# COMPARISON OF LOSS ON IGNITION METHOD AND HYDROGEN PEROXIDE METHOD IN DETERMINING THE PERCENTAGE OF ORGANIC MATTER IN SOILS

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Thesis submitted in fulfillment of the requirements
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.

## ABSTRAK

Faktor hakisan tanah (faktor K) dari persamaan USLE mewakili penunjuk hakisan tanah bertindak pada kesan hujan, larian dan proses hakisan lain. Ia boleh terjejas oleh banyak faktor seperti jenis tanah, kadar penyusupan, kadar kebolehtelapan, dan kandungan bahan organik. Tujuan kajian ini adalah untuk memberikan perbandingan dalam menentukan peratusan kandungan bahan organik di dalam tanah. Sampel tanah untuk kajian ini dikumpulkan secara rawak. Sampel dianalisis untuk kandungan bahan organik menggunakan dua kaedah yang berbeza iaitu kehilangan pada kaedah penbakaran (LOI) dan kaedah pencernaan hidrogen peroksida ($H_2O_2$). Untuk kaedah LOI, ia lebih mengarahkan kaedah di mana sampel itu dinyalakan. Untuk kaedah $H_2O_2$, ia lebih rumit kerana menggunakan $H_2O_2$ yang dipanaskan untuk mengurai bahan organik di dalam tanah. Dari hasil yang diperolehi, kaedah LOI memberikan peratusan tertinggi kandungan bahan organik dengan kaedah $H_2O_2$. Jumlah bahan organik dalam tanah dengan kaedah $H_2O_2$ menunjukkan sedikit menurunkan nilai kepada kaedah LOI. Di samping itu, kaedah $H_2O_2$ kebanyakannya memberikan hasil yang rendah untuk beberapa sampel tanah. Tetapi dengan menggunakan kaedah $H_2O_2$ ia memberikan ralat yang lebih kecil semasa pengiraan peratusan kandungan bahan organik. LOI kadang-kadang memberikan hasil yang terlalu tinggi atau sangat rendah, dan kadang-kadang besar kesilapan. Ini kerana peratusan bahan organik hanya dikira kehilangan berat badan selepas pembakaran. Kesimpulannya adalah kaedah terbaik untuk menentukan peratusan kandungan bahan organik adalah dengan menggunakan kaedah LOI, tetapi penggunaan suhu untuk pembakaran perlu dipertimbangkan berdasarkan jenis tanah untuk memastikan ia menyelesaikan sepenuhnya tahap pembakaran tanah

## ABSTRACT

The soil erodibility factor (K factor) of the USLE equation represents an indicator of the susceptibility of a soil to raindrop impact, runoff and other erosion processes. It can be affected by many factors such as soil type, infiltration rate, permeability rate, and organic matter content. The purpose of this study is to provide a comparison in determining the percentage of organic matter content in soil. Soils sample for this study were collected randomly. The samples were analyzed for organic matter content using two different methods whish are loss on ignition (LOI) method and hydrogen peroxide digestion ($H_2O_2$) method. For LOI method, it more directs method where the sample is ignited. For $H_2O_2$ method it is more complicated because it uses heated $H_2O_2$ to decompose the organic matter inside the soil. From the results obtained, the LOI method provided the highest but comparably similar percentage of organic matter content with the $H_2O_2$ method. The total organic matter in soils by $H_2O_2$ method shows slightly lowers value to the LOI method. In addition, the $H_2O_2$ method mostly gives low results for several soils sample. But by using $H_2O_2$ method it gives the smaller errors in during calculation of percentage of organic matter content. LOI sometimes gives too high or very low results, and occasional large the error. This because the percentage of organic matter is only calculated the loss of weight after combustion. Conclusion is the best method of determine the percentage of organic matter content is by using the LOI method, but the temperature use for combustion need to be consider based on the type of soils to make sure that it totally complete the combustion stage of soils.

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## LIST OF SYMBOLS

| | |
|---|---|
| % | Percentage |
| ºC | Degree Celsius |
| µm | Micro Metre |
| mm | Millimetre |
| ml | Millilitre |
| g | Grams |
| cc | Centimetre Cubic |

## LIST OF ABBREVIATIONS

| | |
|---|---|
| LOI | Loss on Ignition |
| $H_2O_2$ | Hydrogen Peroxide |
| USLE | Universal Soil Loss Equation |
| ASTM | American Society for Testing and Material |
| Cu | Coefficient of Uniformity |
| Cc | Coefficient of Gradation |
| BS | British Standard |
| K factor | Soil Erodibility Factor |

# CHAPTER 1

# INTRODUCTION

## 1.1 Introduction

Organic matter is one of the most important components of soil (Schnitzer, 1978). Organic matter in soils is widely distributed over the earth surface occurring in almost all terrestrial and aquatic environments. The organic matter in soil are formed and produced by organisms such as plant and animals and also their waste product in the environment. From another perspective, organic matter content actually refer to the carbon compound that has been found naturally inside a soil that has gone through various stages of decaying process. For example, decaying process of fallen leaves, dead tree trunks, dead animals, or decaying roots. Each type of soil has a different content of organic matter. In some soil condition, there may be a high organic content in the top few inches of soil, but a very low content in deeper layers. Soil with high of organic matter is considered as fertile soils.

The organic matters in soil are important as helping component in soil that to stabilize the soil particles to decrease the soil erosion. For erosion control, based on study before was determine that data used in the Universal Soil Loss Equation (USLE) indicate that increasing soil organic matter from 1 to 3 per cent can reduce erosion 20 to 33 per cent. It happens because the water infiltration increase and stable soil aggregate formation caused by organic matter in that soil. Other than that, organic matters also help soil to improve the soil workability, enhance aeration and also as water penetration of soil. Besides that, soil organic matter also can increase water-holding capacity and also in same time can supplies nutrients for plants and soil micro-organisms to growth.

The determination of organic matter content can be determined using two different methods through combustion and chemical treatment. For the combustion method also known as loss on ignition, the method is straighter forward. When we heat a soil sample to a high enough temperature the organic matter literally begins to burn off. The mineral fraction of the soil is more resistant to combustion and remains behind. Thus, the weight loss during combustion reflects the weight of organic matter in the original sample. But for chemical method, we need to use hydrogen peroxide to test the content of organic matter.

