

Implementation of Solar Dryer for Using Betel-nut drying at Boke Pyin Township, Myanmar

Hla Myo Aung
Renewable Energy Research
Department, Department of
Research and Innovation,
Yangon, Myanmar

Moe Sam
Advancing Life and
Regenerating Motherland
(ALARM), Myanmar

Zaw Min Naing
Renewable Energy Research
Department, Department of
Research and Innovation,
Yangon, Myanmar

Abstract: The farmers who cultivate the Betel nut plants typically dry the betel nuts on the ground, in the open air, a process that takes about 45 days and the quality is not so good. Therefore, the decreasing the price obtained by the producers. This solar dryer house decrease the drying time by 10-15d days, thereby yielding a higher quality product. The dryer builds a parabolic roof structure covered with polycarbonate sheets on a concrete floor. The dimension of dryer is 10fts in width, 20fts in length and 8fts in height. Two 20-W DC fans powered by two 100-W PV modules were used to ventilate the dryer. The dryer house was built at U Aung's Betel nut plant field in Boke Pyin Township, Tanintharye region, southern part of Myanmar. Therefore, greenhouse type solar dryers are recommended for natural betel nut drying from farmers. According to the performance test, the results also showed that drying air temperatures in the dryer varied from 35°C to 60°C. The betel nuts dried in this dryer were completely protected from animals, insects and rain. Moreover, good quality of betel nuts was obtained. The estimated payback period of this greenhouse solar dryer for drying betel nuts is about one year.

Keywords: solar dryer house, DC fans, PV module, betel nut drying, air temperature

1. INTRODUCTION

In Myanmar, it enjoys abundant sunshine all year round, especially in the Central Myanmar Dry Zone Area. Potential available solar energy of Myanmar is around 51973.8 TWh/year in accordance with NEDO surveying data in 2003. On average; daily global solar radiation in Myanmar varies from the value of 15 MJ/m²-day in the north and the east to 20 MJ/m²-day in the west as shown in Figure 2. High solar radiation (>20 MJ/m²-day) is observed mostly in the fertile plains including the areas of Magway, Mandalay and Sagaing Regions. In the north, low solar radiation (14 MJ/m²-day) is observed as a result of cloudy skies generated from the cold front system. On the other hand, the pattern of low solar radiation (16-18 MJ/m²-day) is also seen in the east and the south regions. This is because of the monsoons, which bring heavy rains and clouds. In contrast, high solar radiation (20-22 MJ/m²-day) is seen over the areas of Mandalay, Magway and Sagaing Regions. The year average solar radiation of Myanmar is found to be 18.3 MJ/m²-day, when averaged over the country. The annual maximum solar irradiation is in February and the minimum in July-August.[1]

Most farmers in the developing countries still use the direct sun drying for the preservation of foods. This traditional method although cheap they are susceptible to dirt, foreign materials and are accessible to animals and require larger open space. As alternative to this traditional method many have suggested to use mechanical solar drying system in which temperature, RH and air flow rate can be controlled to produce even and good quality of the final product.[2] When the betel nut drops from the tree, its moisture content is very high. High moisture contents will lead to fungal growth,

reduction in shelf life, increased germination and increased brown centering, all contributing to higher reject levels, reduced product quality and lower prices to the grower. The damaging effects of high moisture content begin as soon as the nut falls, so harvesting and drying should commence as soon after nut-fall as possible. The mathematical model developed for solar dryer on the basis of energy balance of solar radiations falling on transparent cover, to give air temperature at the outlet of the collector. The collector is a most important part of the solar dryer. An absorber plate and top enclosure cover forms the entire collector. The performance of collector is the key factor in deciding total efficiency of solar dryer.[3]

2. BUSINESS MODEL AND IMPLEMENTATION PROGRAMME OF SOLAR DRYER PROJECT

The main objectives of this research are to develop the solar dryer technology, to increase the utilizing the renewable energy technology and to develop the socio-economic of people who live in rural area.

