Monitoring of Copper, Lead and Nickel in Soil at Bemban Industrial Estate, Batu Gajah, Perak

by

Mohamad Hafiz bin Kamisan

Dissertation submitted in partial fulfillment of
the requirement for the
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CERTIFICATION OF APPROVAL

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A project dissertation submitted to the

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CHEMICAL ENGINEERING

Approved by,

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Dr. Nurlidia Mansor

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

September 2013

CERTIFICATION OF ORIGINALITY

This is to certify that I am bearing the whole responsibility for the work submitted in this project and the originality of the work is my own except the specified in the references and acknowledgements, and the original work contained herein have not been undertaken or done by unspecified sources or persons.

Mohamad Hafiz Kamisan

ABSTRACT

The presence of heavy metal in soil of industrial activities can result in risk to the human health. The exposure of high concentration heavy metals can lead to skin and breathing problem as much as other high risk diseases. Industrial activities around Bemban Industrial Estate has become a major source of heavy metal release to the environment in that area. The heavy metals being studied, lead (Pb), nickel (Ni) and copper (Cu) are suggested to be high in the area. This is because, these metals have become the main concern in industrial related pollution in previous research globally. The investigation of the concentration of heavy metals in soil will be carried out in two ways. Firstly is the measuring of concentration according to the distance from the industrial area and secondly is the comparative studies of the heavy metals in industrial soil with the heavy metals in background soil sample. The results found that level of Lead, Nickel and Copper decreases as distance from the industrial area increases. This is consistent with other researchers which studies heavy metals dispersal from point source. This shown that the emission comes from the industrial area are released as far as 1 kilometers away. The Enrichment Factor also proves that the source originates from anthropogenic sources, confirming that the heavy metals concentration detected were from the industrial activities.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The mobilization of heavy metal into the biosphere by human activity has become an important process in the geochemical cycling of these metals (Chen et al., 2005). This is the very clear evident in the urban areas where various source emitting the large quantities of heavy metals into the atmosphere and soils. Although the urban soils are not being used as in agriculture, but it have the direct influence on the human health since it can easily have contact with human bodies.

This study is suggesting the monitoring of the heavy metals, that have been specified into three elements, the lead (Pb), nickel (Ni) and copper (Cu) in industrial area at Batu Gajah, Perak. Although soils did not show strong heterogeneity in their general properties, high dispersion of the contents in those metals with greater relative availability suggested that pollution with metals could occur in some sampling sites (Madrid et al., 2002). The main reason for selection of these three metals is because, from most related studies, these metals are often being mentioned and investigated. Therefore, it conclude the availability of these metals in the soil resulted from variety of industrial activities.

This study is important as it will expose the concentration measurement of the copper, lead and nickel in soil of Bemban Industrial Estate. In this study also, the concentration of the heavy metals relative to the dispersal range are measured. The heavy metal concentrations were used as the input data for soil pollution maps to study the distribution of metals in urban soils (Lee et al., 2006).

1.2 Problem Statement

At Danang, the concentration of 743 mg/kg of lead were measured in soil of the industrial area that is much higher than its rural soil, 42 mg/kg (Marsan & Biasioli, 2010).The exposure to the high level of heavy metals may affect the health of the residents around the industrial area. Therefore, it is important to measure the concentration of heavy metals at the Bemban Industrial Estate. For the time being, study about heavy metals at the area is practically not available. Therefore, this study will be the pioneer in investigating the copper, lead and nickel concentrations at the area. From the measured concentration of the heavy metals, the level of these heavy metals exposure at Bemban Industrial Estate can be justify wheter it is high or vice versa. Besides that, the data collected can be the reference for other researchers to conduct further studies about copper,lead and nickel content in the soil at Bemban Industrial Estate.

1.3 Objectives

The main objectives of this study are:

i) To measure the concentration of copper, lead and nickel in soils at Bemban Industrial Estate.

ii) To determine the dispersal emissions of copper, lead and nickel from the center of Bemban Industrial Estate.

iii) To compare the concentrations of copper, lead and nickel in soil of Bemban Industrial Estate with the concentrations in soil of background sample by calculating the Enrichment Factor.

1.4 Scope of Study

This study cover the aspect of deciding the locations for the soil sampling. Besides that, the analysis of the copper, lead and nickel concentrations are conducted using the Atomic Absorption Spectroscopy (AAS) equipment. The samples preparation for the AAS analysis are conducted through Aqua-Regia Extraction. This study include the calculation for moisture content and Enrichment Factor.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Heavy Metals

Generally, heavy metal is the elements that are having the densities of greater than 5 g/cm^3. According to Hawkes (1997), heavy metals comprise a block of all the metals in Group 3 to 16 that are in periods 4 and greater in the periodic table. This definition referred directly to the transition and post-transition metals. The example of heavy metals are lead (Pb), zinc (Zn), mercury (Hg), copper (Cu), cadmium (Cd), chromium (Cr) and iron (Fe). Heavy metals can present in the soil through two pathway, naturally present and through anthropogenic source. The naturally present heavy metals usually is emitted from the crust of the earth to the surface. This level of heavy metals are safe for the living organisms. The anthropogenic source means the emission of the heavy metals as a result of human activities. The heavy metals in soil can get contact with living organism, especially human through two pathway, the direct and indirect contact (Chen et al. 2011). The direct contact means the soil is having the direct contact with the human skins. On the other hand, the indirect contact means the heavy metals is transferred to the human through a medium of food. This contact include the inhalation, ingestion and dermal contact absorption.

