Development of a System for Crude Oil Classification

By

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FINAL PROJECT REPORT

Submitted to the Electrical & Electronics Engineering Programme
in Partial Fulfilment of the Requirements
for the Degree
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CERTIFICATION OF APPROVAL

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Approved:

____

Your Supervisor's Name
Project Supervisor

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

May 2014

CERTIFICATION OF ORIGINALITY

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

____

Your Full Name

ABSTRACT

Crude oil is the most sought petroleum product and can be found in different places of the world. It is composed of hydrocarbon, organic compounds and small amounts of metal, this mixture can be refined to produce thousands of products that are generally called petrochemicals including gasoline, diesel oil and plastics. Crude oil can be classified according to the physical and chemical properties of the oil, such as API Gravity of the oil, viscosity, colour and specific gravity. It can also be classified as either "sweet" or "sour" crude oil based on its sulphur content. However, the API gravity classification technique is perhaps the most important because it gives good indication of the commercial value or the price of the given oil. In terms of API gravity, the crude oil is classified as light, medium, heavy and extra heavy crude oils. The classification is done in the laboratory and it’s considered as a time-consuming process.

The scope of this project is to design a system that can minimize the time to classify the crude oil into two types by measuring the optical properties of the oil, applications for this system are mostly used in oil and gas field.

ACKNOWLEDGEMENTS

"Praise to Allah, the most Gracious and the most Merciful"

First and foremost, my deepest gratitude to God, for He had given me strength and guidance to overcome the challenges and problems in completing my final year project program. I would also like to greet my family for giving me great support from the beginning of my journey until the end.

I want to thank UTP for such a wonderful opportunity that helps the student to gain the experience to be more innovative, creative and successful engineer in the future. Also I want to send special thanks to the Egyptian Ministry of Petroleum and for as my official sponsors for pursing my undergraduate studies in UTP. My sincerest appreciation goes to my Supervisor, Dr. Josefina Barnachea Janier who gave me all the support needed throughout the project including but not limited to supplying me with large amount of literature review and providing me with samples at which my experiments and research were conducted.

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CHAPTER1

INTRODUCTION

1.1 Background of Study:

Crude oil is a fluid formed underneath earth's crust, its main components are hydrocarbons, organic compositions and varied amount of metals. Hydrocarbons have the highest percentage in the formation of crude oil; in which they can vary between 50% and 90% in the composition of the crude depending on the type of the oil and how it is extracted. Organic compounds such as oxygen, sulphur and nitrogen typically contribute between 6%-10% of crude oil. Metals Like copper, nickel, vanadium and iron take part by less than 1% of the total composition.

Crude oil is considered as the non-permanent conventional, main source of energy being used nowadays, primary classification of the produced oil from oil wells is mandatory to estimate the significance of the well commercially before it is transported to process plant for further treatment. This project is basically to design a system that can be used to differentiate between different types of oil using electrical resistivity (or conductivity).

The process of crude oil classification is typically conducted at laboratory based on API gravity or sulphur content of the oil.

Classification of crude oil based on API gravity

To develop a classification system where the crude oil can be classified accordingly, various available classification techniques should be studied to be able to compare between the experimental findings with available data collected about the properties of the oil. Crude oil can be classified according to API gravity. In oil and gas industry, API gravity is used to measure how heavy or light a petroleum fluid when compared to water in terms of specific gravity and density properties and it is expressed as degree API.[1] API gravity is an inverse measure of the relative density of petroleum fluid and the density of water, the oil is to be compared to water at standard of (60 °F,

°10.0 API gravity). Most API gravity values of different types of crude oil fall between °10.0 and °70.0 API. The higher the degrees API of the crude, the less dense (lighter, thinner) it will be. Inversely, the lower the degrees API, the denser (heavier, thicker) the crude will be. The following equation describes the relationship between API gravity and specific gravity:

$$API = 141.5/Sg - 131.5 \qquad (1)$$

Where Sg is specific gravity of the oil, Sg can be calculated from the following formula:

$$S_g \ \text{oil} = \frac{\rho_{\text{oil}}}{\rho_{\text{H}_2\text{O}}} \qquad (2)$$

Where ρ_{oil} is the density of oil, and ρ_{H_2o} is the density of water.

1.2 Problem Statement:

Crude oil classification process is considered as a time-consuming process since it is done in the laboratory. The research is to develop a system that can minimise the time to classify the crude oil into several types by developing a system by measuring the resistivity. Based on preliminary studies on the topic, crude oil is considered as insulator and differentiating between two different samples of crude oil using resistivity is considered as the challenging block in this project.

1.3 Objectives:

The objectives of this project are to:

1. Differentiate between various crude oil samples based on their optical properties (i.e., refractive index)
2. Develop a classification system where crude oil can be classified accordingly into heavy oil and light oil.
3. Develop an algorithm to classify crude oil samples.

1.4 Scope of Study:

The scope of study of this project is to conduct research about the physical properties of the crude oil in general, and specifically the resistivity property of the crude oil, how to relate between the resistivity of the oil and its types, and finding alternative properties at which crude oil can be classified accordingly in case resistivity properties failed to supply sufficient data for classification process.

1.5 Feasibility of the Project:

The project is planned to ensure its feasibility, to be carried out within the given time frame. The system that to be designed is based on the relevance costs, where the lower cost is preferable. Efficiency, feasibility, maintenance and reliability of the system are other factors which are highly considered during the designing phase. The most feasible design of the system should be studied thoroughly based on the cost, time frame, efficiency, stability and reliability.

This project can be divided into two major stages; the first stage involves preliminary literature review, initial experiment and verifications, while the second stage is to define algorithm and to write program code used for crude oil classification.

CHAPTER 2

LITERATURE REVIEW

2.1Electrical Properties of Organic Liquids:

The electrical conductivity of hydrocarbons is quite small. The normal hydrocarbons have an electrical conductivity smaller than 10^{-16} s/cm; benzene has an electrical conductivity of 4.4×10^{-17} s/cm. Crude oil electrical conductivity is also small, even smaller than normal hydrocarbons, of the order of 10^{-19} to 10^{-12} s/cm. Conductivity is the reciprocal of resistivity, electrical conductivity is measured in Siemens while resistance is measured in Ohm.

Electrical conductivity data gathered for crude oil is observed to be depending on the measurement method and the presence of chemical and organic impurities in the oil. Conduction through oil is not ohmic; this means that the current and the strength of the electric field are not proportional. It is noticed also that most oils experience an increase in their conductivity levels as temperature increases.[2]

2.2 Measuring the electrical conductivity of fluids by using high accurate, free of calibration method:

The coaxial cylinders technique is used to measure electrical conductivity of fluids. Since the tested liquid is only contacting metal - no electrode contact with the liquid-, the two electrodes are installed between dielectric separators. The two electrodes do not experience direct contact to the investigated fluid. The coaxial cylinders method facilitates the measurement of the electrical properties of liquids which are not accessible by using other conventional techniques. The coaxial cylinder is immersed

in the liquid to certain initial depth; ac impedance is measured at various frequencies. The electrical conductivity is calculated from the variation in measured conductance with the variation in depth of immersion. [3]

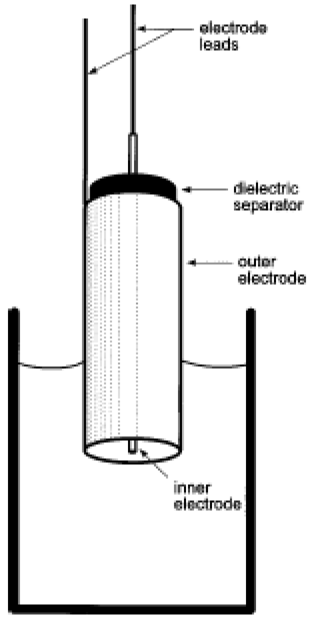

Figure.1 Coaxial cylinder electrodes immersed at certain depth in oil flask

2.3 Resistivity Logging:

Resistivity logging method is one of well-logging techniques which is measured by inducing a low-frequency current into the subsurface with metal electrodes located above the surface. The potential difference created by the induced current is measured at the surface. ABMN installation array is the most commonly used electrode array in resistivity logging, where A and B are the current electrode, while M and N are the potential electrode.[4]