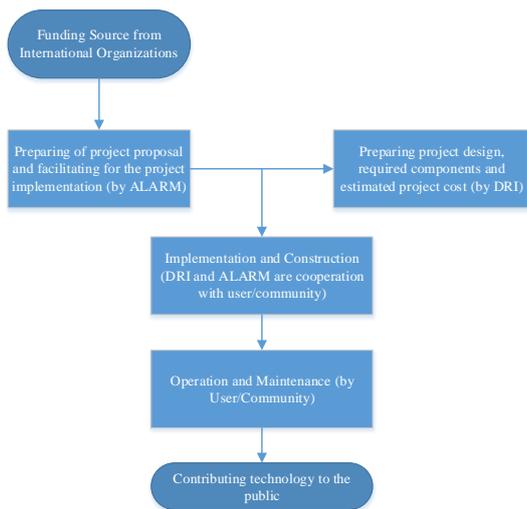


Figure 1. The implementation Structure of Demonstration Project

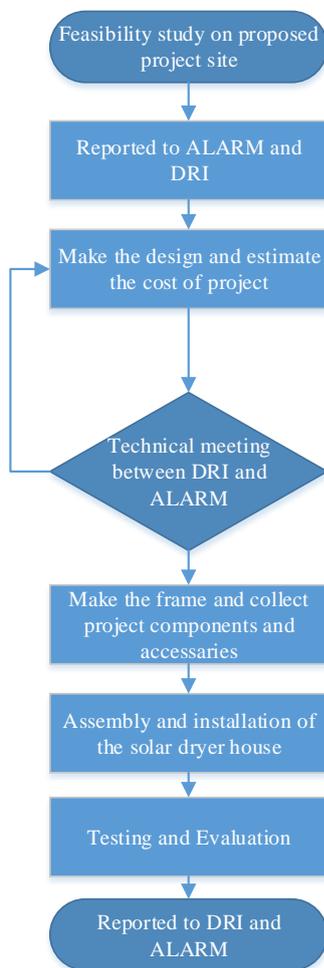


Figure 2. Implementation Programme for Solar Dryer Project

3. PROJECT SITE LOCATION

Myanmar is basically an agriculture country and it is needed to dry the agriculture products after harvesting in country, such as paddy, rubber, betel nut, chili, vegetable and other crops. Currently Myanmar hasn't developed for the systematically

drying the crops which produced by agriculture work. Therefore, the farmers who cultivate the crops have the losses for their income from exported to other countries. In addition, they are facing such kinds of difficulties; utilize the labors, take more time, decrease the quality of crops, etc. therefore, advanced technology like this Solar dryer technology is essential for farmers in country.

The project is located in latitudes 11.5 N and longitudes 98.46 E in which lies in the solar intensity zone of moderate favorable belt. The weather data for solar dryer project is shown in Table 1 and Figure 4.

The site surveying of solar dryer research project is implemented at Htakama village in Boke Pyin Township, Tanintharye region, Myanmar. There are a lot of betel nut plant field in that area as shown in Figure 3.

In accordance with feasibility study on project area, most of the farmers are willingness to construct the solar dryer house and can effort to invest for installation of the solar dryer house.



Figure 3. The Cultivation of Betel-nut Plants in Htakama village

Table 1. the annual weather data for the proposed site area

Month	Air Temperature	Daily solar radiation (horizontal)	Wind speed	Earth Temperature
	°C	kWh/m ² /d	m/s	°C
January	25.9	5.74	3.1	26.3
February	26.5	6.39	2.6	27.4
March	27.1	6.68	2.7	28.4
April	27.2	6.67	2.7	28.5
May	26.8	4.6	3.2	27.8
June	26.3	3.55	4.6	27.1
July	26	3.55	4.2	26.8
August	25.9	3.31	4.7	26.6
September	25.7	4.06	3.4	26.5
October	25.6	4.99	3.3	26.4
November	25.3	5.33	4.7	25.6
December	25.1	5.54	4.8	25.4
Annual	26.1	5.02	3.7	26.9



Figure 4. Daily Solar Radiation and Air Temperature in BokePyin Township, Myanmar [4]

The surveyed data for the project location are described in Table 2. The people in that area mainly focus on the cultivation of betel nut plant for their business. In future, this solar dryer house will be widely used because the betel nut from this township have being exported to India though the Tamu township, Myanmar.

Table 2. The Collected Information data of Project Site

No	Description	Quantities
1	Project Location	Htaukkama Village, Bokpyin Township, Tanintharye Region
2	The area of Beta nut, rubber and coffee	28 acre
3	chickens	6000 nos
4	Pigs	9 nos
5	Start to harvest for beta nut	October (in annually)
6	Rubber	In the whole year
7	The size of beta nut (max)	2 inch x 2inch
8	Take the time for one batch (Beta nut)	Totally 50 days
9	The price of Belta nut	5000 to 5800 Myanmar kyats

In addition, this township hasn't accessed the electricity from the national grid yet. They depend on the diesel generator from private sector for electricity. For that case, The price of electricity is very expensive for them, about 450 MMK/kWh.