2.2 Effect of Heavy Metals to Human Health

The exposure to the heavy metals may cause an adverse health effect. Each of the heavy metals have their own risk on the exposure to the human. Low-level lead exposure will effects on the intellectual development of infants and children (Health Canada, 2013, “Lead and Human Health,” para. 4). On the exposure, the lead usually accumulate in the bone. The chronic exposure to the lead can cause renal dysfunction and liver damage (Monika & Katarzyna, 2003). While on the other hand, the inhaling of a large amount of zinc can cause a short-term disease called fume-metal fever (Agency for Toxic Substances and Disease Registry, 2005, “Public Health Statement,” para. 10). Primarily, the exposure to cadmium can affect the kidney, lung and bone.

Even though some heavy metals such as zinc and copper are needed by human body, but the excess exposure towards these metals can alter the human body function. According to Das, Das & Dhundasi (2008), nickel exposure can cause the formations of free radical in various tissues in human, thus leading to the modification of the DNA bases. The Fig. 1 below shows the effect of lead exposure on human bone.

Figure 1: The X-ray Image of the Bone Affected with Lead Poisoning

The arrow in the picture above shows the denser metaphyseal line as an effect of the lead poisoning to the human body.

2.3 Investigations of Previous Related Studies

A lot of studies had been done to investigate the heavy metals dispersal in the soil at the industrial area and the effects of the industrial activities towards the heavy metals exposure to living organisms. According to Zheng et al (2010), they had study the level of heavy metals at the residential building near the Huludao Zinc Plant (HZP). In this study, they have focused on five types of heavy metals which are the mercury (Hg), lead (Pb), cadmium (Cd), zinc (Zn) and copper (Cu). The result shows that the region which is the closest to the HZP contain the highest heavy metals content compare to the other region.

In the study done by Monika & Katarzyna (2003), they investigate about the level of heavy metals in the kidney of rodents that are lived in the areas around the steelworks and zinc smelter plants in Poland. In this study, they are focusing in four types of heavy metals which are the lead (Pb), cadmium (Cd), iron (Fe) and zinc (Zn). The highest cadmium level were found in the kidney of the rodent caught within the neighbourhood of the zinc smelters in Bukowno. This show that, near the industrial area, the cadmium ingested by the rodent is the highest which indicate the level of cadmium in the soil of the area.

Martley, Gulson & Pfeifer (2004) had conduct the experimental study about the metal concentration in soils around the copper smelter and surrounding industrial complex of Port Kembla, Australia. In their study, the focused on five types of metal which are arsenic (As), chromium (Cr), copper (Cu), lead (Pb) and zinc (Zn). The study on the dispersal of the metals around the industrial complex until a maximum distance of 24 km. In this study, Aqua-Regia extraction that follow Australian Government Analytical Laboratories (AGAL) procedure is being used to determine the metal concentrations. At the end of the study, they conclude that the concentration of the metals being studied are decreasing as the distance of the samples taken increasing. The figures below show the dispersal of the metal concentration with respect to the distances of the samples taken. Fig. 2 below shows the dispersal of the copper (Cu) and lead (Pb) concentration with respect to the distances of the samples taken.

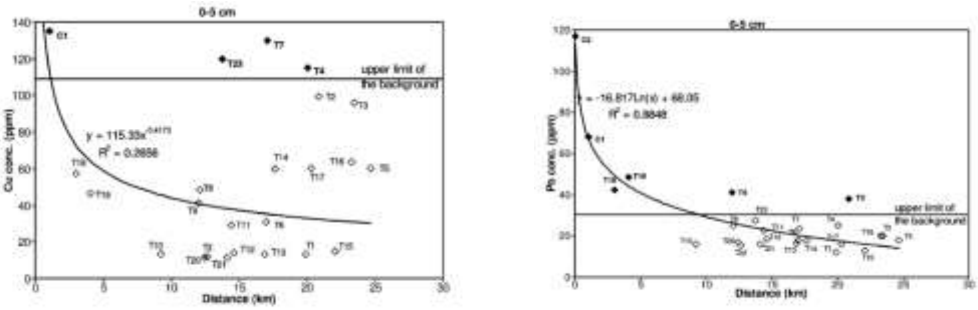

Figure 2: The Dispersal of Copper and Lead Concentration According to the Distances of Samples Taken (Martly, Gulson & Pfeifer., 2004).

