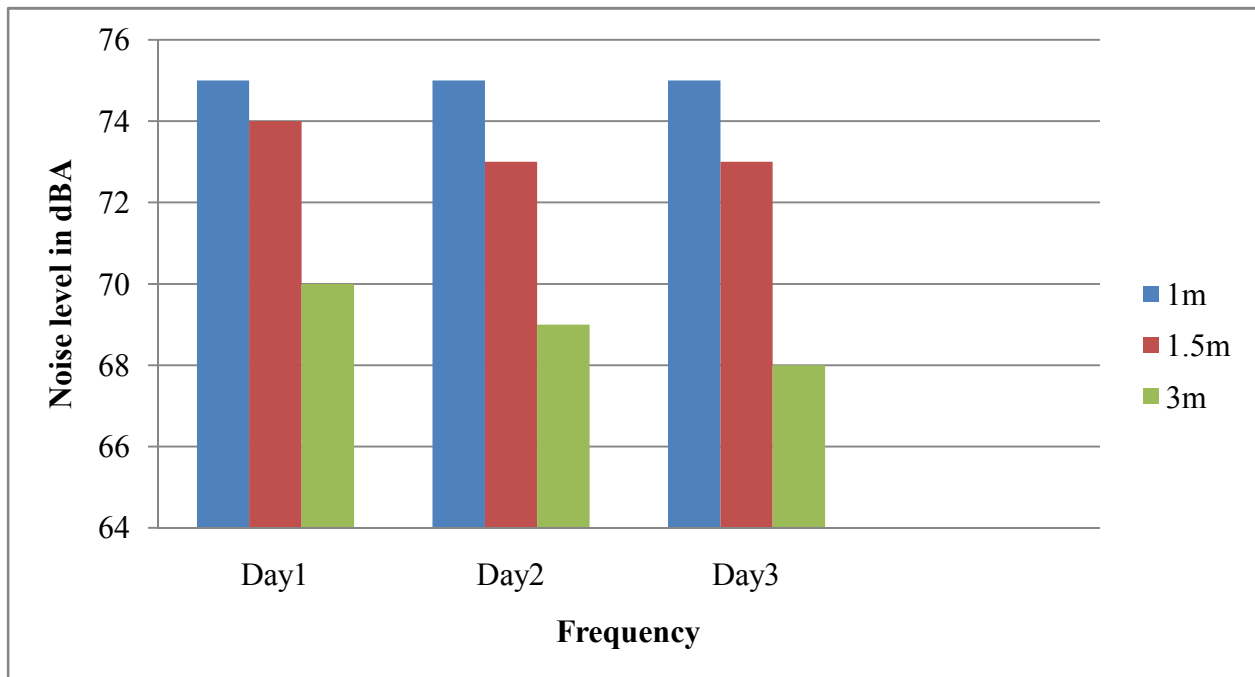


Figure (4.1.10): Measurements of noise level at the distances of 1m, 1.5m and 3m in fiber preparation machine.

Table (4.1.9): illustrates the noise level measurements in carding and spinning machine dBA. The measurements were taken from the distance of 1m, 1.5m and 3m every day and then the

mean value was calculated. In the first day the readings, at distance of 1m, 1.5m and 3m were 92dBA, 90dBA and 83dBA, respectively, in the second day the readings, at distance of 1m, 1.5m and 3m was 91dBA, 90dBA and 83dBA respectively, and in third day at distance of 1m.1.5m and 3m were 91dBA, 89dBA and 84dBA, respectively.

Frequency	1m	1.5m	3m
Day1	92	90	86
Day2	91	90	86
Day3	91	89	85
Men	91.3	89.7	85.7

Table- (4.1.9): Measurement of noise level in dBA at the distances of 1m, 1.5m and 3m in carding machine

Figure (4.11): shows measurement of noise level in dBA at the distances of 1m 1.5m and 3m in carding machine.