Soil type, the vegetation and climatic conditions may affect not only the quantity, but also the quality of the organic matter of soil in uncultivated soils. There are many factors that affect the content of organic matter such as climatic conditions. The temperature and also rainfall give a major influence on the amount of organic matter found in soil. Usually in real life, forming of organic matter in soil is greater where there are more precipitation and lowest temperatures at surrounding area of soil.

## 1.2 Problem Statement

USLE equation can estimate soil erodibility (K) factor for soil series found. From the equation, the organic matter content in percentage value is one of important part to determine K factor. Based on the previous study of the USLE equation the difference percentage of organic matter content about 1 to 3 per cent will reduce 20 to 30 per cent of soil erosion.

The Organic matter is one of the most important components in soil. In other side, Organic content can affect the stability of soil in that time it also can affect the soil erosions. To get the percentage of organic matter content have varies method. Base on the previous study, the determinations the organic content are have two difference methods that is by $H_2O_2$ method and LOI method. There two different methods will give difference result for percentage organic matter content. $H_2O_2$ will discompose soil organic content by convert to carbon. While, the loss in ignition is the process when soil loss of weight of soil in burning process.

## 1.3 Objectives of Study

The purpose of this study is to determine the more suitable method of measuring organic matter to be used in USLE. The objective is to achieve the purpose are:

a) To determination the percentage of organic matter content in soil samples using Loss on Ignition (LOI) method and Hydrogen Peroxide ($H_2O_2$) method.
b) To determine the comparison of organic content by using of LOI method and $H_2O_2$ method and also discuss the best alternative methods based on the result get that give more accurate result.

## 1.4 Scope of Study

The total of sample collected was fourteen samples collected randomly around Kuantan. The samples collected were numbered from A to M. For sample collection, hand auger was used to collect the samples. The depth of sample collection is 0.5m below the ground level surface. The samples should be undisturbed soil samples. After that, the sample that has been collected was put in resealable plastic bags to avoid contamination of the samples.

This study is to estimate the determination of organic matter content for soil .The different percentage of organic matter in soil with give difference estimation of K value in estimation of soil erosion. This study was conducted two different methods in determine the percentage of organic matter in soil. Based on the laboratory testing, it shows that two different methods will give different percentage of organic matter content in soil.

For experiment work, the testing that were conducted are LOI and $H_2O_2$ method. Results from this study are used to compare and determine the best method to get the accurate percentage of organic matter content in soils. For all the procedure and reference of testing are accordance with ASTM, BS standard and Head (2006). For each type of soil sample are tested in three times for get more accurate percentage for each method in determining the percentage of organic matter in soils.

## 1.5 Significance of Study

The estimation of organic matter content in soils is important in calculating the K factor based on the USLE equation. The determination of method the percentage of organic matter is one of the important part in calculating the percentage of organic matter in soils to prevent overestimation of the value.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 Organic Matter Content

The organic matter content is considered as one of most important components of the soil quality (Schnitzer, 1978). The importance of soil organic matter in supplying nutrients, contributing to exchange capacity, and improving soil structure, is well recognized. On the other hand also, organic matter in soil such as span in soil. It will be function as reservoir for supplied nutrient for help in plant growth. Organic matter also affecting of physical environment of soil suitable for plant growth, effect of soil aggregation, affects water infiltration, drainage and roof penetration (Allison, 1973).

The organic matter present in littoral sediments plays an important role in marine ecosystems and can deteriorate the marine environment upon its decomposition (Hiroki, 2017). The organic matter in soils comprises an accumulation of partially disintegrated and decomposed plant and animal residues and different other organic compounds synthesized by the soil microbes as the decaying of these materials occurs (Weil, 2010). Soil humus or the humic material is a heterogeneous mixture of organic compounds formed by degradation and synthesis of organic soils in soils. Soil humus makes up about 60–80% of the soil organic matter, whereas the remaining part comprises less stable and partially decomposed organic residues.

## 2.2 Determination of Organic Matter

In determine the percentage of organic matter that is having two different methods that is by $H_2O_2$ and LOI. All these two methods have different kinds of limitations. Although the method $H_2O_2$ has conventionally been considered to be the standard method for the estimation of the organic matter content of agricultural soil samples, it is not a well-adapted for the rapid analysis of a large number of samples. It makes errors with soils containing high levels of Magnesium and cannot address the measurement of charcoal in many soils (Kimble et al., 2000). Other more, for $H_2O_2$ method (Grossmann, 1908) found that $H_2O_2$ converted from 60 to 90 per cent of the total carbon of the soil to carbon dioxide.

The LOI method is a technique that can be considered causing no hazards to human health and environment with the added advantage of being comparatively simpler. However, different laboratories use various temperatures for the burning, giving rise to variable and inconsistent results. (Ball, 1964) suggested that use of low temperatures (below 400°C) would reduce the extent of structural water losses from clays. However, this has been questioned because such low temperatures lead to very long analysis times and incomplete burning of organic matter in soils producing underestimated organic matter contents (Howard and Howard, 1990).

### 2.2.1 Loss on Ignition

LOI method, which involves combustion of samples at high temperatures and measuring weight loss after ignition, has been proposed to be an inexpensive and convenient method for estimation percentage of soil organic matter content (Konen, 2002). The ability of the LOI method to determine soils organic matter content has been considered reliable (Abella, 2007). However, optimal heating temperatures and durations to maximize of soils organic matter combustion, while minimizing inorganic carbon combustion, are difficult to determine. Both of these variables can substantially affect LOI results (Ben-Dor and Banin, 1989).

Loss on Ignition analysis is used to determine the organic matter content of a soil sample. This is a relatively simple procedure compared to others used to determine. It does not involve the use of any chemicals, only the use of a muffle furnace. LOI calculates by comparing the weight of a sample before and after the soil has been ignited. Before ignition the sample contains organic matter, but after ignition all that remains is the mineral portion of the soil. The difference in weight before and after ignition represents the amount of the organic matter that was present in the sample (Robertson, 2011).