Another study is being conducted by Adamo, Arienzo, Bianco, Terribile & Violante at the former iron-steel industrial plant in Bagnoli, Italy. In the study, they focused on the monitoring of iron,aluminum, copper, cobalt, chromium, zinc, lead, nickel and manganese. They stated that the former steel working facililty of ILVA is a typical example of a heavy metal contaminated industrial site. In the analysis of the heavy metals concentration, they compare the certified value for CRM 141R Standard

Reference Material with the measured value obtain from the procedure they had done. from the findings, in the surfae layer for all samples, the concentration of Co, Cr, Pb, Zn and Ni were above the maximum concentrations establish for soils of public. They have make a conclusion that, except Al, the concentrations of heavy metals tend to decreases with depth. This conclusion achieved after they tested the concentration of the heavy metals according to the depth of the samples taken.

2.4 Atomic Absorption Spectroscopy (AAS)

Atomic absorption spectroscopy use the light source that emits discrete line and then being absorbed by the substances with the narrow absorption profile (Parker et al., 1982). The AAS machine functioning by measuring the degree of absorption of the light of the wavelength which specified each of the elements. The light generated by a discharge lamp which will be emitted to the samples solution. The solution then dissociated to give a cloud of atoms in the light path. The detector in the machine will detect the light that is passing through the sample region, and the degree of absorption is measured. In practice, there is some species that will disrupt the process by absorbing the light other than the species in interest. Such absorption is known as non-atomic absorption (NAA). The method to repair the disruption by NAA is by using the continuum light source such as hydrogen and measuring it over the broad spectral band in the wavelength vicinity of the atomic absorption line.

To use the Atomic Absorption Spectroscopy, the standard solutions should be prepared. In the standard solutions, the solutions of copper, nickel and lead are to be prepared to a concentrations which the samples are expected to lie within. The concentration of the standard solution to be prepared are based on the average concentrations that had been investigated by the previous researcher. According to Gowd, Reddy & Govil (2010) the concentration of lead in the soil is at 10.1 mg/kg to 67.8 mg/kg (average at 47.0 mg/kg). On the other hand, the concentration of copper in the soil is at 1.7 mg/kg to 126.1 mg/kg (with average of 16.77 mg/kg). Therefore, five standard solutions are to be prepared to plot the calibration curve for the purpose of determination of the concentrations in the samples.

2.5 Enrichment Factor

Anthropogenic is a source of heavy metals distribution into the soils. This anthropogenic includes the factory activities. To measure for the anthropogenic involvement, the Enrichment Factor is used. The value is being calculated with respect to the background value. The formula of EF is shown as below:

$$EF_i = C_i/B_i$$

Where;

C_i = Concentration of the heavy metal i of examined sample in industrial soil (mg/kg).

Bi = Concentration of the heavy metal i in the background sample (mg/kg).

The heavy metals are considered accumulated in the soil from anthropogenic source if the value of EF is exceeding 1 (Luo et al., 2012).

The concentration of heavy metals in the background sample are the concentrations at the natural conditions. The value for each metals is obtained from Gowd, Reddy & Govil (2010), as they stated that, the typical concentration of lead in the soil is at 10.1 mg/kg to 67.8 mg/kg (average at 47.0 mg/kg). On the other hand, the concentration of copper in the soil is at 1.7 mg/kg to 126.1 mg/kg (with average of 16.77 mg/kg).

CHAPTER 3

METHODOLOGY

3.1 Sampling Location

The sampling location are chosen at the Bemban Industrial Estate. The location is chosen because it consist of both the industries and residential area. Bemban Industrial Estate covers 320 acres (129.50 hectares) subdivided into 86 industrial lots of various sizes. Variety of industries are available at the industrial park. This include:

i. Electrical and electronics
ii. Food and beverages
iii. Textiles and apparel
iv. Rubber based and plastics
v. Paper and wood based
vi. Non-metallic mineral products.

The companies available at the industrial estate include Murata Electronics (Malaysia) Sdn. Bhd., HCM-Hygenic Corporation (M) Sdn. Bhd., Nihon Canpack (M) Sdn. Bhd., Camfil Air Filter Sdn. Bhd., Sagami Manufacturers Sdn. Bhd. And Watanabe Metal Industries Sdn. Bhd. Fig. 3 below shows the location of the Bemban Industrial Estate. The red spot in the picture is the location of the bemban industrial estate.

Figure 3: The Location of Bemban Industrial Estate (Source: Google Map)

The main concern that lead to idea of the research is unavailability of study and published paper about heavy metals concentration in soil of the Bemban Industrial Estate. Therefore, the significant of investigation is related to current situation.

The location of sampling is listed as follow:

i) At the center of the industrial estate.

ii) 250 m from the center of the industrial estate.

iii) 500 m from the industrial estate.

iv) 750 m from the industrial estate.

v) 1000 m from the industrial estate.

The location of the sampling are measured using the help from Google Maps from Google. The locations are then marked by noting the coordinates in the map. The coordinates for each of the distance are listed as below:

i. Centre of industrial estate (4°27'45"N 101°0'10"E).

ii. 250 m from centre of industrial estate (4° 27' 46"N 101° 0' 13"E).

iii. 500 m from centre of industrial estate (4° 27' 45"N 101° 0' 15"E).

iv. 750 m from centre of industrial estate (4° 27' 28"N 101° 0' 10"E).

v. 1000 m from centre of industrial estate (4° 27' 20"N 101° 0' 10"E).