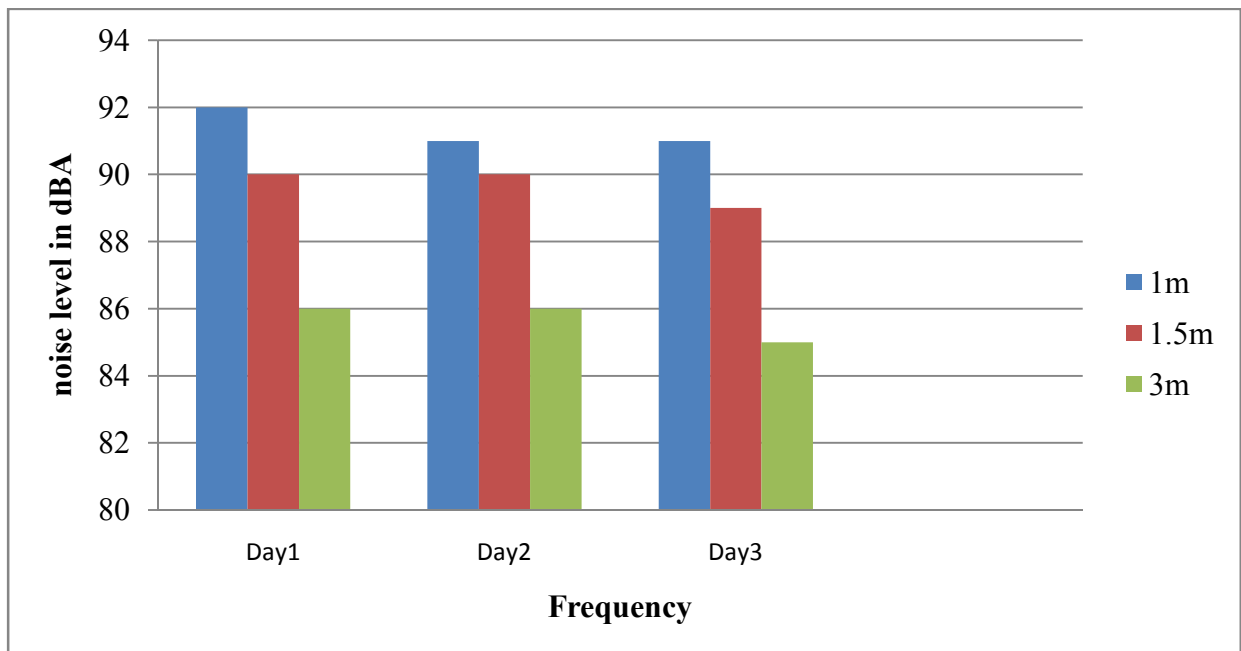


Figure (4.1.11): Measurement of noise level at distance of 1m, 1.5m and 3m in carding machine.

Table (4.1.10) clarifies the noise level measurements in knitting machine dBA. The measurements were taken from the distance of 1m, 1.5m and 3m every day and then the mean value was calculated. in the first day the readings, at distance of 1m, 1.5m and 3m were 90dBA, 88dBA and 83dBA respectively, in the second day readings, at distance of 1m, 1.5m and 3m were 89dBA, 88dBA and 83dBA, respectively and in third day the reading, at distance of 1m,1.5m and 3m were 89dBA ,87dBA and 84dBA, respectively.

Frequency	1m	1.5m	3m
Day1	90	88	83
Day2	89	88	83
Day3	89	87	84
Mean	89.3	87.7	83.3

Table (4.1.10): Noise levels at distance of 1m, 1.5m and 3m in knitting machine

Figure (4.1.12): Shows the measurement of noise level in at distance of 1m, 1.5m and 3m in knitting machine.