4. DESIGN SPECIFICATIONS OF SOLAR DRYER

The heat received by the collector was calculated using Eq. (4.1)

$$Q_c = I \times 0.86 \times A_c \quad (4.1)$$

Where,

I = Solar insolation, (18MJ/m²/day)

A_c =Area of collector. (18.5m²)[3]

Table 3. Technical data for Solar Dryer Project

No	Description	Material /quantity
1	Type	Green House type
2	The size of solar dryer	6.096m x 3.048m
3	The type of material for roofing	Poly carbonate sheet

		(3 sheets)
4	The area of Concrete Foundation	7.315m x 4.267m
5	Frame of Solar dryer	Angle Iron and iron pipes
6	Exhaust Fan (12 inches Dia)	2 nos
7	Solar panel (100watts)	2 nos
8	Battery (65Ah)	2 nos
9	UPS (500Watts)	2 nos
10	Charger controller (10A)	2 nos

The technical data for solar dryer project are as described in Table 3.

In accordance with Eq (4.1), the calculation result of the heat received by the solar dryer is 286.38 MJ per day.

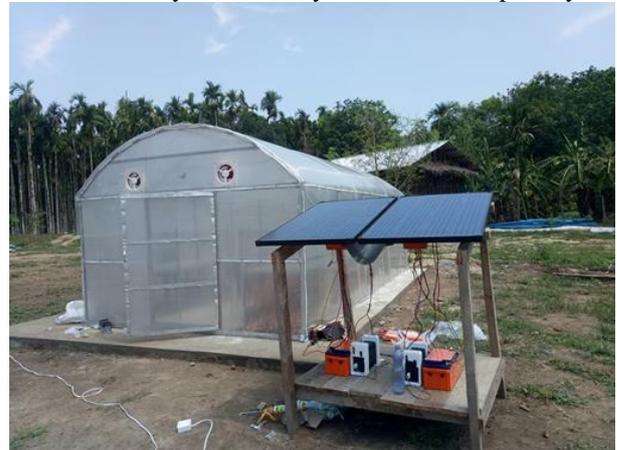


Figure 5. The Whole System of the Constructed Solar Dryer

5. RESULT AND DISCUSSION

The solar dryer dried using sunlight to the test when the best available measure of the maximum temperature of 70 ° C minimum, received up to 43 ° C. The average temperature is receiving up to 53 ° C temperature for a day was found to be able to maintain. According to the measure, when the outside temperature is 35 ° C Indoor temperature 53 ° C, the difference between internal and external temperature of about 18 ° C according to the test. The inside temperature testing result data are as shown in Figure 6.

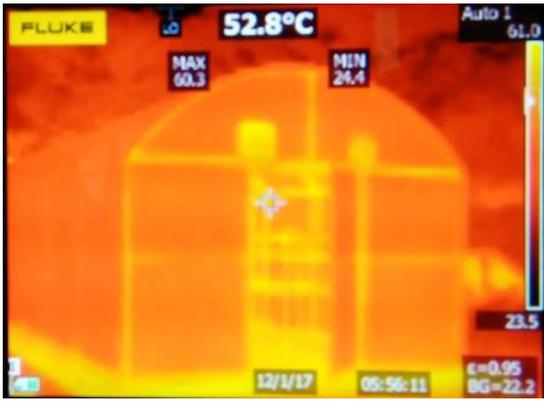


Figure 6. The measurement of Temperature inside Solar Dryer House



Figure 7. Drying on Betel-nut by using Solar Dryer

Table 4. The Survey records data for Betel-nut Drying Process

Date	Temperature (C)			
	8:00	11:00	2:00	5:00
15-May,2018	37.7	55.3	43.9	34.0

7. ACKNOWLEDGMENTS

Our thanks to the experts who have contributed towards development of the template. The author would like to express special thanks to U Win Khaing Moe, Director General, Department of Research and Innovation, Ministry of Education, Myanmar for his effective suggestions and valuable ideas. The author is deeply grateful to U Win Myo Thu, Chairman, Advancing Life and Regenerating Motherland (ALARM), Myanmar, for his invaluable support, suggestions and sharing experience in the research period.