LOI method is testing that determinate the organic matter content in soil involving the process of heating all organic matter in soil. In testing will put a sample into ceramic crucible and will be heated between 350ºC and 440ºC overnight (ASTM, 2000; Nelson and Sommers, 1996). After sample through process of heating, sample is then cooled in a desiccator and weighed the sample. Organic matter content is calculated as the difference between the initial and final sample weights divided by the initial sample weight times 100%. LOI method temperatures should be maintained below 440ºC to avoid the destruction of any inorganic carbonates that may be present in the sample.

### 2.2.2 Hydrogen Peroxide

The Division of Soil Chemistry and Physics of the Bureau of Chemistry and Soils has for some years used $H_2O_2$ as a part of the procedure of the method of mechanical analysis of soils. This method is based on the international method, essentially the British official method. $H_2O_2$ is primarily employed to ensure increased dispersion by removing the organic matter (Alexander, 1932). It shows that, the $H_2O_2$ can help to digest the organic matter content in soils. But, based on previous study by (Robinson, 1927) shows that by using $H_2O_2$ method there are has some limitation to define the organic matter content in his first suggested method.

Total soil organic matter that can be oxidized by mean of $H_2O_2$ concentration. But, for $H_2O_2$ it not only oxidizes the humified substance but also decomposes completely all other forms of organic content (Robinson, 1927). $H_2O_2$ digestion method has several limitations that markedly reduce its effectiveness to quantify organic matter. The major limitation of the peroxide digestion technique is that the oxidation of the organic matter is incomplete and the extent of oxidation varies markedly from one soil or sediment to another (Robinson, 1927). Another potential source for error with this method is the loss of volatile organic compounds if samples are oven dried prior to digestion. It should be noted that this method is a common pre-treatment during the determination of particle-size distributions in soils and sediments since organic matter is known to bind particles together.

The $H_2O_2$ method the soil organic matter is determined from the loss in weight caused by digesting the soil with $H_2O_2$ (Robinson, 1927). Based on the pervious study ,show that by using $H_2O_2$ it will decompose more organic matter content of soil. But it seemed possible that the organic matter content might be determined by treating a sample of soil with $H_2O_2$ and nothing with the loss in weight. The determination of organic matter content in soil can be determined by using chemical reaction. $H_2O_2$ is one of the others method to determine the percentage of organic matter by converting it to carbon dioxide by mean of moist and dry combustion. For each of soil can be content of different percentage of carbon. In other word, the percentage of carbon in the organic matter of soils varies widely depend on the soil type.

Based on the previous study, show the different ability of $H_2O_2$ in digests the organic matter content. (Robinson, 1927) found that it very serious limitation. $H_2O_2$ does not remove all the carbon or carbon compounds from the soil (Robinson, 1927). The result obtained the residual carbon found after treatment with $H_2O_2$ ranged from 0.04 to 1.90 per cent in the samples examined. It was believed that for the most part this residual carbon consists of adventitious charcoal or graphite and is therefore not actually soil organic matter in the ordinary sense.

But, the different opinions in research about the ability of $H_2O_2$ in determine organic matter. $H_2O_2$ used is roughly proportional to the quantity of organic matter in the soil and about 60 to 90 per cent of the total carbons in soil are converted by using $H_2O_2$ (Cameron, 1904).

$H_2O_2$ is of off the mechanical analysis to destroy the organic matter content of soil which prevented the deflocculation of the soil particles (Robinson, 1932). From the study, Robinson obtain that the destruction of the organic matter is not complete. Then the new research has been continuous. Cotton fibre, crude fibre from straw was not decomposed by $H_2O_2$ under experimental condition. But, organic matter which had been extracted from soils by ammonia was completely decomposed the determination of difference between the humified and non-humified organic matter of soil has been proposed to use of $H_2O_2$ . By subtracting the ignition loss of the soil after treatment with $H_2O_2$ can be determine the humified organic matter (Jones, 1925).

The percentage of organic matter destroyed is doubtless somewhat too low, since the LOI is almost invariable greater than the organic matter contained in a soil. The previse study from Robinson took precautions to minimize this error by selecting soils free from carbonates and, presumably, low in combined water, since they were of low clay content. Method for determining the degree of humification of soil organic matter by oxidizing the humified part with a dilute solution of $H_2O_2$ haven been proposed by (Jones, 1925). For that method, it can conclude that a method may be discovered by which the oxidation may affect only humified part of soil organic matter. From that , an assumption have been made that thought the action of $H_2O_2$ that the artificial humification of undecomposed residues is first obtained and only afterwards does complete oxidation of the whole soil organic matter result.

## 2.3 Comparison of Hydrogen Peroxide and Loss on Ignition Methods in Determining Organic Matter

For comparison of the quantity of percentage of organic matter content that was determine by using $H_2O_2$ and LOI method is one of important part. Although, by using the method of LOI consider determine the total organic matter that content in soils is can give accurate percentage by considering the temperature in burning process used based on the soils type. Since considerable carbon is found in the residues. The $H_2O_2$ method has an advantage in that it gives a direct determination of the weight of the organic matter destroyed. Since, the quantity of not decomposed carbonaceous matter is small in many cases. It would seem that this method might give results as near the correct value as would the loss in ignition methods (Robinson, 1927).

The results of these combustion determinations by $H_2O_2$ show that the percentages of organic matter obtain more lowers than using of LOI method. Based on the previous study, the organic matter determined by $H_2O_2$ method is corrected for the carbonates present in the residues. All percentages are calculated on the dry weight of the untreated material.

# CHAPTER 3

# METHODOLOGY

## 3.1 Introduction

This chapter will be discussing on how the methods will be obtained in order to achieve the objectives of this study. In this study, it will be utilizing the quantitative way of experimental approach methodology. For this study, testing analysis will be more on laboratory works to obtain the percentage of organic matter. Figure 3.1 shows the flowchart of the research methodology process.