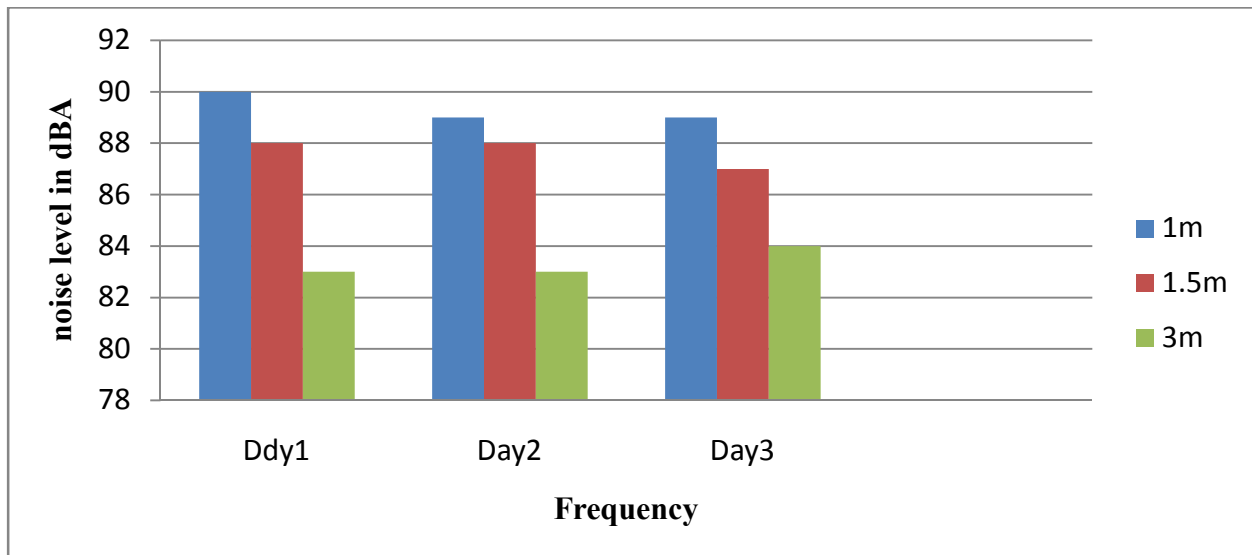


Figure (4.1.12): Measurement values of noise level at the distances of the distances of 1m, 1.5m and 3m knitting machine

Table (4.1.11): describes the measurements of noise level in finishing machine. The measurements were taken from distance of 1m, 1.5m and 3m every day and then the mean value was calculated. In the first day the readings, at distance of 1m, 1.5m and 3m were 84dBA, 82dBA and 78dBA respectively, in the second day the reading at distance of 1m, 1.5m and 3m were 83dBA, 82dBA and 77dBA respectively and in the third day the readings at the distance of 1m, 1.5m and 3m were 83dBA, 81dBA and 77dBA respectively.

Frequency	1m	1.5m	3m
Day1	84	82	78
Day2	83	82	77
Day3	83	81	77
Mean	83.3	81.7	77.3

Table (4.1.11): Measurement of noise levels at distance of 1m, 1.5m and 3m in finishing machine

Figure (4.1.13): shows the measurement of noise level at the distance of 1m, 1.5m and 3m in finishing machine