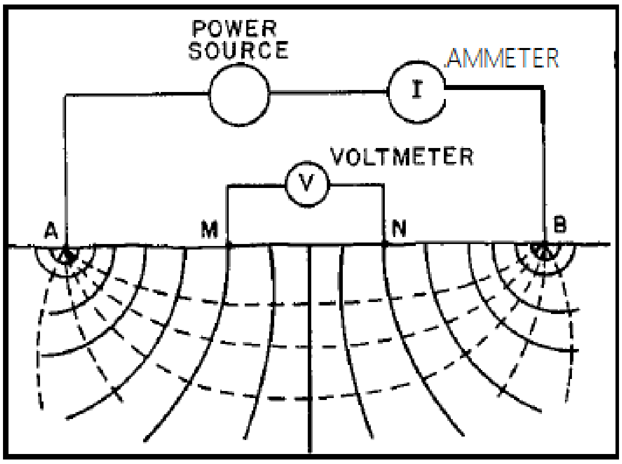

Figure.2 Current flow and equalpotentials for a typical ABMN quadripole

2.4 Measurement of high Resistive Components:

Varies techniques can be implemented to measure electrical resistances which have large values. Some of these methods are as follow:[5]

i) Loss of charge technique.
ii) Megohm connection.
iii) Megger.

Throughout this section, these methods are going to be explained in more details.

i) Loss of charge technique

This technique is very common in measuring the insulation resistance of very high values. The following figure illustrates the typical circuit arrangement used in this method.

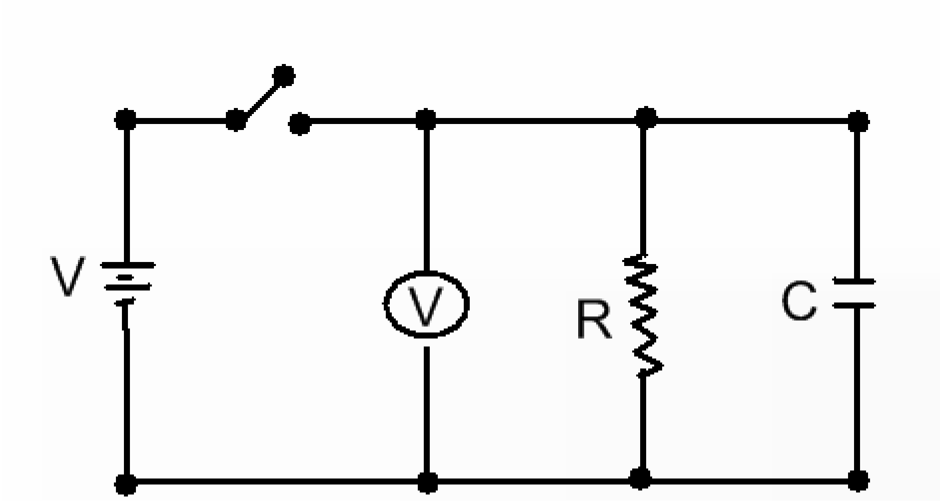

Figure.3 circuit installation for loss of charge method

Shunt capacitance with a known value is connected in parallel to the resistance to be measured. The voltage across the parallel combination is measured using electrostatic voltmeter. A d.c voltage source supplies the circuit with voltage of value V

Initially the switch is open. When the switch is closed to connect the circuit, the capacitor C starts to charge. In which the voltage across C can be calculated using this formula

$$Vc = v\,(1 - e^{-\frac{t}{RC}}) \qquad (3)$$

At certain time t = t_1, the switch is opened to disconnect the power source V, while capacitor will start to discharge in the given resistance through the following equation

$$Vc = v \times e^{-\frac{t}{RC}} \qquad (4)$$

$$\frac{Vc}{v} = e^{\frac{-t}{RC}} \qquad (5)$$

Where R can be calculated using the following equation:

$$R = \frac{t}{C \ln\frac{v}{Vc}} \qquad (6)$$

If the value of R is very large, the capacitor will take longer time to fully discharge in resistance R. by calculating time consumed by C to fully discharge, the value of R can be obtained. This method is considered as a time consuming method and does not give instantaneous results.

ii) Megohm bridge

This technique is considered as a modified Wheatstone bridge which is used to measure resistors with higher values which could fall in the range of terohms. The main characteristics which differentiate Megohm bridge from other Wheatstone bridge are the three terminal resistance and the guarded circuit, which are used to minimize the leakage current to avoid measurement errors. The following figure illustrates the Megohm bridge:

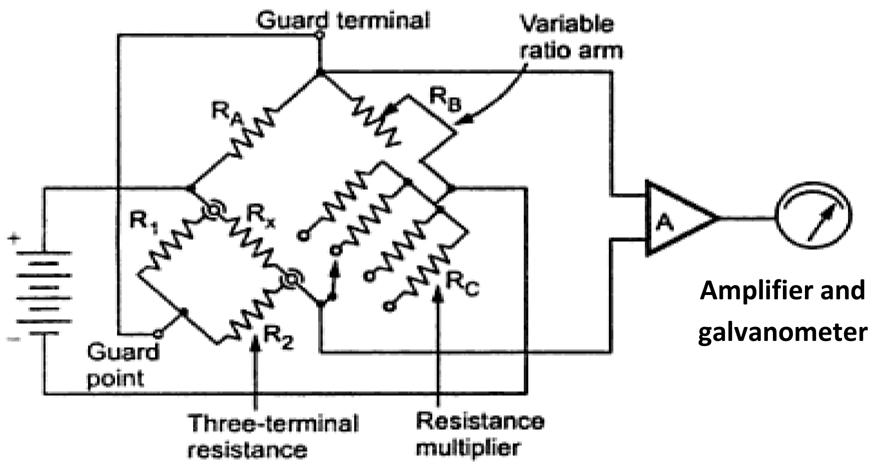

Figure.4 guarded Megohm bridge with three terminal resistance connection

R_A and R_B are ratio arm resistors in which their junction is connected as a separate guard point which is used to avoid leakage current upon using three terminal resistance.

The unknown resistance R_x is connected as shown in FIGURE.4, in which the two main terminals of the three-terminal resistance are connected to R_x terminals in the bridge, while the third terminal is the junction point between R_1 and R_2 which creates the leakage path.

This connection makes R_1 and R_A parallel to each other, the shunting effect of R_1 is neglected as R_1 is much larger than the ratio arm R_A, and similarly R_2 and the galvanometer are connected, which could be followed by neglecting the value of R_2 as the galvanometer's resistance is much smaller than R_2. [5]

Varying the value of R_C until the indicator of the galvanometer is set to zero, simple Wheatstone bridge calculations can be implemented to identify the value of the unknown resistor.[6]

2.5 Refractive index

Refractive index is the measurement of the speed of light in a medium. The speed of light in vacuum (usually denoted by c) is approximately 3×10^8 m/s, and it is considered as the highest value amongst other media. The index of refraction of a medium measures the reduction of the speed of light when light passes through it. The following equation defines the refractive index (n):

$$n = \frac{c}{v} \quad (7)$$

Where (n) is the refractive index of a given medium, (c) is the speed of light in vacuum while (v) is the speed of light in the measured medium.

(n) has always a value greater than 1 since the speed of light in vacuum is higher than its speed in any other medium that is due to the constant absorption and remittance of the light particles by the atoms of other medium.