16-May,2018	34.0	44.7	44.7	41.9
17-May,2018	42.1	35.0	44.3	36.8
18-May,2018	34.0	49.9	41.4	29.6
19-May,2018	35.9	35.0	40.6	39.8
20-May,2018	31.8	33.0	43.9	37.0
21-May,2018	30.8	37.2	37.0	28.1
22-May,2018	32.0	30.8	31.7	32.4
23-May,2018	34.0	40.0	32.7	32.2
24-May,2018	29.3	36.8	41.6	27.6
25-May,2018	39.1	39.8	37.5	37.2
26-May,2018	27.7	29.1	36.6	29.3
27-May,2018	29.4	37.5	27.6	27.6

Previously, the traditional drying takes the 45 days for drying these betel nuts, but if dried in the solar dryer house, it is found that lasted only 10 days for drying them. According to measurements, over 30000 numbers of betel nuts are dried in the dryer house for each batch. Other crops are found to be able to dry the amount equivalent to the size.

6. CONCLUSION

The solar drying system used to dry the crops and keep the original quality of the Holy export has increased the income of farmers in rural area in our country. Therefore, this technology can support the people who live in rural area in Myanmar in order to develop the socio-economic. We will carry on the testing and measuring the quality of other fruits and crops by using this solar dryer house.

8. REFERENCES

- [1] *Assessment of solar energy potentials for Myanmar*, Solar Energy Research Laboratory, Department of Physics, Faculty of Science, Silpakorn University, Thailand, 2009.
- [2] YefriChana, NiningDyahb,Kamaruddin Abdullah, Performance of a recirculation type integrated collector drying chamber (ICDC) solar dryer, 2nd International Conference on Sustainable Energy Engineering and Application, ICSEEA 2014.
- [3] D.H. Kokatea, D. M. Kaleb, V. S. Korpalea, Y. H. Shindec, S. V. Panseb, S. P. Deshmukha, A. B. Panditic, Energy Conservation Through Solar Energy Assisted Dryer For Plastic Processing Industry, 4th International Conference on Advances in Energy Research 2013, ICAER 2013.

[4] NASA-SSE.

<https://en.openei.org/datasets/dataset?tags=NASA>

Analysis of Solar PV, Battery and Diesel Hybrid Generation System for Village Electrification

Tin Tin Htay
Electrical Power Engineering
Department, Yangon
Technological University,
Yangon, Myanmar

Hla Myo Aung
Renewable Energy Research
Department, Department of
Research and Innovation,
Yangon, Myanmar

Okka
Electrical Power Engineering
Department, Yangon
Technological University,
Yangon, Myanmar

Abstract: Myanmar, central dry zone has abundant solar resources. The government of Myanmar is trying to substitute using the new and renewable sources of energy. So, the proposed research paper is the one of the rural electrification project for Na Bu Taw (North) village, which is situated at Natogyi Township in Mandalay Region in Myanmar. The purpose of this paper is to propose the best hybrid technology combination for electricity generation from a hybrid of solar PV, Battery and Diesel Generator to satisfy the electrical needs in a reliable manner of an off grid area, in Myanmar. The system includes a 10 kW PV array, 2.76 kWh worth of battery storage, and a 4 kW diesel generator. The paper describes a detailed analysis of the energy flows through the system and excess electricity, LCOE and emission of the system.

Keywords: solar energy, renewable energy, rural electrification, off-grid area, mini-grid system, environmental friendly

1. INTRODUCTION

Myanmar has good solar resource potential, with 60% of the land area suitable for PV development, having Global Horizontal Irradiation (GHI) levels of between 1,600 and 2,000 kWh/m²/yr, and average Direct Normal Irradiation (DNI) levels of about 1400 kWh/m²/yr. Because of Myanmar's mountainous terrain and protected areas, more than a third of the land area is unsuitable for solar PV installations. Myanmar's maximum technical solar power potential is estimated at 40 TWh/yr.[1] With a population of 52.8 million, Myanmar is one of the largest countries in mainland Southeast Asia. However, Myanmar is one of the least developed countries in the region, with GDP per capita of US\$1,275 in 2016. According to the 2017 World Bank Poverty Analysis, 37% of people still live near or below the poverty line. Poverty in Myanmar is concentrated in rural areas, where poor people rely on agricultural and casual employment for their livelihoods.[2] Therefore, some of Myingyan district area cannot access the electricity from the national grid, until now, Na Bu Taw village in Natogyi Township is essential and most of people from this village are willing to access the electricity for their economy and social development.