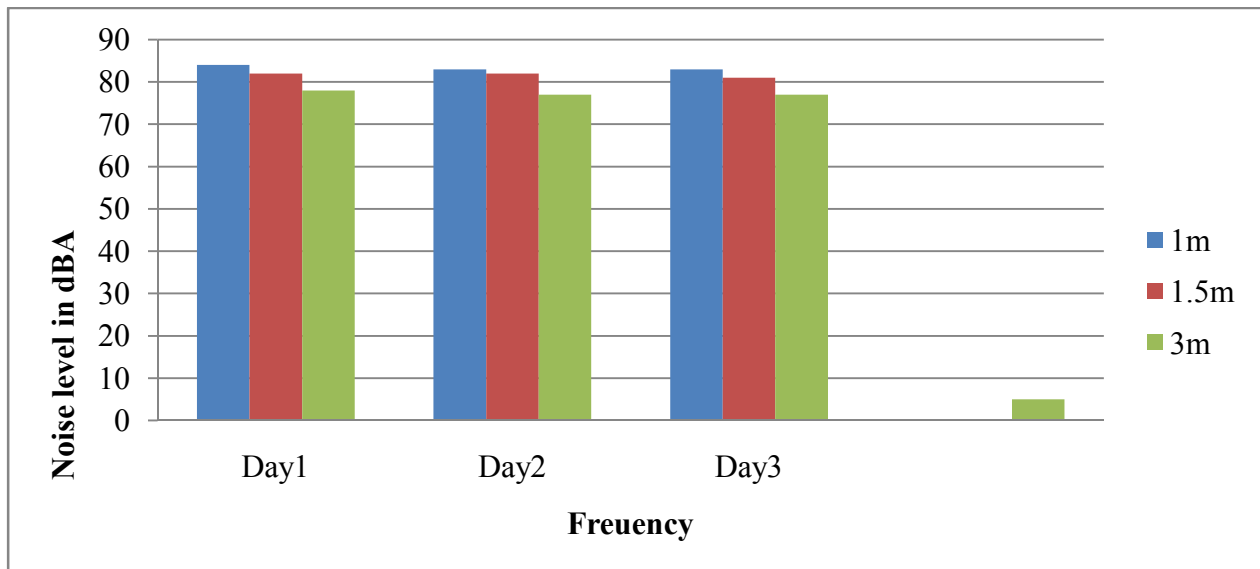


Figure (4.1.13): Measurement values of noise level at the distances of 1m, 1.5m and 3m in finishing machine.

**C. the measurements of noise level of duration hour per day and in the morning, at noon and night in every day**

The measurements of noise level, duration hour of 1hr, 2hr and 3hr: The measurements of noise level were presented in tables (4.1.12—4.1.14) duration of 1hour, 2hr and 3hr in re-cycling, preparation and carding

Table (4.1.12): shows noise level measurements duration of 1hour, 2hours and 3hours in re-cycling machine at the distance of one meter from the machine in dBA. The measurements were taken from duration of 1hr, 2hr and 3hr every day and then the mean value was calculated. In the first day the reading duration of each hour was 94dBA, in the second day for each hour was 93dBA and in the third day for each hour was 93dBA.

Frequency	1hr	2hr	3hr
Day1	93	93	93
Day2	93	93	93
Day3	93	93	93
Mean	93.3	93	93.3

Table (4.1.12): Measurement of noise level of hour per day in re-cycling machine

Table (4.1.13): illustrates the noise level measurements from duration for 1hour, 2hours and 3hr in fiber preparation at distance of one meter from the machine dBA. The measurements were taken from duration of 1hr, 2hr and 3hr every day and then the mean value was calculated. In the first day the reading at duration for each hour is 72dBA, in the source of noise.

Frequency	1hr	2hr	3hr
Day1	72	72	72
Day2	72	72	72
Day3	73	73	73
Mean	72.3	72.3	72.3

Table (4.1.13): Measurement of noise level in dBA of hour per day in preparation machine

Table (4.1.14): explains the noise level measurements from duration for 1hr, 2hr and 3hr in carding and spinning machine at a distance of one meter. The measurements were taken from duration of 1hr, 2hr and 3hr every day and then the mean value was calculated. In the first day the reading at duration for each hour was 90dBA, in the second day for each hour was 89dBA and in the third for each hour was 90dBA.

Frequency	1hr	2hr	3hr
Day1	90	90	90
Day2	89	89	89
Day3	90	90	90
mean	89.7	89.7	89.7

Table (4.1.14): Measurement of noise level of hour per day in carding machine.