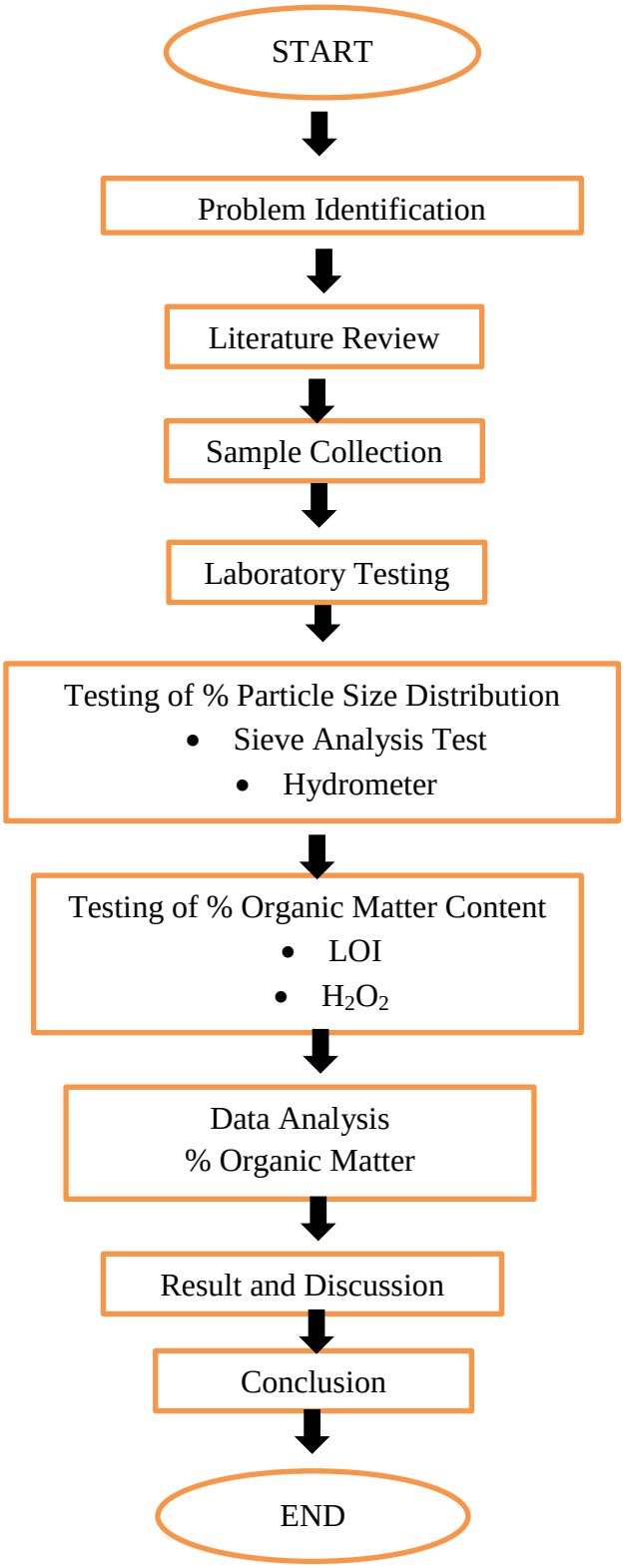


Figure 3.1: Flowchart of Research Methodology Process

## 3.2 Sample Collection

In sample collection, the reference standard that used is American Society for Testing and Materials (ASTM). The sample collecting will use auger type of hand-operated auger that we used is Post-Hole Auger of Iwan Type. Iwan type of hand auger consists of two tubular steel segments. This segments is connected to the top of a handle or extension to form a nearly complete tube but with opposite openings.

At the end, it has two radial blades pitched. This radial blades function as cutters as well as blocking the contained soil from escaping. Auger boring is very more easy compare to wash boring, percussion or rotary drilling as it is fast and economical due to the equipment used which is light and inexpensive. This boring is so suitable for soft to stiff cohesive soils but not suitable for saturated cohesionless soil. The procedure is very simple according to (ASTM, 2009)**.** The auger is bored by rotating and advanced to the desired distance. For this study the depth of the sampling is fixed at 0.5 meters from the ground. The auger is then with draw from the hole and the soil is removed. The empty auger is returned to the hole and the procedure is repeated until the required depth is fixed.

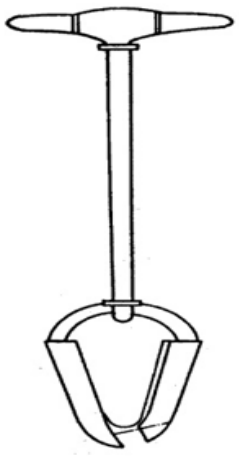

Figure 3.2: Post-Hole Auger of Iwan Type
Source: http://www.abuildersengineer.com/2012/10/boring-methods-site-exploration.html

## 3.3 Particle Size Distribution Testing

The particle size distribution of a material can be important in understanding its physical and chemical properties. By doing the particle size distribution it can determine the classification of soil based on the size of distribution soil. The particle size distribution of soil can affects the strength and load-bearing properties of soils. To determine the soil particle size distribution, need to do sieve analysis and hydrometer test for each soil sampling.

### 3.3.1 Machinery Sieve Analysis Test

Mechanical sieve analysis usually use for coarse grained soil, it can determine the distribution of soil for the larger grain sizes. The standard grain size analysis test determines the relative proportions of different grain sizes as they are distributed among certain size ranges.

Start the soil testing with oven dried about 500g soil sampling. Usually for sample preparation the sizes of sample is greater than 4.75mm. Then arrange all the sieve sizes according to British Standard (BS) are shown in Figure 3.3. In mechanical sieve test, the soil was passed through a series of sieves. However, the sieves were arranged with the mesh size reducing progressively. In this test, the test sieves of sizes 6.30 mm, 5.00 mm, 3.35 mm, 1.18 mm, 600 µm, 300 µm, 150 µm , 63 µm and lastly ended with pan used according to BS. Then, the proportions by weight of soil that was retained on each sieve are measured. The duration of the sieve test was about 10 minutes.

| Aperture size | A. Full Set (19) | B. Standard Set (13) | C. Short Set (7) | Suitable sieve diameters | | |
|---|---|---|---|---|---|---|
| | | | | 450 mm | 300 mm | 200 mm |
| 75 mm | + | + | | + | | |
| 63 mm | + | + | + | + | | |
| 50 mm | + | | | + | | |
| 37.5 mm | + | + | | + | + | |
| 28 mm | + | | | + | + | |
| 20 mm | + | + | + | + | + | |
| 14 mm | + | | | | + | |
| 10 mm | + | + | | | + | |
| 6.3 mm | + | + | + | | + | |
| 5 mm | + | | | | + | |
| 3.35 mm | + | + | | | + | + |
| 2 mm | + | + | + | (+) | + | + |
| 1.18 mm | + | + | | | | + |
| 600 μm | + | + | + | (+) | + | + |
| 425 μm | + | | | | | + |
| 300 μm | + | + | | | | + |
| 212 μm | + | | + | | | + |
| 150 μm | + | + | | | | + |
| 63 μm | + | + | + | (+) | + | + |

Note: Many other test sieves, up to 125 mm and down to 38 μm aperture size, are available. They are manufactured to BS 410: 2000. (+) indicates sieves useful for wet sieving of large samples.