When the speed of light changes due to crossing the boundaries from one medium to another, the light deflects from its proper pass and get refracted, the relationship between the angle of incidence and angle of refraction can defines the relationship between the refractive indices of the given medium.

2.6 Lorentz-Lorenz relation

The Dutch physicist Hendrik Lorentz and the Danish physicist Ludvig Lorenz established an equation that relates between the refractive index and the density of dielectric materials [7]

$$\frac{n^2-1}{n^2+2} = K\,\rho \quad (8)$$

Where n is the refractive index, ρ is the density of a given dielectric, and K (m^3/Kg) is the proportionality factor. The proportionality factor K is defined as

$$K = \frac{A}{M} \times 10^3 \quad (9)$$

where M is the molar mass and A is the molar refractivity which is defined as [8]

$$A = \frac{4\pi}{3}\, N_{Avg}\alpha \quad (10)$$

Where N_{Avg} is Avogadro's constant, and α is the molecular polarizability of one molecule

2.7 One-third rule

The molar refractivity, A, of a dielectric material can be correlated to its refractive index, n, molar mass, M, and its density ρ, using the Lorentz-Lorenz model,

$$A = \frac{n^2-1}{n^2+2}\,\frac{M}{\rho} \qquad (11)$$

The following figure illustrates the relationship between molar refractivity and the molecular mass of various aliphatic and aromatic hydrocarbons.

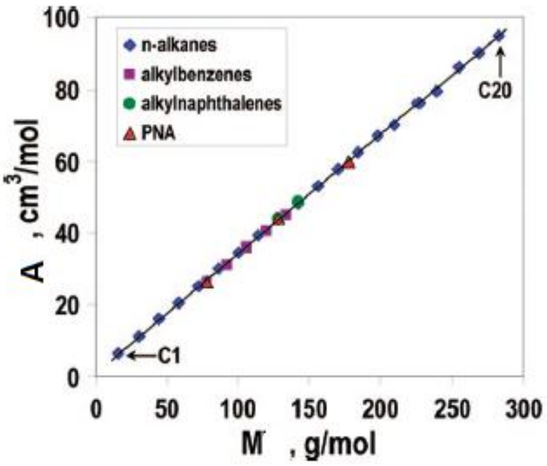

Figure. 5 graph illustrates the correlation between molar refractivity and molecular mass, retrieved from[9]

A linear slope equals to approximately 1/3 is acquired when molar refractivity is plotted against respective molecular mass, [9] which implies that the function of the refractive index divided by the mass density is equal to 1/3 from the following equation:

$$\frac{A}{M} = \frac{n^2-1}{n^2+2} \times \frac{1}{\rho} \approx \frac{1}{3} \qquad (12)$$

CHAPTER 3

METHODOLOGY

3.1 FYP I System Flowchart

The flowchart for FYP I is shown in the following table:

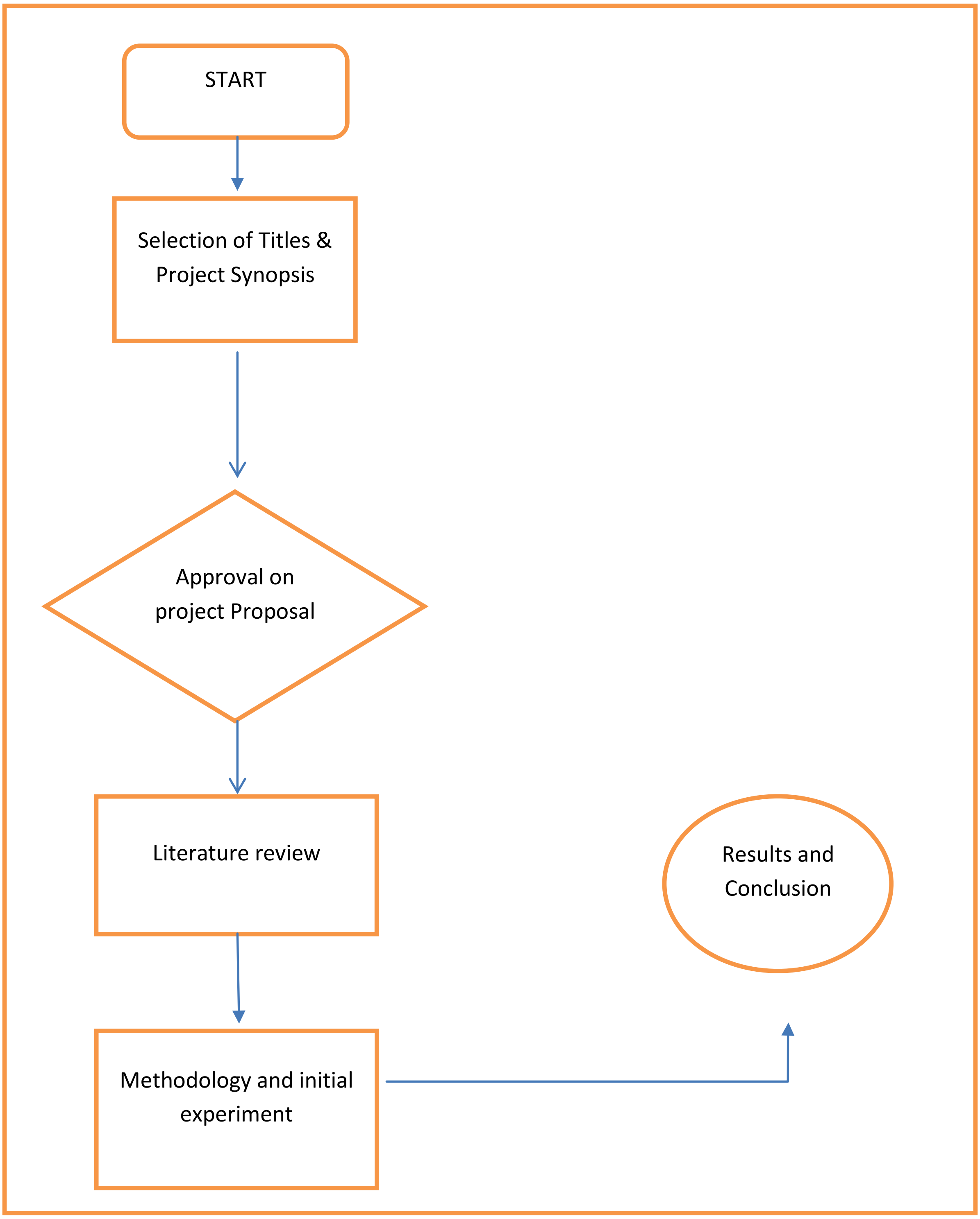

Figure.6 Flowchart of the project- FYP Part I

3.2 FYP II System Flowchart

The flowchart for FYP II is shown in the following table:

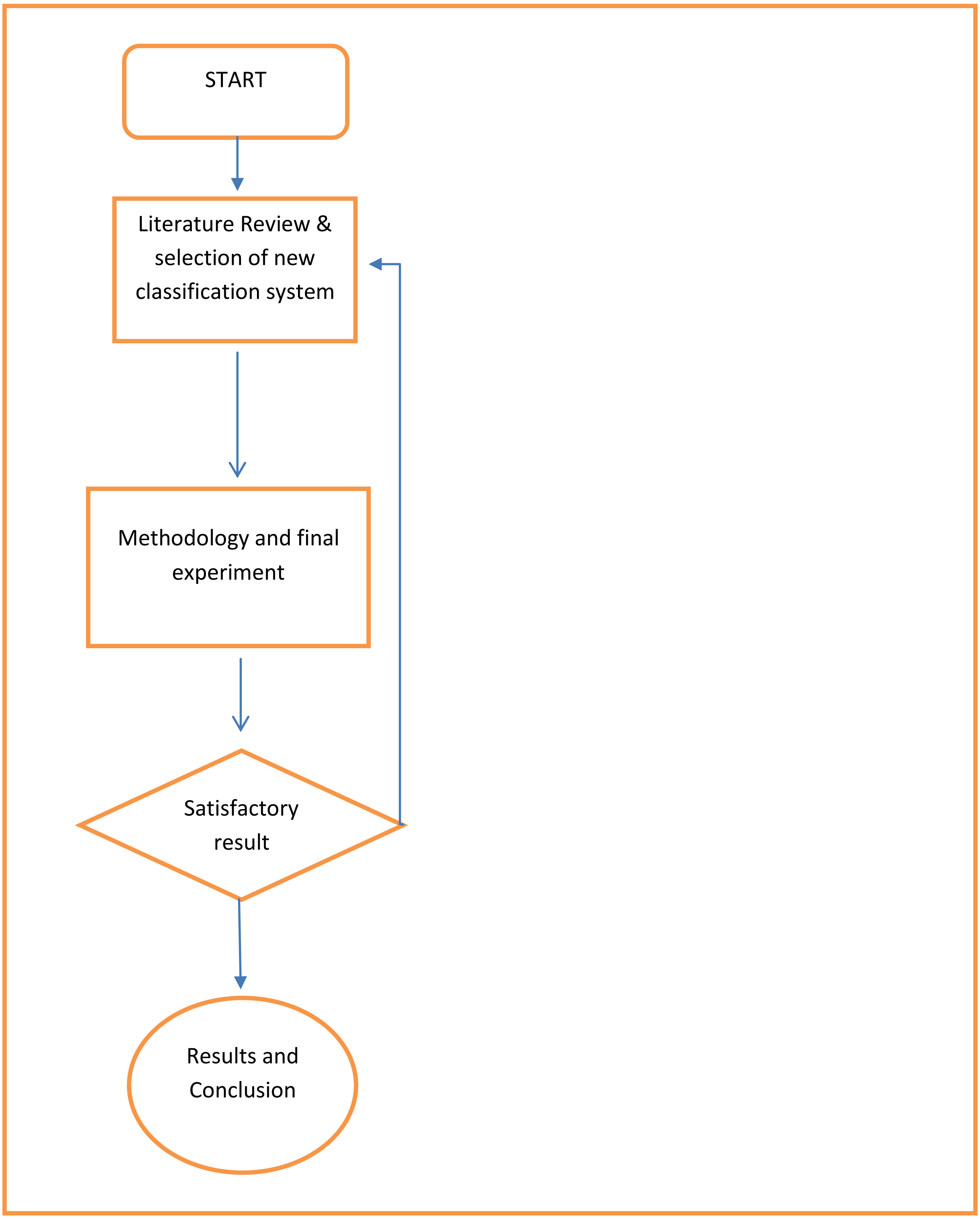

Figure.7 Flowchart of the project- FYP Part II

3.3 FYP I / FYP II Gantt chart/ Key Milestone:

No.	Detail/ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Selection of Project Topic	■													
2	Literatures Review		■	■	■	■									
3	Submission of Extended Proposal						○								
4	Design and simulation phase							■	■						
5	Proposal Defence									○					
6	Modelled Experiments Execution										■	■	■	■	
7	Submission of Interim Draft Report													○	
8	Submission of Interim Report														○

Legends:

■ Project Activity

○ Key Milestone

FYP I Project Activity and Key Milestone

No.	Detail/ Week	1	2	3	4	5	6	7		8	9	10	11	12	13	14	15
1	Modeled Experiments Execution and Optimization								**MID SEM BREAK**								
2	Submission of Progress Report									○							
4	Analyze the Result of Experiments																
5	Pre-EDX												○				
6	Submission of Draft Report													○			
7	Submission of Dissertation (soft bound)														○		
8	Submission of Technical Paper														○		
9	Oral Presentation															○	
10	Submission of Project Dissertation (Hard Bound)																○

Legends:

Project Activity

○ Key Milestone

FYP II Project Activity and Key Milestone

3.4 Tools and Software:

-Conductivity/ resistivity sensor/ probe. [3]

-Voltage source: It's a two -terminal device which can supply a finite amount of electrical current and can maintain fixed voltage. [10]

-Matlab: is a program based on numerical computations and it is considered as fourth-generation programming language. MathWorks developed this program in late 1970's. MATLAB can compute matrix manipulations, plot functions and data, create user interfaces, and communicate with programs written in other languages, including C, C++, and JAVA. [11]

-Refractometer (RX-5000α): is a laboratory or field apparatus used to measure the refractive index of liquids (refractometry). The principle of operation of the device is based on Snell's law.

-Microsoft Visual Studio express 2013: Microsoft Visual Studio is an integrated development environment (IDE for short) for Windows operating systems. It supports multiple programming languages such as C ++, C #, Visual Basic NET., Java, Python, Ruby, PHP; like web development environments such as ASP.NET MVC, Django, etc., to which add new capabilities in Windows Azure online form editor.

Visual Studio allows developers to create Microsoft Windows applications, websites, web applications and web services in any environment supporting NET. platform. So you can create applications that communicate between workstations, websites, mobile devices, embedded devices, game consoles, etc.[12]

3.5 Samples

-Crude oil samples: 2 differently originated samples of crude oil are going to be tested during this project, Sample A is originally extracted from Kerteh, Malaysia and Sample B is extracted from Columbia. Both samples were collected by Enhanced Oil Recovery Centre (EORC), in Universiti Teknologi Petronas, Malaysia.

More oil samples were used for the verification of the experiment, number of oil samples used during the experiment is five.

3.6 Initial Experiment:

Objectives:

- To determine initial resistivity characteristics of the tested samples to be able to determine the range of measurements shall be used, and the required probes as well.
- To acquire further data concerning the tested samples such as place of origin.

Methodology:

The experiment was held in UTP 22-022 Project lab, based on two different crude oil samples to differentiate between them based on resistance characteristics by inducing d.c voltage at different voltage levels through two copper wires at distinct distance dipped inside the samples, and measuring the electrical current passing through it by connecting ammeter on series to the copper wires. Based on

$$V = I \times R \qquad (13)$$

The value of the resistance of the oil can be determined.

3.7 Final Experiment:

Objectives:

- To determine the value of index of refraction for the tested samples.
- To relate between the index of refraction and the API gravity degree of the tested samples.

Methodology:

The experiment was conducted in UTP at 03-00-06 unit operation lab based on five different crude oil samples to differentiate between them based on their index of refraction

Procedures:

- Switch on (RX-5000α) by pressing on the power button.
- Make sure that the prism surface is clean by wiping it with a clean piece of cloth with the aid of distilled water.
- Set the desired temperature for the experiment environment (20.0°C)
- Drip the sample onto the prism lens so as to cover the entire surface of the prism with the sample to be examined.
- Close the cover of the prism and start the device by pressing on the START button.
- When measurement is completed, wipe up the sample from the surface of the prism with a clean piece of cloth and distilled water.
- Turn off the power button in the back of (RX-5000α).
- Repeat the experiment for the desired number of samples.

3.8 Program coding:

After refractive indices are obtained by using experimental method, data are correlated to Specific gravity values obtained in previous research paper conducted in UTP as follows:

Samples	Specific gravity Kg/m3	API gravity
1	0.82346	40.33
2	0.90172	25.42
3	0.943	18.55
4	0.86654	31.79
5	0.88374	27.95
6	0.86220	32.61

Table.1 shows the Specific gravity, and API gravity

With the aid of data retrieved from [13] including aliphatic, aromatic and poly-nuclear aromatic hydrocarbons' specific gravity values, the system algorithm is defined accordingly; in which the classification of crude oil is performed as follows:

Type	API Gravity
Light	>30.0°
Heavy	<30.0°

Table.2 classification of crude oil into heavy and light based on API gravity

The following graph illustrates the relationship between API gravity and refractive indices of given hydrocarbons based on equation (1) and equation (12).