**Noise level measurements duration time per day (morning, noon and night) in dBA: -**

The measurements of noise level were presented in tables (4.1.15 and 4.1.16) in re-cycling and carding.

Table (4.1.15): shows noise level measurements in duration of time per day in re-cycling machine. The noise level measurements were taken from the duration time per day every day and then the mean value was calculated. In the first day the reading at morning, at noon and at night was 93dBA, 93dBA and 94dBA respectively. In the second day at morning, at noon and at night were 93dBA, 93dBA and 94dBA respectively in the third day at morning, at noon and at night were 93dBA, 93dBA and 94dBA respectively.

Frequency	Noise level measurement in dBA		
	Morning	Noon	Night
Day1	93	93	93
Day2	93	93	94
Day3	93	93	94
Mean	93	93	93.7

Table (4.1.15): Measurement noise level in dBA at the morning, noon and night in re-cycling machine.

Table (4.1.16): illustrates noise level measurements in duration of time per day in carding. The noise measurements were taken from at morning, at noon and at night per day and then the mean value was calculated. In the first day the reading at morning, at noon and at night was 90dBA for each, in the second day at morning, at noon and at night was 89dBA, 88dBA and 89 dBA respectively, and in the third day at morning, at noon and at night was 89dBA for each.

Frequency	Morning	Noon	Night
Day1	90	90	90
Day2	89	89	89
Day3	89	89	89
Mean	89.3	89	89.3

Table (4.1.16): Measurement of noise level in dBA at the morning noon and night in carding machine.

## 4.2. Discussion

When we measured noise level in each machine repeating three times per day for three days in a week and recorded, we found that the mean measurement of noise level in re-cycling machine it was the highest from the measurements of noise level of other machines and it reached 93.9dBA. Infact in carding machine it was 90dBA, in knitting machine it was 87.3dBA, in finishing machine it was 82.4dBA and lastly in fiber preparation it was 73.4dBA at different arbitrary points.

Subjective symptoms of exposure of ultrasonic noise with frequency over 21KHz and the level exceeding 70dBA may cause negative symptoms on any exposed workers as excessive fatigue, nausea, ear fullness and headache[1]. So we compared our all measurement values higher than 70dBA in all machines.

Exposure to continue and extensive noise at a level higher than 85dBA may lead to hearing loss [9]. So we compared our measurement values of noise level in the re-cycling, carding and knitting higher than 85dBA. Any noise rating above 80dBA produce physiological effect and a long exposure at 90—100dBA produce permanent damage to a person’s hearing [6]. So we compared our measurement values of noise level in the re-cycling, carding, knitting and finishing machine higher than 80dBA and the measurement of noise level value in re-cycling machine

higher than 90dBA. The noise emitted by ultrasonic washers with level over 75dBA caused annoyance and discomfort [1]. So we compared our measurement values of noise level in the recycling, carding, knitting and finishing higher than 75dBA.

The mean value of noise levels measurements at the distance of 1m, 1.5m and 3m in recycling machine were 92.7dBA, 90.7dBA and 86.7dBA respectively. Noise level measurements at distance of 1m is the highest for other the distances. the mean value of noise level measurements at the distances of 1m, 1.5m and 3m were in fiber preparation were 75dBA, 73.3 and 69 respectively. So we compared the mean values of noise level measurement at each distance, the measurement mean value at the distance of 1m is the highest for the distances of 1.5m and 3m

The mean value of noise level measurements at the distances of 1m, 1.5m and 3m were 91.3dBA, 89.7dBA and 85.7dBA respectively in carding machine. So we compared the mean measurements value of noise level, with each other, the mean value of noise level measurement of 1m is the highest for distance of 1.5m and 3m. the mean value of noise level measurements of 1m, 1.5m and 3m were 89.3dBA, 87.7dBA and 83.3dBA, respectively in knitting machine. So we compared the mean value of noise level measurements with each other, the mean value of noise level measurement of 1m is the highest for distance of 1.5m and 3m.