Figure 3.3: All Sieve Sizes According to British Standard

Source: Head (2006)

### 3.3.2 Hydrometer Test

Hydrometer analysis test usually use for determine the size distribution of a fine grained soil.in other word, it determine size for material passing the 63 μm. If the sample are less than 10% passing 63 μm, the testing cannot be carried out. In case of fine grained soil, sieve analysis test does not give reliable test result. This because a fine grained soil consist of different sizes of particles starting from 0.075 mm to 0.0002 mm and it is not practicable to design sieve having so smaller screen size. Also there is a chance of loss of sample during sieving of sample. For the hydrometer test the sample are continuous from sieve analysis test that sample passing 63 μm is collected.

In hydrometer test, the soil is mixed with water and a dispersing agent. For this testing, use Sodium Hexametaphosphate solution as dispersing agent. Start for prepare sample with warm and gently the sample about 10 minutes with Sodium Hexametaphosphate before transfer the sample to wash with distilled water. The sample that passing throw 63 µm will use as hydrometer test sample. The entire samples are transfer into hydrometer jar. Take another hydrometer jar with 1000cc distilled water to store the hydrometer in between consecutive readings of the soil suspension to be recorded. Next, Transfer the suspension to the hydrometer jar and make up the volume exactly to 1000cc by adding distilled water. Then, Take another hydrometer jar with 1000cc distilled water to store the hydrometer in between consecutive readings of the soil suspension to be recorded. Before put the hydrometer jar with sample into tub, make sure sample is stirred vigorously and allowed to settle to the bottom of a measuring cylinder.

Take the subsequent hydrometer readings at elapsed timings of 4, 9, 16, 25, 36, 49, 60 minutes and every one hour thereafter for each reading at the total elapsed times of ¼, ½, 1 and 2 minutes. Each time a reading is taken remove the hydrometer from the suspension and keep it in the jar containing distilled water. Care should be taken when the hydrometer recorded to see that the hydrometer is at rest without any movement. As time elapses, because of the fall of the solid particles the density of the fluid suspension decreases reading, which should be checked as a guard against possible error in readings of the hydrometer.

The specific gravity of the mixture reduces as the soil particles settle out of the suspension. The variation of specific gravity with time was recorded using a hydrometer as shown in Figure 3.4. By making use of Stoke's Law that relates the velocity of a free falling sphere to its diameter, this test provide the particle diameters and the % by weight of the sample finer than a particular particle size. The diameter of soil grain can be calculated using

$$v = \frac{GS-GW}{18\eta}(D)^2 \qquad \text{(Eq 3.1)}$$

Where,

v = Settling velocity of the fluid, water plus dispersing agent

$G_s$ = Specific velocity of the soil solids

$G_w$ = Specific gravity of the water and dispersing agent solution

η = Absolute viscosity of the suspending fluid which depends on the temperature

D = Particle diameter

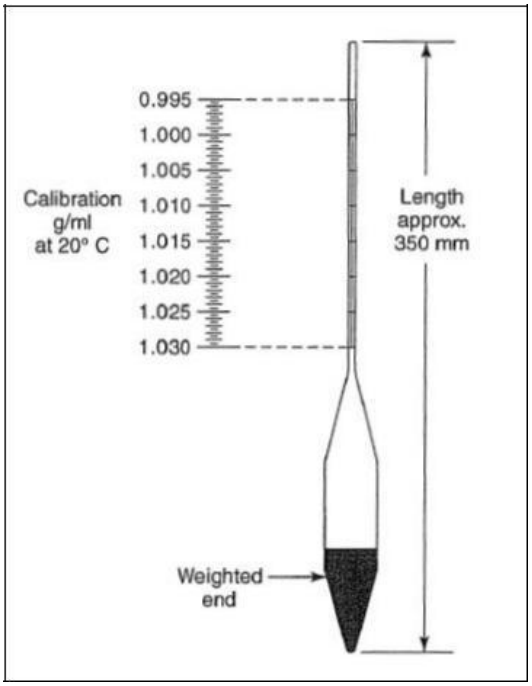


Figure 3.4: Soil Hydrometer

Source: Head (2006)

## 3.4 Testing For Organic Matter

For determine the percentage of organic matter in soils are divide in two methods that is by LOI and $H_2O_2$ methods. In the laboratory works, all the testing follow by standard according to BS and Head (2006) to determine the percentage of organic matter content.

### 3.4.1 Loss of ignition (LOI)

For measuring the organic matter content in soils the LOI by method of combustion. There are plenty of factors that will influence its accuracy during the measurement such as the furnace type, sample mass, duration and temperature of ignition and clay content of samples. In this study, the loss of ignition test on samples only involves the use of muffle furnace and does not involve the use of any chemicals. In this test using ASTM D 2974, the testing method will be according to the test methods C and D. We will need to determine the ash content of an organic soil sample by igniting the oven-dried sample which is from the moisture content determination in a muffle furnace at 440˚C for test method C or 750˚C for test method D. After the ignition the sample remaining will be ash. The content of the ash is expressed as a percentage of the mass of the oven-dried sample and to find the organic matter, we will be subtracting the percentage of ash content from one hundred.