2. SITE LOCATION AND LOAD DEMAND FORECASTING

This case study is Na Bu Taw (North) village which is situated at Natogyi Township in Mandalay Region of central Myanmar. The geographical location of this village is between Latitude 22.039° and Longitudes 95.66°. There are about 100 households, one monastery, one primary school, one clinic and the population is 606 in this village. The regional map of Na Bu Taw village, Natogyi Township is shown in Figure (1). The

geographical location of the Na Bu Taw (North) Village from Homer Software is shown in Figure (2).



Figure 1. Regional map of Natogyi township

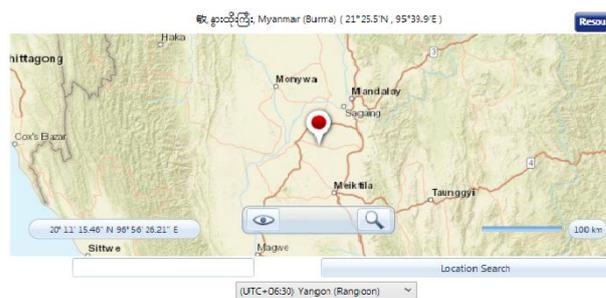


Figure.1 Site location map

2.1. Load Estimation for Na Bu Taw (North) Village

Load demand is essential consideration facts to construct modelling of this research village. In Na Bu Taw (North) Village, the load consumptions are three types of 100 households, one monastery, one primary school, one clinic. Different types of household consumption are 30 numbers of low power consumption, 60 numbers of the medium power consumption and 10 numbers of the high power consumption.

The proposed system load profile is 86 KWh/day and 15 kW peak.

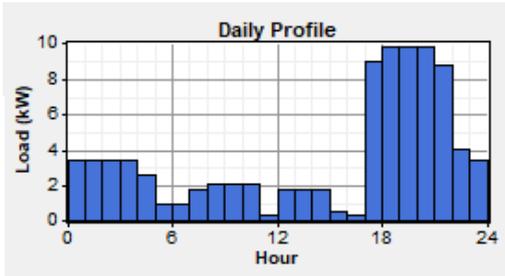


Figure 3. Daily load profile of proposed system

For simulation, Daily load profile input data as described in Figure 3.

3. Energy Resources in proposed site

Monthly average solar Global Horizontal Irradiance (GHI) resource is shown in Figure (4) and annual average solar radiation is 5.06 kWh per m2 per day.

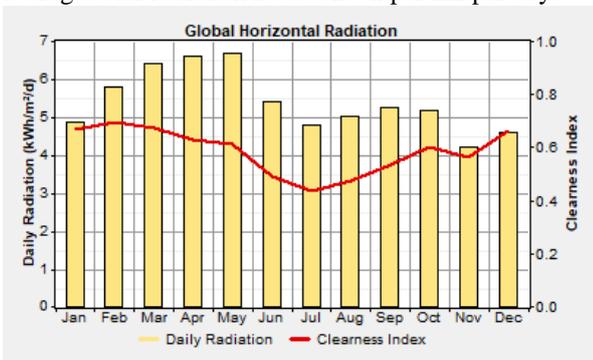


Figure 4. Monthly average solar Global Horizontal Irradiance (GHI) resource of proposed village

The proposed model for Na Bu Taw (north) village by Off-Grid, PV-Diesel Hybrid System is developed in HOMER as shown in Fig. 5. The schematic is created by adding the main components (PV, Generator, Storage, and Converter) and Load.

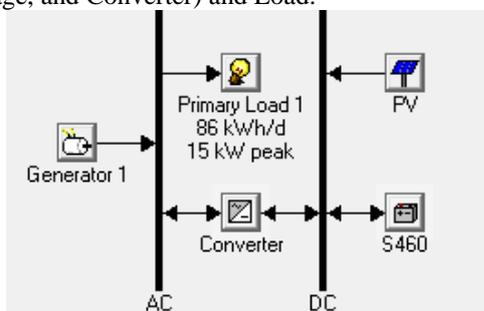


Figure 5. Schematic Diagram of Hybrid system

4. COMPONENT OF PV HYBRID SYSTEM

4.1. Solar PV

Beyond the local solar resource and the cost of fuel (and its potential escalation), many other parameters influence the actual payback period of a hybridization investment. Solar PV panels have a long lifespan (more than 20 years), but their yield gets slightly reduced over time. This parameter has to be computed in the economic analysis across the project timeframe. PV panel manufacturers generally guarantee 90% of initial performance after 10 years and 80% after 25 years. Further, the actual possibility of resorting to the guarantee, if needed after a few years, remains an open question in areas where distributors are not well-established companies.[3]