Fig. 4 below shows the distribution of the sampling site with respect to the centre of the industrial estate. The label A below is the centre of Bemban Industrial Estate.

Figure 4: The Distribution of Sampling Location from the Centre of Bemban Industrial Estate (Source: Google Map)

3.2 Soils Sampling

Gardening hand tool will be used to collect the sample with the depth of about 2-cm. Ruler is used to measure the depth of the soils. Then, the soil sample will be kept in a plastic bag and labelled with A: center, B: 250 m, C: 500 m, D: 750 m, and E: 1000 m. All samples will be kept in laboratory for elemental analysis.

3.3 Experimental Procedure

The experimental procedure of the study includes all the steps after the soils sampling procedure. The procedure are shown as Project Flow Chart in the Fig. 5 below.

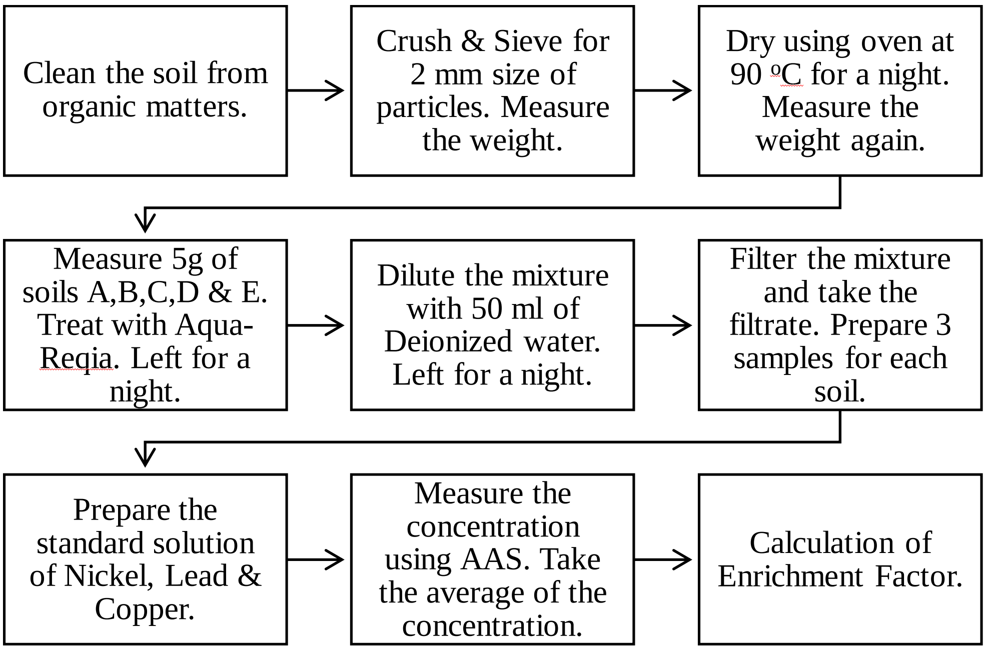

Figure 5: Project Flow Chart of the Experimental Procedure

3.4 Significant of the Experimental Procedure

3.4.1 Clean, Crush, Sieve, Dry and Measure the Weight

i. Clean the soil from organic matter such as grass, dead wood and leaves. This is to ensure that the organic matter will not affect the measurement of the weight.
ii. Crush and sieve for 2 mm size of soil. This is to ensure the soil particles are tiny enough to be dissolved in the Aqua-Regia. Besides that, the tiny particles will prevent the clogging to the equipment during analysis.
iii. Dry for a night is important to remove the moisture content in the soil. The availability of the moisture will disrupt the purity of the soil.
iv. Measure the weight before and after drying is important in determining the moisture content in the soil. This is because, the moisture content in the soil can be calculated from the weight of the sample according to the equation below:

$$moisture\ content = \frac{\text{weight before drying} - \text{weight after drying}}{weight\ before\ drying} x\ 100\%$$

3.4.2 Aqua-Regia, Dilution and Filtering of Solution

i. Aqua-Regia is the product after mixing Hydrochloric Acid with Nitric Acid. This solution are able to dissolve most metals into the solution thus extracting the Copper, Lead and Nickel from the soil.
ii. Dilution with deionized water is a step to lowering the acidity of Aqua-Regia for the filtering purpose. Deionized water is used because it is the cleanest water.
iii. Filtering of the solution after Aqua-Regia Extraction is crucial as the undissolved soil will be removed from the solution. Besides that, the filtering process will remove the large particles that can cause clogging to the AAS tubing during the analysis.

3.4.3 Standard Solution and AAS Analysis

i. The preparation of the standard solutions are important. This is because, the standard solutions will form a calibration curve, which will be used to measure the concentrations of Copper, Lead and Nickel in the samples. The standard solutions that are being prepared are tabulated in the Table 1 below. The concentration of the standard solution are being prepared according to the literature review of the typical concentration of the metals in the soil. The heavy metals of the specified species are expected to possess the concentration in the range of the standard solutions being prepared.