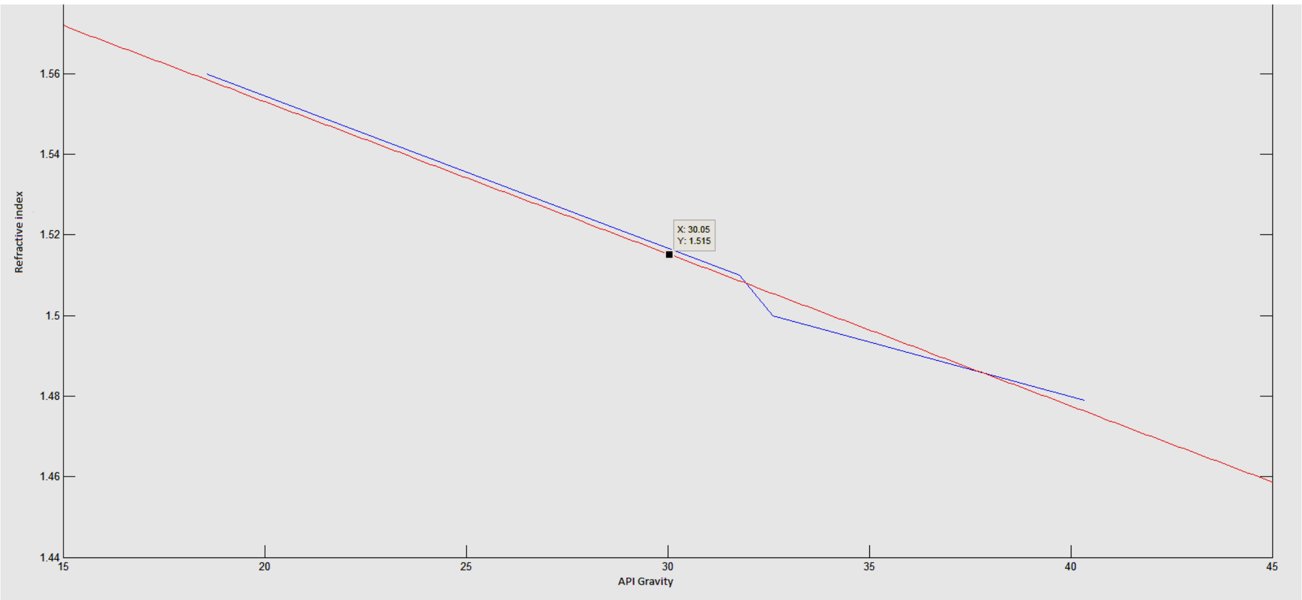

Figure.7 API gravity versus Refractive index values

Based on findings obtained by using MATLAB software shown in figure.7, the threshold value of index of refraction at which crude oil is classified into heavy or light is obtained, and program code is developed accordingly.

The following is the program coding in Visual Basic language :

```
Public Class Form1

    Private Sub Button1_Click(sender As Object, e As EventArgs) Handles
Button1.Click
        If System.Convert.ToDouble(TextBox1.Text) > 1.515 Then
            MsgBox("Heavy!")
        Else
            MsgBox("Light!")
        End If
    End Sub
End Class

<Global.Microsoft.VisualBasic.CompilerServices.DesignerGenerated()> _
Partial Class Form1
    Inherits System.Windows.Forms.Form

    'Form overrides dispose to clean up the component list.
    <System.Diagnostics.DebuggerNonUserCode()> _
    Protected Overrides Sub Dispose(ByVal disposing As Boolean)
        Try
            If disposing AndAlso components IsNot Nothing Then
                components.Dispose()
            End If
        Finally
            MyBase.Dispose(disposing)
        End Try
    End Sub

    'Required by the Windows Form Designer
    Private components As System.ComponentModel.IContainer

    'NOTE: The following procedure is required by the Windows Form Designer
    'It can be modified using the Windows Form Designer.
    'Do not modify it using the code editor.
    <System.Diagnostics.DebuggerStepThrough()> _
    Private Sub InitializeComponent()
        Me.TextBox1 = New System.Windows.Forms.TextBox()
        Me.Button1 = New System.Windows.Forms.Button()
        Me.Label1 = New System.Windows.Forms.Label()
        Me.SuspendLayout()
        '
        'TextBox1
        '
        Me.TextBox1.Location = New System.Drawing.Point(50, 71)
        Me.TextBox1.Name = "TextBox1"
        Me.TextBox1.Size = New System.Drawing.Size(185, 20)
        Me.TextBox1.TabIndex = 0
        '
        'Button1
        '
```

```
            Me.Button1.Location = New System.Drawing.Point(105, 105)
            Me.Button1.Name = "Button1"
            Me.Button1.Size = New System.Drawing.Size(75, 23)
            Me.Button1.TabIndex = 1
            Me.Button1.Text = "&Decision"
            Me.Button1.UseVisualStyleBackColor = True
            '
            'Label1
            '
            Me.Label1.AutoSize = True
            Me.Label1.Location = New System.Drawing.Point(34, 35)
            Me.Label1.Name = "Label1"
            Me.Label1.Size = New System.Drawing.Size(169, 13)
            Me.Label1.TabIndex = 0
            Me.Label1.Text = "&Please enter the refractive index:"
            '
            'Form1
            '
            Me.AcceptButton = Me.Button1
            Me.AutoScaleDimensions = New System.Drawing.SizeF(6.0!, 13.0!)
            Me.AutoScaleMode = System.Windows.Forms.AutoScaleMode.Font
            Me.ClientSize = New System.Drawing.Size(284, 163)
            Me.Controls.Add(Me.Label1)
            Me.Controls.Add(Me.Button1)
            Me.Controls.Add(Me.TextBox1)
            Me.Name = "Form1"
            Me.StartPosition = System.Windows.Forms.FormStartPosition.CenterScreen
            Me.Text = "Oil type Decider"
            Me.ResumeLayout(False)
            Me.PerformLayout()

        End Sub
        Friend WithEvents TextBox1 As System.Windows.Forms.TextBox
        Friend WithEvents Button1 As System.Windows.Forms.Button
        Friend WithEvents Label1 As System.Windows.Forms.Label

    End Class
```

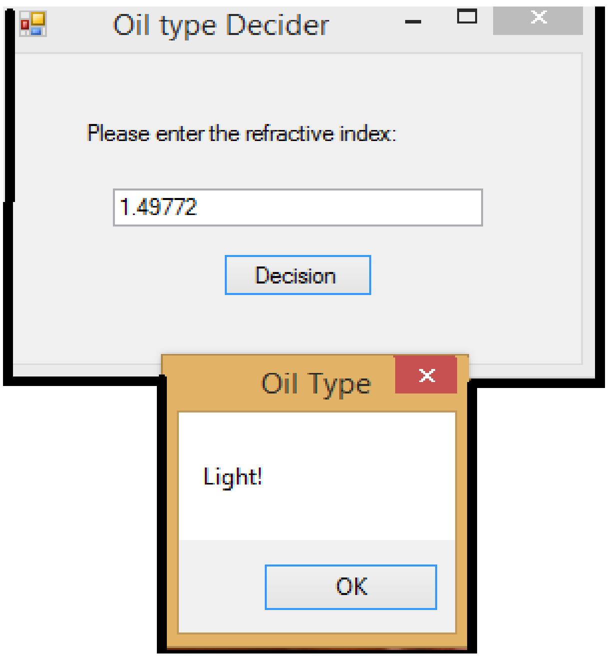

Figure.8 Program interface

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1.1 Initial experiment's Results:

The results obtained for the tested samples did not show enough data based on the current measurement using the Multi-meter, the following images illustrates the data acquired in this experiment:

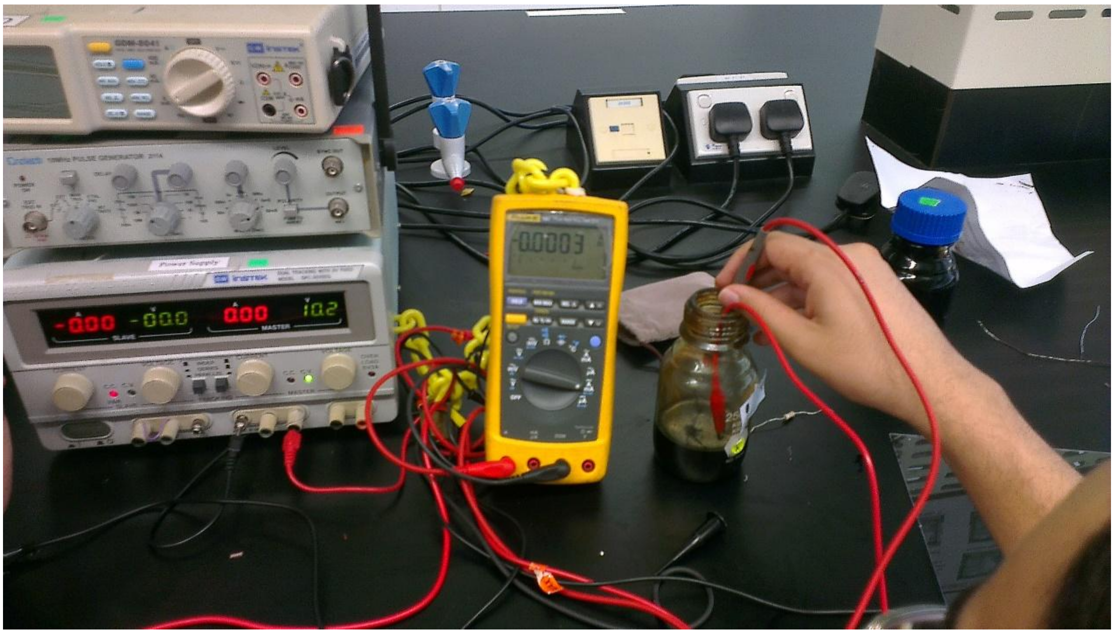

Image.1 Sample –A- current reading at 10.2V

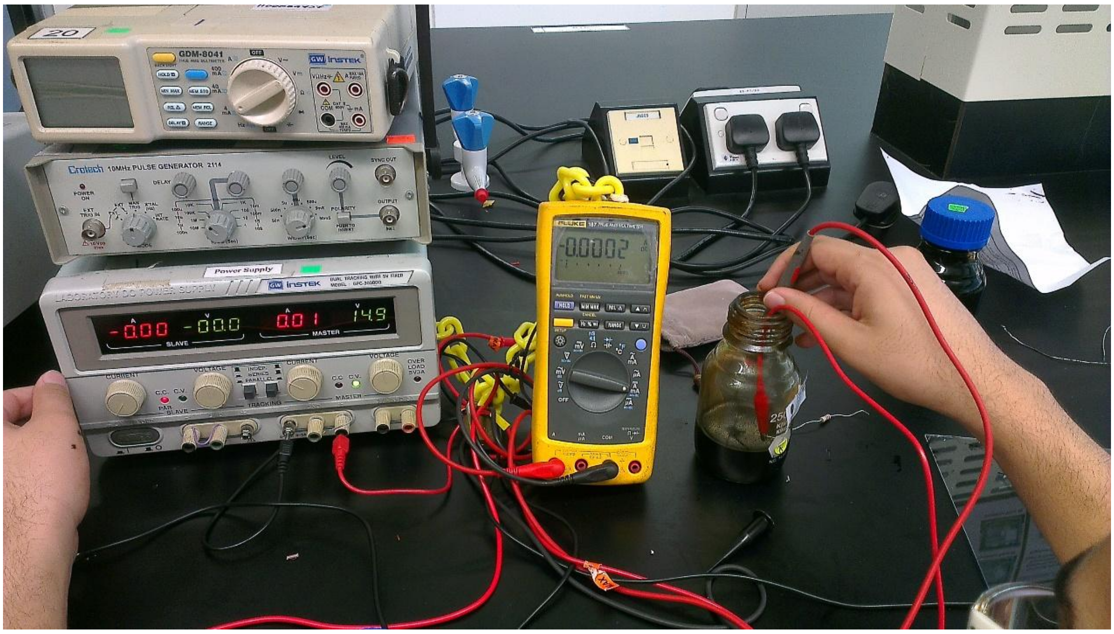

Image.2 Sample –A- current reading at 14.9V

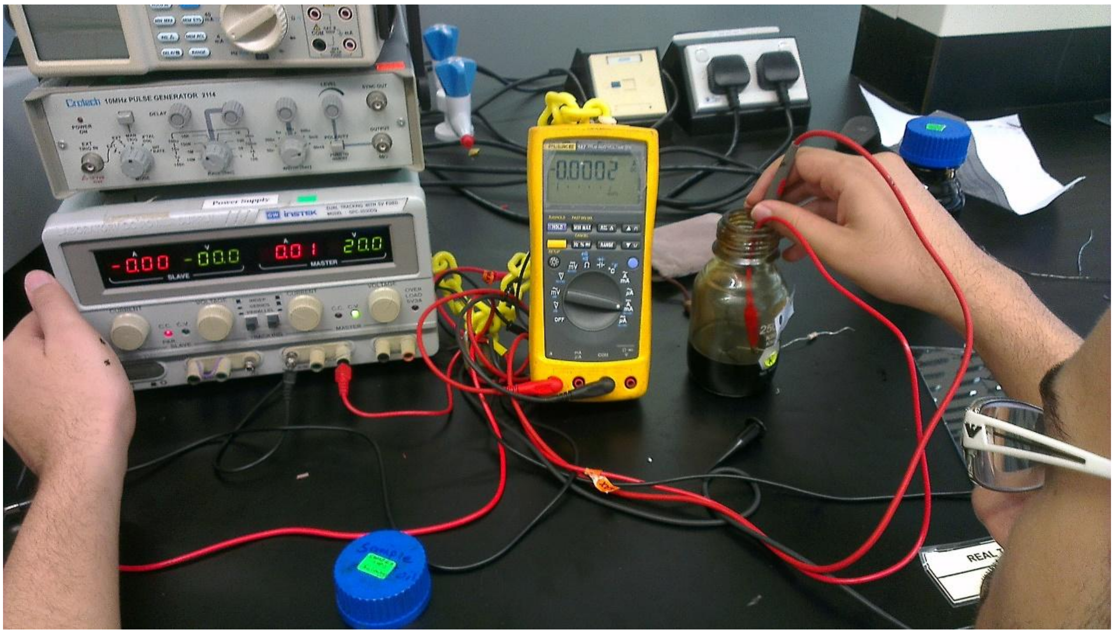

Image.3 Sample –A- current reading at 20V

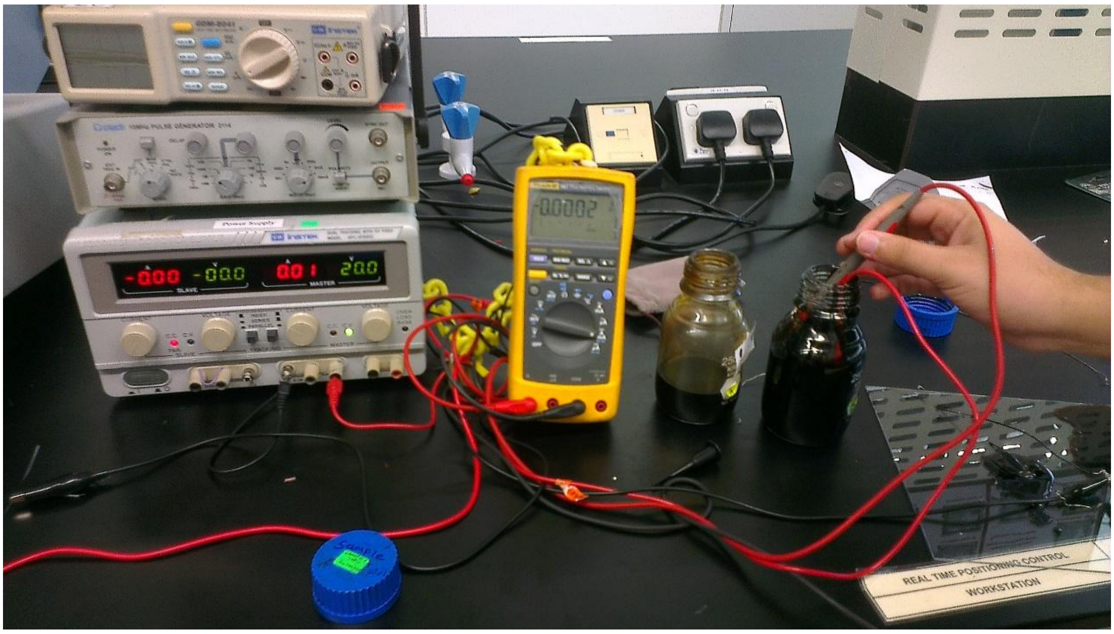

Image.4 Sample –B- current reading at 20V

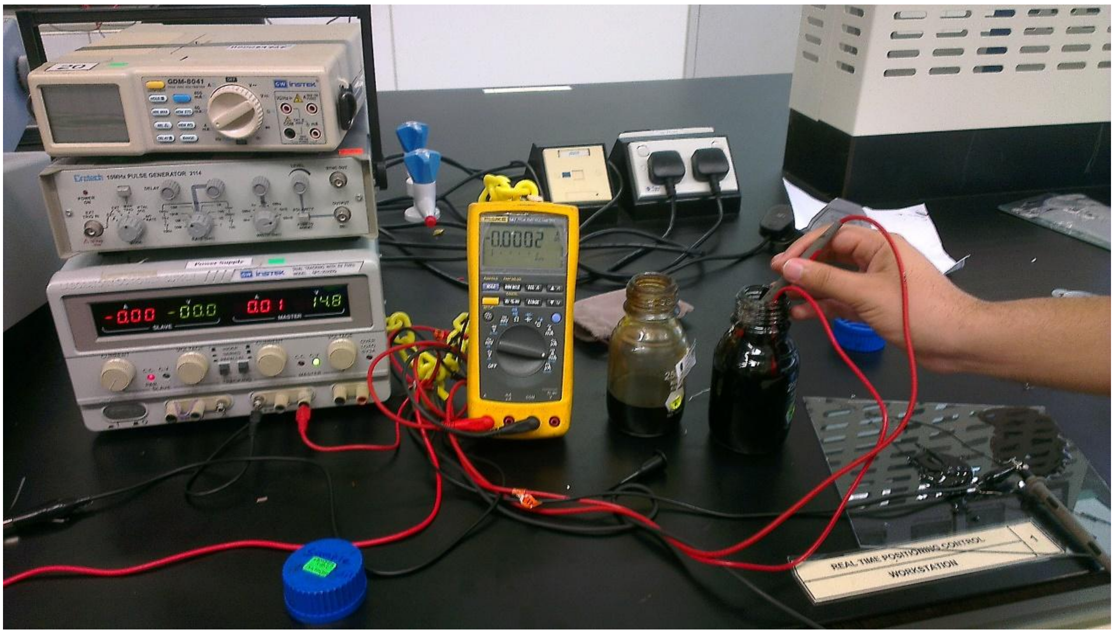

Image.5 Sample –B- current reading at 14.8V

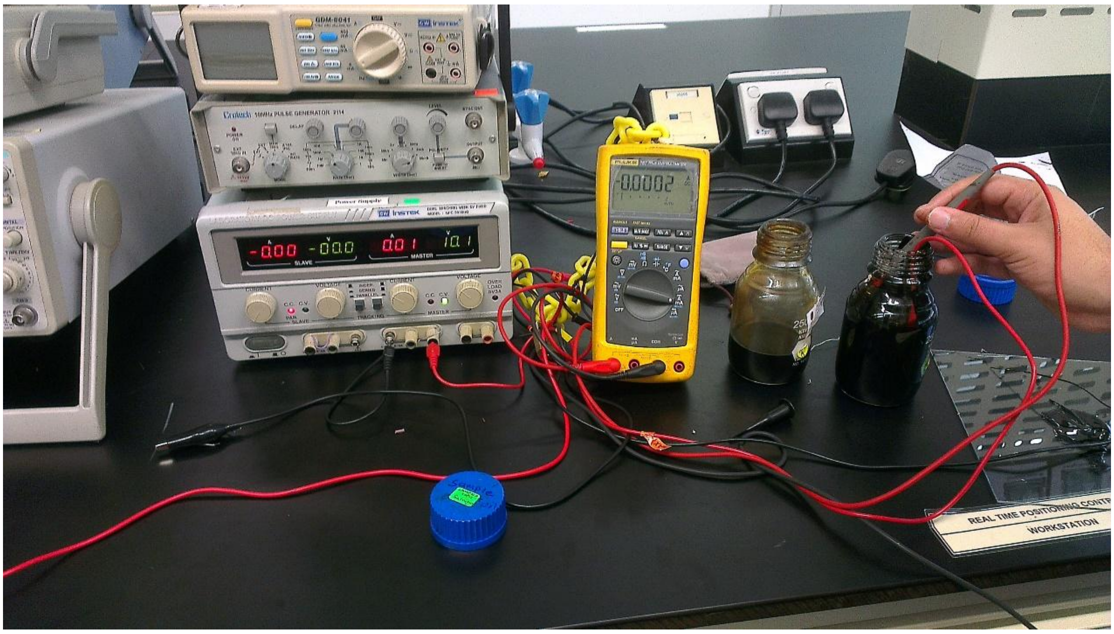

Image.6 Sample –B- current reading at 10.1V

Image.7 Sample –B- current reading at 5V

Voltage Level (V)	Sample –A- current level (I_A)	Sample –B- current level (I_B)
5.0	0.0002	0.0003
10.0	0.0003	0.0002
15.0	0.0002	0.0002
20.0	0.0002	0.0002

Table.3 Current readings for two crude oil samples.

Based on Table.1, the results showed that electrical characteristics taken from the initial experiment are not reliable to differentiate between the tested samples.