### 3.4.2 Hydrogen Peroxide ($H_2O_2$)

$H_2O_2$ is unlike LOI method, would not be expected to affect the combined water content or appreciably change the weight of the inorganic material. In testing the use of $H_2O_2$ for determining organic matter, information has been obtained regarding the decomposability of various kinds of soil organic matter when applied to the organic matter of different soils.

By using $H_2O_2$ method, the organic matter is determined from the loss in weight caused by digesting method destroys the organic matter in the sample through oxidation the soil using $H_2O_2$. $H_2O_2$ digestion involves the addition of concentrated $H_2O_2$ (30% or 50%) to a known weight of soil. $H_2O_2$ is continually added to the sample until sample frothing ceases.

The method adopted in this investigation is described as follows about 50-100g of soil that passing saving 2mm the soil sample is weighted and putted into conical flask .after that, add 150 ml hydrogen peroxide. Stir and covered and then let it overnight. After that, heat that sample at $60^{O}C$ during peroxide addition to increase the speed and completeness of the peroxide digestion. Care must be taken to avoid excessive frothing and sample loss over the lip of the digestion container. Wait until it reduces about 50ml. While doing the heating process, stir to avoid bubbles in sample solution. For peat soil, add more $H_2O_2$ to more accurate result. Next step, wait until sample cool and start to filter sample using Buchner funnel. In process of filter going, wash sample truly with distilled water. After finish the process of filter, sample is dried at $105^{\circ}C$, cooled in a desiccator, and weighed. Organic matter content is determined gravimetrically and calculated as the difference between the initial and final sample weights divided by the initial sample weight times 100%.

# CHAPTER 4

# RESULTS AND DISCUSSION

## 4.1 Introduction

In this chapter, it will focus on discuss about result and discussion that has been obtain from the testing that already conducted based on the discussion on the previous chapter.

## 4.2 Machinery Sieve Analysis Test Result

In the sieve analysis results, the uniformity coefficient was determine which was Coefficient of Uniformity (Cu) and Coefficient of Gradation (Cc) from the particle size distribution of each soil samples. Therefore, the typical values used in determining the uniformity coefficient were $D_{10}$, $D_{30}$ and $D_{60}$. The $D_{10}$, $D_{30}$ and $D_{60}$ can be recognized as the average particle size. $D_{10}$ was the effective particle size. It represent the 10 per cent of the particles which are finer and 90 per cent of the particles are coarser. While, $D_{30}$ shows that the sample consist of 30 per cent of fine and 70 per cent of coarser. $D_{60}$ was the soil particles diameter for which the 60 per cent of the soil particles are finer and the remaining 40 per cent are coarser than $D_{60}$. Cu was the ratio of $D_{60}$ by $D_{10}$ while the Cc was equivalent to the ratio of $D_{30}$ square by $D_{60}$ multiplies $D_{10}$. The purposes of the Cu and Cc serve as a measure of the gradation as well as classification of the soil.

According to (Das and  Sobhan, 2014), there are three type of grading curves which is well graded curve, uniformly graded curve and poorly graded curve as shown in Figure 4.1. The curve I is a poorly graded soils which the grains of the soils are mostly same size. Cu for poorly graded soils less than four. The curve II represents a well graded soil. A well graded soil is where the soil particle sizes are distributed over a wide range. In the meantime, the curve III shows us the gap graded soil. A gap graded soil will sometimes show the combination of two or more uniformly graded fractions. For the well graded soils, the Cu must greater than four for gravels and six for sand. The Cc for sands and gravels are around one to three.

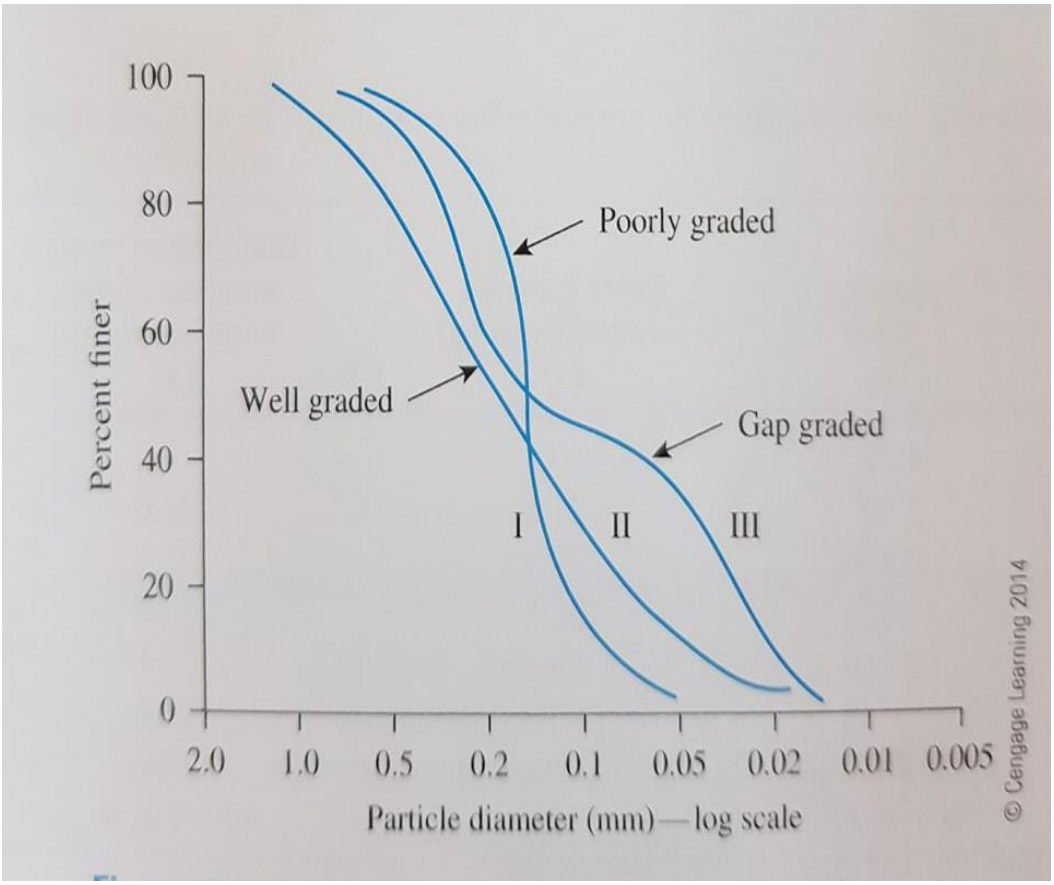


Figure 4.1: Different Particle Size Distribution Curve

Source: (Das and Sobhan, 2014)

From the thirteen soil samples, the computation of Cu and Cc were shown in Table 4.1 The computation of Cu and Cc were taken from the average of the three samples for each soil series. Based on the results, the Cu for the soil samples were mostly less than six except C, L and M. This is because the particle size distribution graph for C and M sample shows sample is well graded curve but contrasting to the L soils sample shown a poorly graded curve.