Table 1: The Standard Solutions Concentrations

Standard solution number	Copper (ppm)	Nickel (ppm)	Lead (ppm)
1	20	20	50
2	30	30	60
3	40	40	70
4	50	50	80
5	60	60	90

ii. AAS analysis is important to measure the concentrations of the Cooper, Lead and Nickel in the samples.

3.5 Access to Equipment and Materials

The accessibility to the equipment and materials related to the study are tabulated in the Table 2 below. The table describe the type of equipment and locations of availability of the equipment and materials.

Table 2: The List of Equipment and Material for the Research Activities.

No	Equipment/Material	Places
1	Atomic Absorption Spectroscopy	Block 4,UTP
2	Nitric Acid	UTP
3	Hydrochloric Acid	UTP
4	Sieve	UTP
5	Mortar	UTP
6	Oven	Block 4, UTP
7	Deionized Water	Chemical Store,UTP

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Moisture Content

The moisture content of the soil is measured directly from the difference in the weight of the soil before and after drying. The moisture content of the soil is represented in percentages. The moisture contents are calculated using the equation as stated in previous section **3.4.1**. The value of the moisture contents are tabulated in Table 3 below.

Table 3: The Moisture Content of the Soils

Sample	Weights before drying (g)	Weight after drying (g)	Moisture Content (%)
A	238.28	197.44	17.21
B	354.42	276.45	22.45
C	372.22	308.94	17.56
D	450.38	369.31	18.44
E	270.48	216.38	20.68

From Table 5 above, the moisture content of soils are different according to samples location. This is because, each of the sample are exposed to different level of humidity in environment. The highest moisture content might be because of the shadowed location that are preventing the direct exposed to sunlight, thus making the moisture is less evaporated from soils.

4.2 Standard Solution Calibration Curve

The calibration curves are plotted from the concentrations that were prepared with the respective Absorbance value after it were analyze with Atomic Absorptions Spectroscopy. From the calibration curve, the concentrations of the copper, lead and nickel in the samples can be calculated with respect to their Absorbance values. In order to make the reliability of the calibration curves are trusted, the slope of the curves are measured. The slope approaching the value of 1 is the best and the most reliable curve. The calibration curves for each standard solutions are shown in the Fig. 6, Fig. 7 and Fig. 8 below. The slope for cooper curve is 0.7783, lead curve is 0.997 and nickel curve is 0.9638

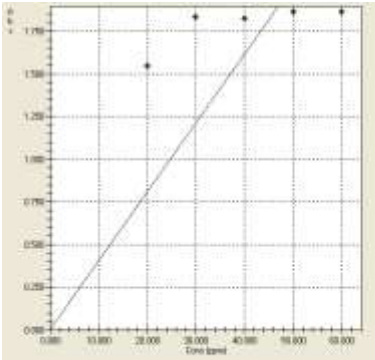

Figure 6: The Calibration Curve (Absorbance vs Concentration) for Copper

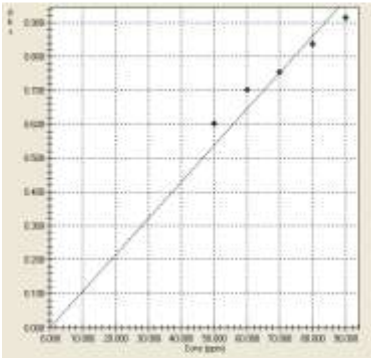

Figure 7: The Calibration Curve (Absorbance vs Concentration) for Lead

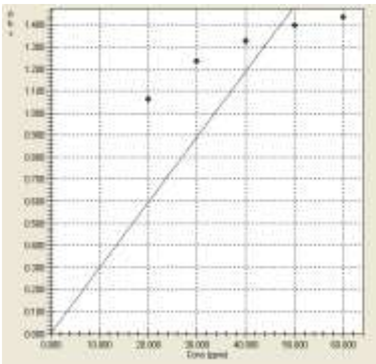

Figure 8: The Calibration Curve (Absorbance vs Concentration) for Nickel

4.3 Concentration of Copper, Lead and Nickel in the Soils

The concentration of the metals calculated by the AAS computer is in unit of mg/l or ppm. To evaluate the concentrations, the unit should be changed into the standard unit which is mg/kg. The conversion from mg/l to mg/kg is shown in the equation below.

$$concentration\left(\frac{mg}{kg}\right) = \frac{AAS\ \left(\frac{mg}{l}\right) x\ Extraction\ Volume\ (l)}{Sample\ weight\ (kg)}$$

The extraction volume for the above equation is 70 ml or equal to 0.07 l.

The sample weight used in the analysis is 5g or equal to 0.005 kg.

Therefore to calculate the concentration of the metals in mg/kg or ppm, the equation is as below:

$$concentration\left(\frac{mg}{kg}\right) = \frac{AAS\ \left(\frac{mg}{l}\right) x\ 0.07\ (l)}{0.005\ (kg)}$$

4.3.1 Copper

After AAS analysis, the measurement of the copper concentrations are obtained based on the calibration curve plotted from the standard solutions. The concentration of the copper in the samples are tabulated in Table 4 below. From the concentrations tabulated in the table, the bar graph of Average Concentration versus Distance from center is plotted. The concentration is then analyze through the bar graph. Fig. 9 below shows the bar graph for the copper. The concentration of copper decreases as the distance from the center increases. The behavior is following showing that the emissions of copper from industrial activities become less as the location farther from the center.