4.2. Battery Bank

The lifespan of the battery depends on many parameters related to the way they are operated and to external conditions, in particular the ambient temperature. For instance, typical lead-acid batteries designed for solar energy applications will lose between 15% to 20% of their lifespan for each 5°C above the standard temperature of 25°C. In addition, the deeper the battery is discharged at each cycle (depth of discharge), the shorter its lifespan. This implies that to reach an optimal battery lifespan, one has to install a large enough battery to achieve a suitable depth of discharge. Considering the battery cost (around 20% to 30% of total system cost) it is reasonable to design the battery bank and its operating conditions to last for six years minimum and ideally eight to ten years. [3]

4.3. Inverter

An inverter’s lifespan can extend to more than ten years, but this component is a high-technology product and the replacement of a failing component has to be undertaken by a technician from the supplying company. The specific complexity of the inverter often requires that a proper after-sales service plan be implemented to ensure long-term sustainability of the system. Risks associated with the failure of an inverter should be considered, especially in remote locations or countries with very limited presence of specialized suppliers. [3]

4.4. Diesel Generator

Regarding the diesel generator, major maintenance operations should be considered with respect to the cost and unavailability of the equipment. Gensets in the range of 30 kVA to 200 kVA would typically need a major maintenance operation after 15,000 to 25,000 running hours.[3]

Table 1. Energy data and cost and lifespan of Components

Energy Data	
Solar Resource	5.06 kWh/m2/day
Energy Demand	86 kWh/day

Peak Load	15 kW(based line)
Fuel Cost (constant)	0.7 US \$/L
Cost of Components	
Genset kVA	400USD/kW
Solar PV	1000USD/kW
Battery	200USD /kWh
Converter	250USD/kW
Life Span of Components	
Solar PV panel	20 years
Genset	25000hrs
Battery	8 years
Converter	10 years

5. THEORY OF PV HYBRID SYSTEM

HOMER defines the levelized cost of energy (COE) as the average cost per kWh of useful electrical energy produced by the system. To calculate the COE, HOMER divides the annualized cost of producing electricity (the total annualized cost minus the cost of serving the thermal load) by the total electrical load served, using equation 1:

$$COE = \frac{C_{ann,tot} - C_{boiler} H_{served}}{E_{served}} \quad \text{Eq: 1}$$

where:

$C_{ann,tot}$ = total annualized cost of the system [\$/yr]

E_{served} = total electrical load served [kWh/yr]

The discount factor is a ratio used to calculate the present value of a cash flow that occurs in any year of the project lifetime. HOMER calculates the discount factor using equation 2:

$$f_d = \frac{1}{(1+i)^N} \quad \text{Eq: 2}$$

where:

i = real discount rate [%]

N = number of years

HOMER uses the following equation to calculate the output of the PV array:

$$P_{PV} = Y_{PV} f_{PV} \left[\frac{\bar{G}_T}{G_{T,STC}} \right] \left[1 + \alpha_p (T_c - T_{c,STC}) \right]$$

Eq: 3

where:

Y_{PV} = the rated capacity of the PV array, meaning its power output under standard test conditions [kW]

f_{PV} = the PV derating factor [%]

G_T = the solar radiation incident on the PV array in the current time step [kW/m²]

$G_{T,STC}$ = the incident radiation at standard test conditions [1 kW/m²]

α_p = the temperature coefficient of power [%/°C]

T_c = the PV cell temperature in the current time step [°C]

$T_{c,STC}$ = the PV cell temperature under standard test conditions [25°C]

In every time step, HOMER calculates the renewable penetration using the following equation:

$$P_{ren} = \frac{P_{ren}}{L_{served}} \quad \text{Eq: 4}$$

where:

P_{ren} = total renewable electrical power output in this time step [kW]

L_{served} = total electrical load served in this time step [kW]

The battery capacity is the total Ampere-hour required to support the load requirement and is given by:

$$BC = \frac{E_{bat}}{\eta_{disch} (N_{cell} \cdot V_{disch}) \cdot DOD \cdot N_{par}} (Ah) \quad \text{Eq: 5}$$

where, BC- battery capacity (Ah)

E_{bat} - energy required from the battery per discharge

η_{disch} - efficiency of discharge path (including inverters, wires, diodes, etc)

N_{cell} - Number of series cells in one battery

V_{disch} - average cell voltage during discharge

DOD- maximum allowed Depth of Discharge for required life cycle

N_{par} - number of parallel batteries

Batteries are generally not allowed to be discharged fully. The minimum value to which a battery can be discharged before it is recharged is called maximum depth of discharge, DOD. Deep discharge batteries can discharge up to 30-40 percent of their state of charge, SOC.[4]

6. ANALYSIS AND EVALUATION OF SOLAR HYBRID SYSTEM

The proposed system consists of three main generation components such as Solar PV, Diesel Generator and Battery Storage system to cover the whole load demand.