Table 4.1: Machinery Analysis Test Results

| **Soil Samples Name** | **Coefficient of Uniformity,Cu** | **Coefficient of Gradation,Cc** |
|---|---|---|
| A | 4.2 | 2.1 |
| B | 4.9 | 0.8 |
| C | 3.4 | 1.3 |
| D | 3.2 | 1.3 |
| E | 5.1 | 1.1 |
| F | 4.7 | 1.3 |
| G | 5.0 | 1.1 |
| H | 7.8 | 0.9 |
| I | 5.2 | 1.8 |
| J | 5.6 | 1.2 |
| K | 3.8 | 0.9 |
| L | 11.1 | 3.1 |
| M | 9.4 | 0.9 |

## 4.3 Hydrometer Test Result

Hydrometer test is normally carried out for fine grained soil as the sieve analysis does not provide a test result that is reliable. The fine grained soil range from 0.075 mm to 0.002 mm and this range of sizes are not suitable for sieve analysis as there are no sieves with smaller screen size. There also a possibility of sample lost during sieving. Therefore, the grain size analysis of fine grained soils is usually done with hydrometer analysis. In the hydrometer testing, the testing was done with three samples of each soil series.

In such a way, the comparison and averaging the fine analysis results between the three samples of each soil series were done. The per cent finer of silt particle of which sizes range from 0.05mm – 0.002mm and per cent finer of clay particles which means particles smaller than 0.002mm were obtained. The percentage finer of silt and clay are shown in Table 4.2.

Table 4.2: Silt and Clay Percentage for Soil Samples

| Soil Samples Name | Silt, % | Clay, % |
|---|---|---|
| A | 0.03 | 0.21 |
| B | 0.04 | 0.08 |
| C | 0.07 | 0.17 |
| D | 0.13 | 0.12 |
| E | 0.13 | 0.31 |
| F | 0.14 | 0.18 |
| G | 0.14 | 0.64 |
| H | 0.15 | 0.39 |
| I | 0.18 | 0.22 |
| J | 0.22 | 0.20 |
| K | 0.25 | 0.31 |
| L | 0.29 | 0.19 |
| M | 0.46 | 0.32 |

### 4.4 Loss on Ignition Test Result

Organic matter content in soils is widely distributed over the earth surface (Schnitzer, 1978). Organic matter is a part that consists of plant and animals that undergoes several stages of decomposition (Greenland, 1980). The percentages of organic matter content for each soil are different based on the condition of soil. There are several factors that affect the percentage of organic matter such as temperature and rainfall for that area of soil. Other than that, the poor drainage soils that will make high moisture content also affect the percentage of organic matter content in soils.

Table 4.3 shows that the percentage of organic matter content for each soil sample that using the LOI method. The range of organic matter was not more than twelve per cent. Soil sample M had the highest percentage of organic matter with 11.13% by using LOI method. A high percentage of organic matter made the soil highly resistant to the soil erosion as organic matter helps to bind the individual soil particles together to form large stable aggregates. This large stable aggregate has the capability to resist erosion as well as withstand the forces of raindrop impact (Bot and Benites, 2005).

Table 4.3: The Percentage of Organic Matter in Soil by Using LOI Method

| **Soil Samples Name** | **Percentage of Organic Matter Using LOI Method** |
|---|---|
| A | 4.87 |
| B | 10.98 |
| C | 2.83 |
| D | 1.86 |
| E | 5.52 |
| F | 5.17 |
| G | 1.91 |
| H | 4.12 |
| I | 6.11 |
| J | 2.23 |
| K | 7.40 |
| L | 1.49 |
| M | 11.13 |

### 4.5 Hydrogen Peroxide Digestion Test Result

The result for determine percentage of organic matter using hydrogen peroxide digestion show in Table 4.4. By using $H_2O_2$ method, the percentages obtain more low than by LOI method. For all fourteen sample series, it show sample M have highest percentage of organic matter that is 24.30%.

Table 4.4: The Percentage of Organic Matter in Soil by Using $H_2O_2$ Method

| **Soil Samples Name** | **Percentage of Organic Matter Using $H_2O_2$ Method** |
|---|---|
| A | 6.66 |
| B | 8.41 |
| C | 2.36 |
| D | 1.64 |
| E | 3.78 |
| F | 3.81 |
| G | 2.05 |
| H | 2.36 |
| I | 6.43 |
| J | 3.32 |
| K | 4.69 |
| L | 1.99 |
| M | 24.30 |

## 4.6 Comparison Result between LOI and $H_2O_2$

Table 4.6 shows the percentage of organic matter content using LOI and $H_2O_2$ obtain during the experiment that has been done fourteen samples collected around Kuantan area.