Table 4: The Concentration of the Copper

Samples	Concentration 1 (mg/l)	Concentration 2 (mg/l)	Concentration 3 (mg/l)	Average Concentration	
				mg/l	mg/kg
A	6.6963	6.3205	6.2314	6.4161	89.82
B	6.093	5.9248	4.816	5.6213	78.69
C	5.7023	5.5687	5.5539	5.6083	78.52
D	3.4031	2.3462	3.361	3.0368	42.52
E	1.6775	2.6132	2.5984	2.2963	32.15

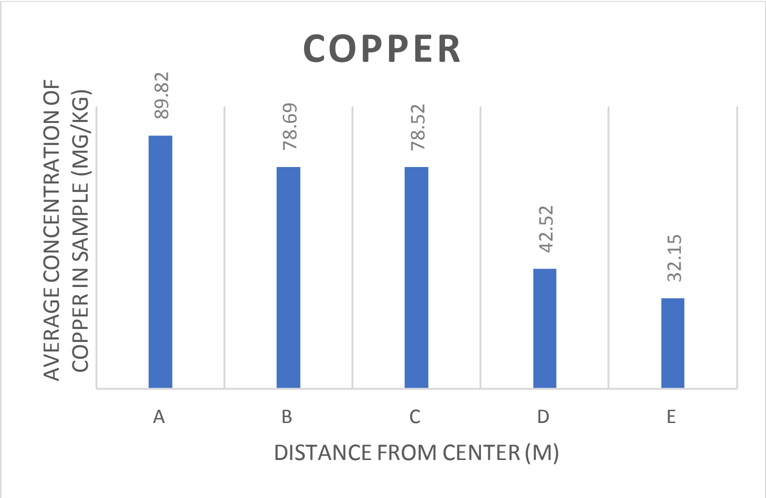

Figure 9: The Average Concentration vs Distance from Center for Copper

From Fig. 9 above, the concentration of copper is the highest as location A with 89.82 mg/kg. This is suspected as A is the center of industrial estate. The emission is expected to be highest at this point. At location B, the concentration is decreased slightly from concentration at A. The reduction of copper emissions is suspected as the reason for the decreased value. At the farthest locations, concentrations of copper 32.15 mg/kg, is lowest as compared to nearer locations.

4.3.2 Lead

After AAS analysis, the measurement of the lead concentrations are obtained based on the calibration curve plotted from the standard solutions. The concentration of the lead in the samples are tabulated in Table 5. From the concentrations tabulated in the table, the bar graph of Average Concentration versus Distance from center is plotted. The concentration is then analyze through the bar graph. Fig. 10 below shows the bar graph for the lead. The behavior of the lead emission follows the trends from copper emissions.

Table 5: The Concentration of Lead

Samples	Concentration 1 (mg/l)	Concentration 2 (mg/l)	Concentration 3 (mg/l)	Average Concentration	
				mg/l	mg/kg
A	12.1377	9.5673	8.132	9.9450	139.23
B	7.622	7.427	4.2785	6.4425	90.19
C	6.6127	4.13	5.0186	5.2538	73.55
D	6.0494	1.8102	4.3342	4.0646	56.90
E	2.9334	0.8355	1.6127	1.7940	25.12

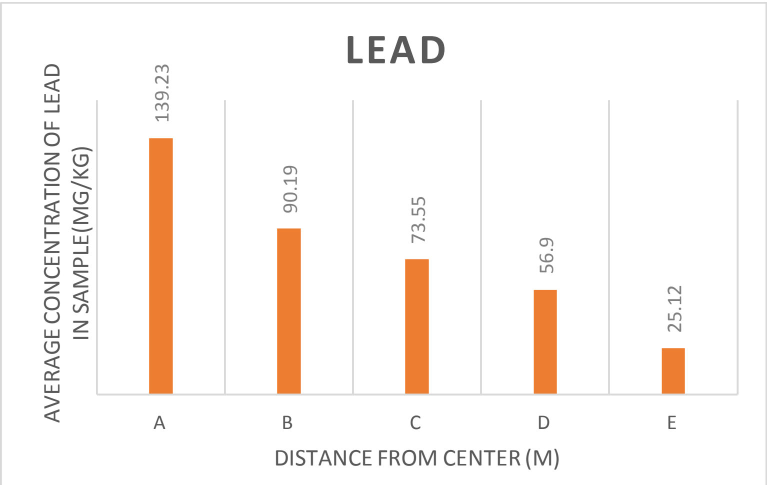

Figure 10: The Average Concentration vs Distance from Center for Lead

From Fig. 10 above, the concentration of lead is the highest as location A with 139.23 mg/kg. This is suspected as A is the center of industrial estate. The emission is expected to be highest at this point. At location B, the concentration is decreased slightly from concentration at A. The reduction of lead emissions is suspected as the reason for the decreased value. At the farthest locations, concentrations of lead 25.12 mg/kg, is lowest as compared to nearer locations.