In accord with the simulation results, Total net present cost (NPC) is 99604 US\$ and the optimized cost of energy for the project is 0.321US\$ per kilo watt hour and it is more cost effective than other compared systems.

In this system, 10 kW PV Solar system and 4 kW diesel generator are the electric power producing sources and the battery is the storage unit. According to the cost summary, net present cost for each component of system and cash flow are shown in Figure 6 and 7. In figure 8, the monthly average energy production is described in figure 8, in this system, 15747 kWh of energy production from solar PV and 17983 kWh of energy production from diesel generator annually and the excess electricity is about 10%. The values of key elements of the system are as described in Table 2.

Table 2. Electrical System, Cost Summary and Emission of the whole System

Electrical System		
Quantity	Value	unit
Auto geset	4	kW
Solar PV	10	kW
Battery	24	
Production (solar PV)	15747	kWh/yr
Production (DEG)	17983	kWh/yr
Consumption	27067	kWh/yr
Excess Electricity	3443(10.2%)	kWh/yr
Fuel Consumption	5945	L/yr
Cost Summary		
Total net present cost (NPC)	99604	US\$
LCOE	0.321	US\$/kWh
Emission		
Carbon Dioxide	15655	Kg/yr
Carbon monoxide	38.6	Kg/yr

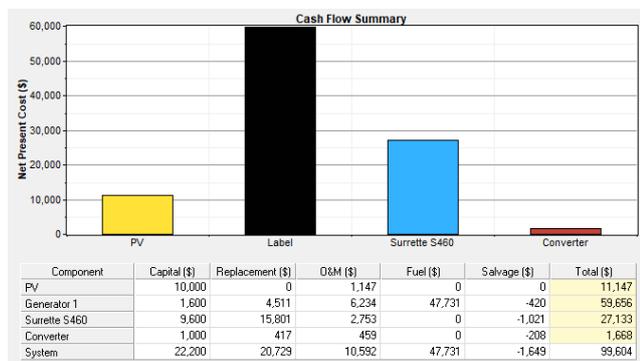


Figure 6. Cash Flow Summary for the System

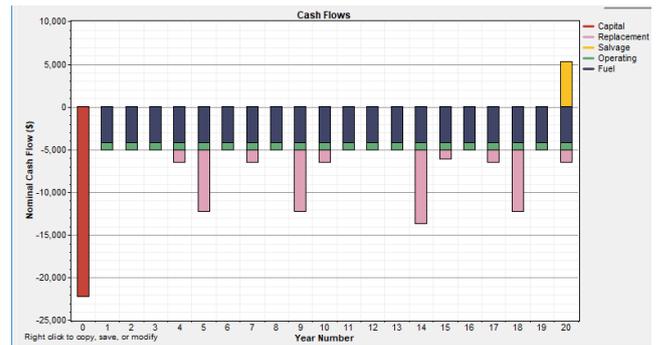


Figure 7. Cash Flow for the project life

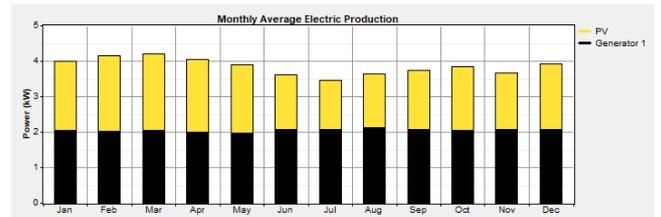


Figure 8. Monthly Average Electric Production

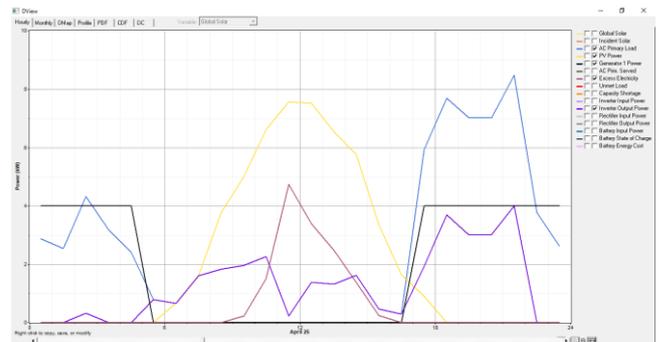


Figure 9. Energy mix in Clear Sky day

In accord with result of figure 9, this condition show a results of energy mix when the weather is clear sky and the solar resource is good condition for this day. Therefore, the most of electricity generation are from the solar PV system in day time and the load for the evening and night time are compensated by diesel generator and battery storage system.