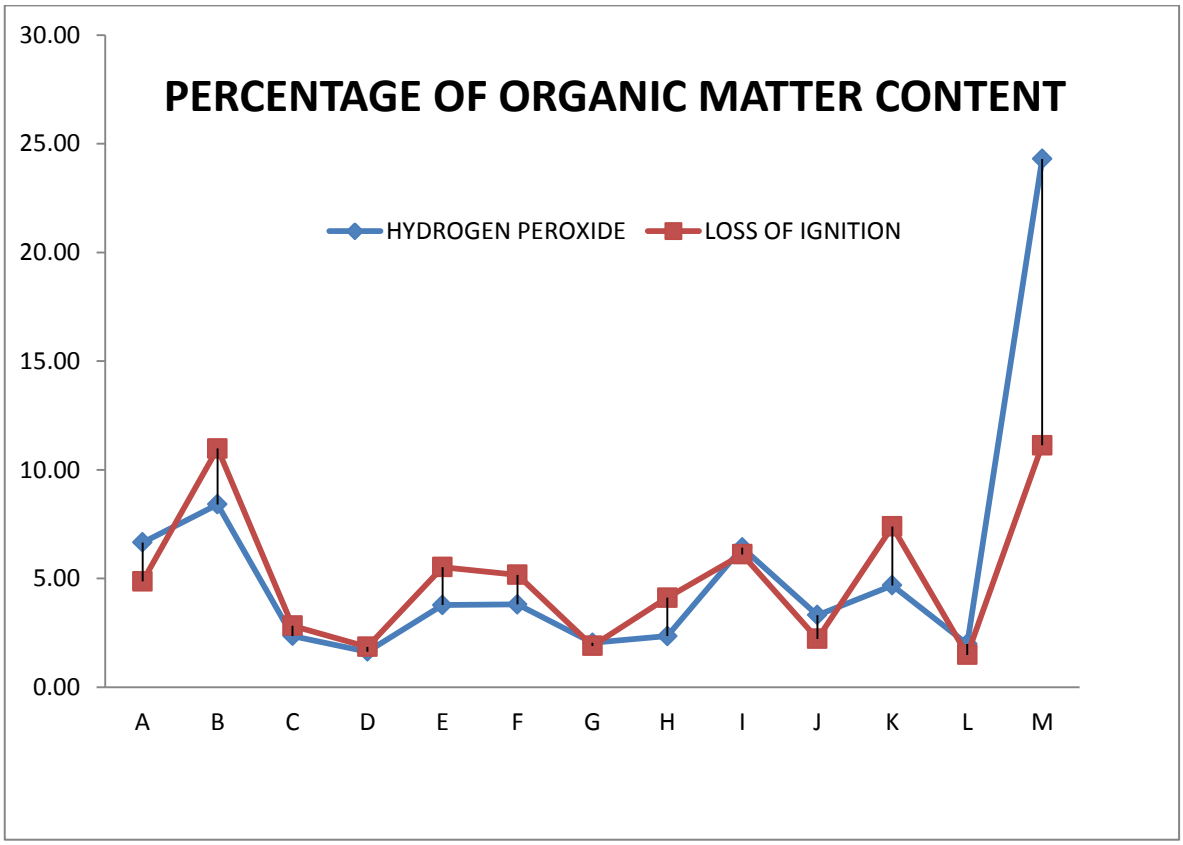


Figure 4.2: The Percentages of Organic Matter Content Using LOI and $H_2O_2$ Method

For the result shows that determining the total organic matter in soils by $H_2O_2$ method shows little percentage of organic matter more lowers to the LOI method. The $H_2O_2$ method mostly gives low results. But by using $H_2O_2$ method it give the smaller errors in calculating the percentage of organic matter content. Furthermore for The LOI method, it's sometimes gives too high or too low results, and occasionally the errors are large. This because the percentage of organic matter is only calculated the loss of weight after combustion.

Determination of percentage organic matter content of different soil sample showers variations among the difference technique used. The percentage of organic matter content using LOI method showed a wide range for testing the soil type sample. For the most tested has been done on the soil sample, the LOI method provide the highest or comparably similar percentage of organic matter content with the $H_2O_2$.

For $H_2O_2$ method, it does not involve the use of an empirical conversion factor and burning at too high or too low temperature that would cause errors in final calculations of soil organic matter contents. However, the removal of the organic matter was not complete with $H_2O_2$. Samples may be heated to 60°C during peroxide addition to increase the speed and completeness of the peroxide digestion. Based on the previous study by (Robinson, 1922) reported findings on the can use of hydrogen peroxide for determining soil organic matter content with various kinds of organic matter. However, materials such as cotton fiber and crude fiber from straw are not decomposed by hydrogen peroxide whereas humus or organic matter which had been extracted from soils by ammonia was completely decomposed (Robinson and Jones, 1925).

# CHAPTER 5

# CONCLUSION AND RECOMMENDATIONS

## 5.1 Introduction

In conclusion, the two specific objectives set earlier had been achieved through the study. First objective is to determine the percentage of organic matter in soils by using Hydrogen Peroxide method and loss on ignition method. From the laboratory testing done, it shows that by using the LOI method, the percentages of organic matter in soils are highest than by $H_2O_2$. It shows that by using LOI method, all the organic matter that content in soils is fully ignition at high temperature. But some of soils sample show that by using two different methods, the percentage of organic matter obtain is similar. From this research show that, by LOI method the determine percentage of organic matter in soils is more to true value than by $H_2O_2$. The estimation of organic matter in calculated soil erodibility factor, K in the USLE model important to prevent overestimate in computed the soil erosion rate. After archive the first objective of this study, the second objective of this study is to determine the most accurate method in determine the percentage of organic matter in soil by this different method.

With regards to the all objectives of the study, there are several points that can be concluded from this study such as the percentage of organic matter in soil, use LOI method to get accurate result and by LOI method the percentage are nearest to correct value. This is because, by using $H_2O_2$ method it's to fully decomposed the organic matter in soil. Other more, $H_2O_2$ cannot decompose all material such as crude fibre in soil. It only decomposed humus in soil.

For LOI method, this method is mostly accurate method. But, in using LOI method it must need to consider the high temperature that will be used in ignition process. This is important to make sure that all the organic matters in soil are fully burning and with high temperature it not changes the properties of soils sample. Considering the cost of analysis and the high labour requirement in the $H_2O_2$ and it appeared that the LOI method is the most suitable for analysing the organic matter contents of soils, simply and rapidly, for a wide range of soil organic matter content levels.

## 5.2 Recommendations

These study findings suggest that there should be a few recommendations for improvements to be carried out so that the future studies on the methods use in determine the percentage organic matter in soils.

a) Minimize all the human error during the laboratory work.
b) There should be a continuous studies on the difference method in determine the percentage of organic matter content in soil series as there are none previous study before.
c) To ensure that the samples are not fill soil or others, the samples must be taken from the original soil at the area

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