4.3.3 Nickel

After AAS analysis, the measurement of the nickel concentrations are obtained based on the calibration curve plotted from the standard solutions. The concentration of the nickel in the samples are tabulated in Table 6 below. From the concentrations tabulated in the table, the bar graph of Average Concentration versus Distance from center is plotted. The concentration is then analyze through the bar graph. Fig. 11 below shows the bar graph for the nickel.

Table 6: The Concentrations of Nickel

Samples	Concentration 1 (ppm)	Concentration 2 (ppm)	Concentration 3 (ppm)	Average Concentration	
				mg/l	mg/kg
A	3.6462	2.627	2.2671	2.8468	39.86
B	3.256	2.5597	2.0922	2.6357	36.89
C	1.6751	1.2782	1.1706	1.3746	19.24
D	0.814	0.7198	0.6727	0.7355	10.29
E	0.9317	0.8678	0.9418	0.9138	12.79

From Table 6 above, the concentration of nickel is the highest as location A with 39.86 mg/kg. Concentration of nickel is lowest at location A as compared to copper and lead. The pattern of nickel emission is the same as copper and nickel, except for location D and E. From table above, concentration at D is higher than at E. This is quite contradict with hypothesis being applied in observing the emissions. Even though it is different from the trend of copper and lead, it is not a major concern since the value is close.

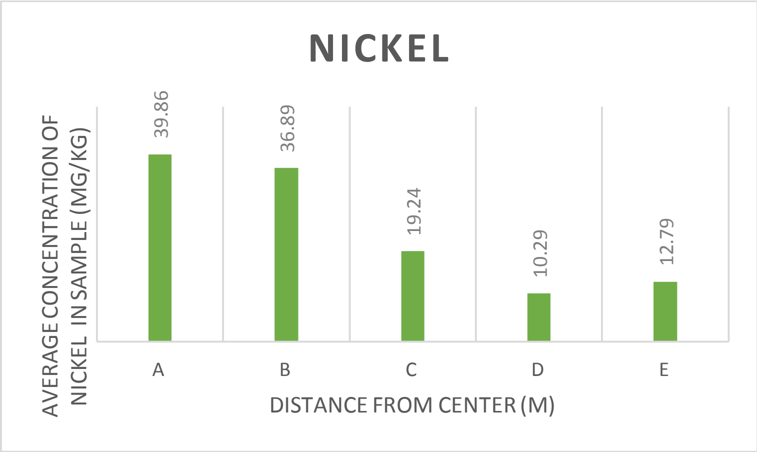

Figure 11: The Average Concentration vs Distance from Center for Nickel

4.3.4 The Exposure Level of Copper, Lead and Nickel

The exposure level of Copper, Lead and Nickel are determined by comparison of the data obtained from field studies with the standard data as listed in the Dutch Target and Intervention Value. This Dutch Standard provide data for the environmental reference. The Target Value are underpinned by an environmental risk analysis wherever possible and apply to individual substances. In most cases, target values for the various substances are related to a national background concentration that was determined for the Netherlands. Therefore, values exceeding the Target Value will be categorized as the unsafe concentration. Heavy metals concentrations that are exceeding the Intervention Value are considered as a serious case of soil contamination (Zarcinas et. al, 2004). The Dutch Standard data are tabulated in Table 7 below:

Table 7: Dutch Standard Data for Selected Metals

Heavy Metal	Target Value (mg/kg)	Intervention Value (mg/kg)
Arsenic	29	55
Cadmium	0.8	12
Copper	36	190
Lead	85	530
Mercury	0.3	10
Nickel	35	210

Table 8 below shows the classification of the exposure level for copper, lead and nickel after comparison with Dutch Standard. The concentration above the Target Value of Dutch Standard is considered as not safe and risky to the residential area. Other than that, the exposure is considered as safe.

Table 8: Level of Heavy Metals Exposure

Distance	Copper Conc.	Exposure Level	Lead Conc.	Exposure Level	Nickel Conc.	Exposure Level
A	89.82	Not safe	139.23	Not Safe	39.86	Not Safe
B	78.69	Not safe	90.19	Not Safe	36.89	Not Safe
C	78.52	Not safe	73.55	Safe	19.24	Safe
D	42.52	Not safe	56.90	Safe	10.29	Safe
E	32.15	Safe	25.12	Safe	12.79	Safe

Figure 11 below represent the heavy metals dispersion from the industrial area to the residential area. The nearest residential area is estimated to be further away from the point source with a distance of 2000 m. The level of copper, lead and nickel are estimated to be safe at the distance of 2000 m. This is stated based on the concentration at the farthest distance, 1000 m. At that point, copper, lead and nickel have the safe exposure level towards the environment and residential area.