The mean value of noise level measurements at the distances of 1m, 1.5m and 3m were 83.3dBA, 81.7dBA and 77.3dBA respectively in finishing machine. So we compared the mean value of noise level measurements with each other, the mean value of noise level measurement of 1m is the highest for distances of 1.5m and 3m. When we came from the distance of 1m to 3m, the distance was double in each machine and the measurements noise level decreased by 5.6dBA in re-cycling machine, 6dBA in preparation machine and 5.6dBA in carding machine, 6dBA in knitting machine and 6dBA in finishing machine.

We can *find out the intensity* of sound by using eq(2) and eq(3)

$$B = 10 \log \frac{I}{I_0} \gg \frac{I}{I_0} = 10^B, \quad I = I_0 \times 10^B$$

for example the noise level measurement of knitting machine is 90dBA, to check the intensity of this noise level we substituted it in equation and then we got  $I = 1 \times 10^{-3} \frac{W}{m^2}$

To express the relation between intensity of sound, the rate of energy and the distance, we used eq (1)

$$I = \frac{P}{A} \quad A = 4\pi r^2 \text{ so, } P/A = \frac{P}{4\pi r^2}$$

if we take the above example  $I = 1 \times 10^{-3} \frac{W}{m^2}$  and the distance of 1m, 1.5m and 3m from the source noise, the power will be

At 1m,  $p = 12.56 \times 10^{-3} W$

At 1.5m,  $p = 28.26 \times 10^{-3} W$

At 3m,  $p = 113.4 \times 10^{-3} W$

This indicates that the distance increase from the source of sound, the intensity of sound will be decrease and the rate energy of sound will be increase

These hours they were not change. The mean value of noise levels measurements at duration of 1hr, 2hr and 3hr in re-cycling machine it was 93.3dBA and the noise levels are similar each for duration of hour. The noise levels measurements at duration of 1hr, 2hr and 3hr in fiber preparation is 72.3dBA and the measurements of noise levels in each duration hour was constant. The noise level measurements at duration of 1hr, 2hr and 3hr in carding it was 89.7dBA and measurements of noise levels are equal each for duration of hour.

Noise levels measurements in the morning, noon and night in re-cycling was 93dBA and the noise levels measurements in morning, noon and night was the same. The noise measurements at morning, noon and night in carding was 89.3dBA and the measurement of noise levels was similar for each at the morning, noon and night.

- The reading of noise level measurement in re-cycling, carding and knitting more than permitted limit (85dBA) at arbitrary points.
- The reading of noise level measurement at distance of 1m was the highest the distance of 1.5m and 3m in all machines.
- The measurements of noise levels at all duration of hours were equal in each the same machine

# CHAPTER FIVE

## Conclusion and Recommendation

Noise problem is not a simple problem and it needs a careful handling from many sides i.e. from the owner's, worker himself as he should know how to deal with the problem. The basic aim this research is to study the effect of ultrasonic noise on human body. The output from noise levels measurement can be concluded in the following points. The readings of measurement value of noise level at arbitrary points, distances, at duration of hour and at duration of time in re-cycling, carding and knitting machine were above permitted limit. On other hand readings of measurement value of noise level in preparation and finishing machine were blow permitted limit. So the re-cycling, carding and knitting are higher noisy than preparation and finishing machines.

When the distance far from the source of noise, the measurement noise level was decreased and if the distance increased in double, noise level decreased by 6dBA approximately. Noise levels measurements in different duration of hours is constant at the same points. Noise levels do not change at the morning, at the noon and at the night in the same point and the same distance.

We recommended that concerned body should check:-

- The application of new technologies requires that have been developed for various noise controls.
- Absorptive enclosure and design modification engine can result in quiet industrial operation.
- There must be educational program to teach the workers about the effects of noise on their health and they must know the important of using ear protection

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