4.1.2 Final experiment's Results:

Image.8 Castilla sample refractive index reading

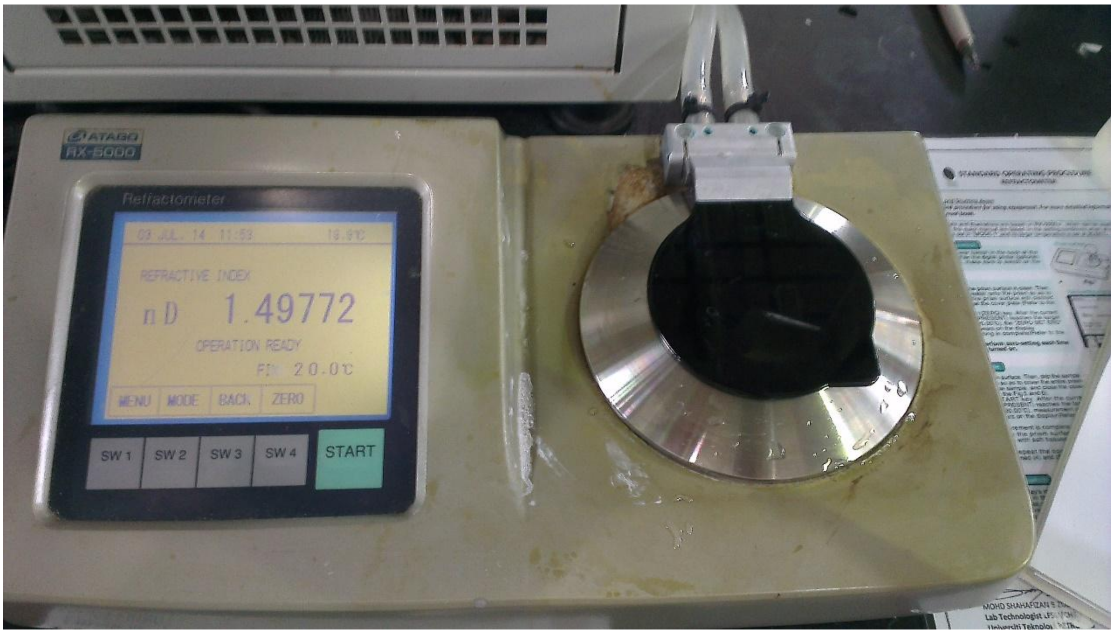

Image.9 El Shaheen sample refractive index reading

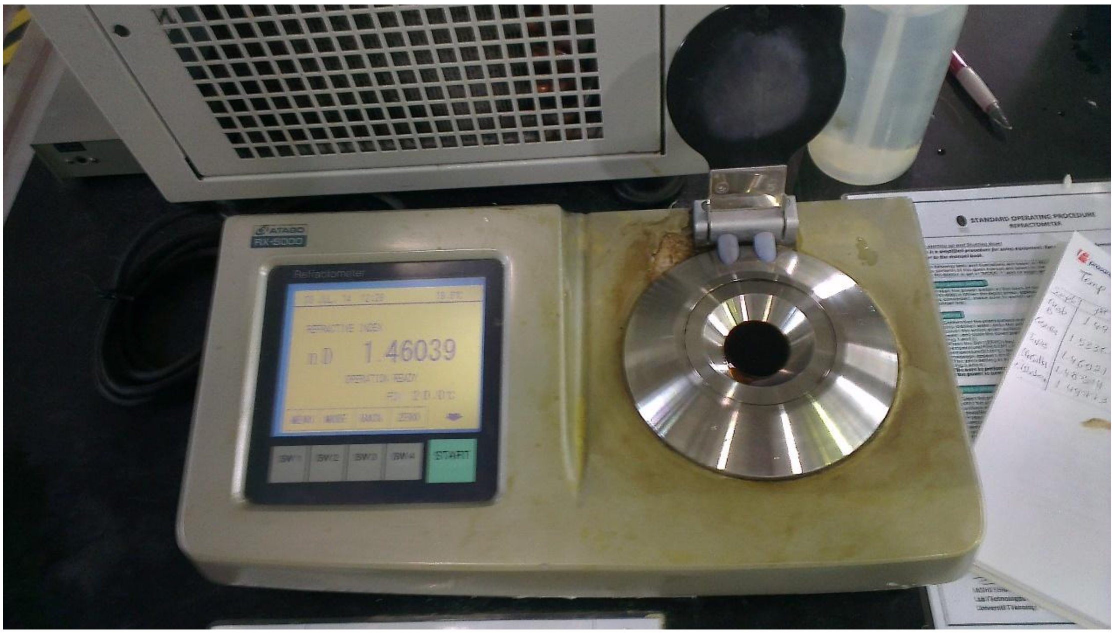

Image.10 Tapis sample refractive index reading

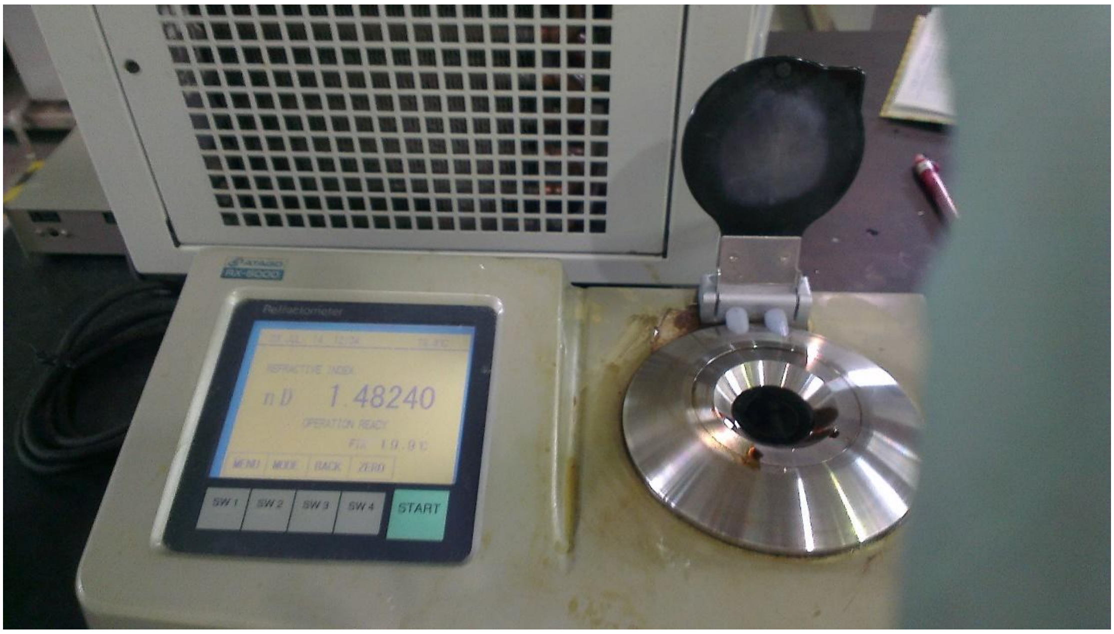

Image.11 Masiila Sample refractive index reading

Trials \ Samples	Arab	Castilla	Tapis	Masiila	El Shaheen
first trial	1.49777	1.53366	1.46021	1.48314	1.49773
second trial	1.49775	1.53559	1.46018	1.4824	1.49772
third trial	1.49933	1.53531	1.46039	1.48261	1.49773
Average	1.498283	1.534853	1.46026	1.482717	1.497726667

Table.4 Index of refraction of crude oil samples

Based on the new developed system, which assumes that the criterion between heavy and light crude oil is at n=1.515, the experimental results matches the theoretical values obtained for each sample respectively at which Castilla sample is heavy crude oil, while Arab, Tapis, Masiila and El Shaheen samples are light crude oil.

4.2 Recommendations:

- Design a circuit that can be used to differentiate between high resistive components based on loss of charge method and guarded Wheatstone bridge.
- Introduce a new classification characteristic that can be used to differentiate between the crude such as salt analyses, refraction properties, electromagnetic characteristics and electrical capacitance characteristics.
- The final proposed system can be developed to classify crude oil into heavy, medium and light crude oil.
- The proposed algorithm can be modified to include the classification of mixed crude oils, as the proposed algorithm can only classify pure crude oil samples.

4.3 Conclusion:

In conclusion, using electrical resistivity properties to classify crude oil is in-applicable as crude oil is considered as an electrical insulator. The proposed system which relies on the optical properties of crude oil represented in identifying the index of refraction, is able to classify crude oil into heavy and light crude oil based on Lorentz-Lorenz formula and one-third rule. The proposed algorithm is able to correlate between the specific gravity of a given crude oil, refractive index and API gravity. The process of identifying the crude oil class using the proposed system is not time consuming process which is able to achieve the objectives of the project.

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