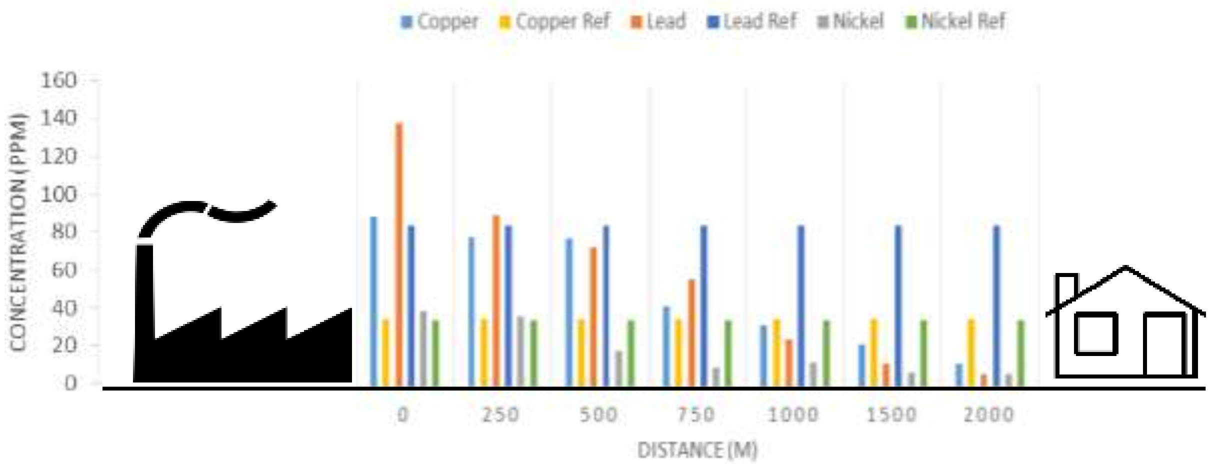

Figure 11: The Dispersal of Copper, Lead and Nickel According to Distance

4.4 Enrichment Factor

The value of Enrichment Factors are calculated using the equation available in the section 2.5. The value of Enrichment Factor calculated are tabulated in Table 9 below.

Table 9: Enrichment Factor

EF_i	Lead (B_i = 47.00 mg/kg)	Copper (B_i = 16.77 mg/kg)	Nickel (B_i = 20.44 mg/kg)
EF_A	2.96	5.36	1.95
EF_B	1.92	4.69	1.80
EF_C	1.56	4.68	0.94
EF_D	1.21	2.54	0.53
EF_E	0.53	1.92	0.49

From the Enrichment Factor tabulated in the table above, only six samples have the value more than 1. Theoretically, when the EF_i is exceeding 1, the presence of that particular element is present unnaturally, in this case, by human activities or industrial activities. The presence of the metal by anthropogenic way proving that the industrial activities at Bemban Industrial Estate are emitting copper, lead and nickel into environment.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The results for the soil samples from the Bemban Industrial Estate, shows that the presence of Copper, Lead and Nickel were detected. This shows that, the industrial activities had released some of the metals to the environment. The first objective of this project had successfully achieved. The concentration of Copper, Lead and Nickel are successfully determined. Besides that, the second objective is also successfully achieved as the dispersal pattern of the Copper, Lead and Nickel are successfully observed. The last objective, calculation of the Enrichment Factor are also successfully achieved. From the Enrichment Factor value, six concentrations of the metals are detected to presence unnaturally. This prove that, nearer to the industrial estate, the heavy metals are emitted to the environment. Based on the results, it shows that industrial activities does emit certain amount of Copper, Lead and Nickel into the environment. The government and other professional bodies should push into regulations where locations of industrial area should not be situated near residential area as formed in Bemban.

5.2 Recommendation

As an improvement, the project could be continued in the future by adding or changing the type of heavy metals being studied such as cadmium and arsenic. The addition can be compared to this study. Besides that, a modelling of equation which relate the concentration with the distance can be designed. The model suggested could help people to find the concentration of copper, lead and nickel with respect to the distance of locations with the center, without the necessity to collect the soil from there. The basic emission of the heavy metals to the environment is by wind. In order to reduce the emission and dispersion of the heavy metals to the area nearer, trees can be planted around it, in order to minimize the heavy metals being blown by wind.

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APPENDICES

Appendix 1: Gantt's Chart for May 2013 Semester (FYP 1)

Activities	Weeks														
	1	2	3	4	5	6	7		8	9	10	11	12	13	14
Proposal						☆		Mid Semester Break							
Proposal Defence									☆						
Collect Samples											☆				
Drying												☆			
Sieve												☆			
Acid Treatment															
Measuring Concentration using AAS															
Analysis and Documentation															
Interim Report Submission															☆

☆Milestone

Start date: 20th May 2013

End date: 23th August 2013

Appendix II: Gantt's Chart for September 2013 Semester (FYP II)

Activities	Weeks													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Experiment Progress						☆								
Samples testing using AAS						☆								
Analysis and Documentation						☆								
Interim Report Submission								☆						
Poster Presentation											☆			
Viva/Final Presentation														
Dissertation / Final Report Submission														

☆Milestone

Start date: 23th September 2013

End Date : 27th December 2013