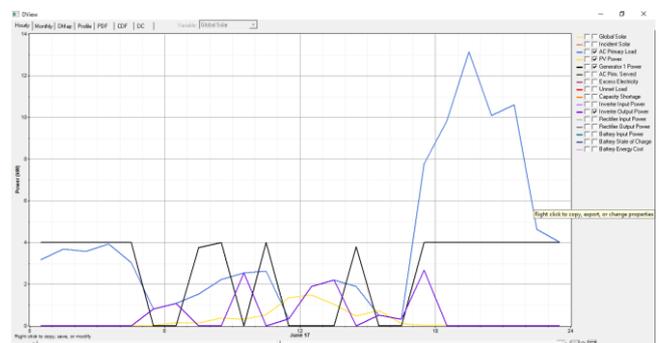


Figure 10. Energy mix in Cloudy day

According to the results of figure (10) a cloudy day, the availability of energy production from solar is very weak therefore, in order to meet the load demand more

diesel generating likely to be used in energy mix of hybrid system elsewhere.

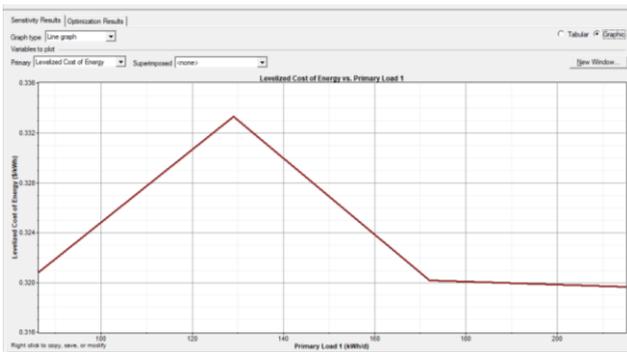


Figure 11. The sensitivity analysis for evaluating the increase of load

The sensitivity analysis for evaluating the increase of load demand, according to the figure (11), firstly the levelized cost of energy is increased to 0.334US\$ per kWh for a marginal increase in load and then the cost of energy is gradually declined in original value (0.32US\$) even though the load increased in maximum demand of this village.

7. CONCLUSION

In fact, according to discussion the condition of solar energy resource is good potential in proposed site area and nearly 50 % of energy can get from solar energy resource but requires additional backup diesel generator for covering the load demand in proposed area.

8. ACKNOWLEDGMENTS

Our thanks to the experts who have contributed towards development of the template. The author would like to express special thanks to Dr. Myint Thein, Rector of the Yangon Technological University, for his effective support, suggestions and valuable ideas. The author is deeply grateful to Dr. Okka, Head of Department of Electrical Power Engineering of the Yangon Technological University, for his invaluable support, suggestions and sharing experience in the research period.

9. REFERENCES

- [1] Renewable energy developments and potential in the Greater Mekong Subregion, ISBN 978-92-9254-831-5, Asian Development Bank, Published in 2015.
- [2] Project Information Document/Identification/Concept Stage (PID), World Bank Group, 18-Jun-2018, Report No: PIDC142398
- [3] IEA PVPS Task 9, Subtask 4, Report IEA-PVPS T9-13:2013, CLUB-ER, Thematic Paper, July 2013, ISBN: 978-3-906042-11-4 Author: Grégoire Léna (IED)].
- [4] www.homerenergy.com

An Experimental Approach to Study on Small Types of Hydrogen Generators

Themar Wint
Department of Fuel and Propellant
Engineering
Myanmar Aerospace Engineering
University
Meikhtila, Myanmar

Saw Doo Nay Htoo
Department of Fuel and Propellant
Engineering
Myanmar Aerospace Engineering
University
Meikhtila, Myanmar

Abstract: Two small types of hydrogen generators: STHG 1 and STHG 2 are constructed with the four steps of experimental procedures as: (i) Collecting the required materials, (ii) Constructing STHG 1 and STHG 2, (iii) Operating the electrolysis process and (iv) Testing the hydrogen gas. Hydrogen evolved from STHG 1 is tested as a flame and that from STHG 2 is put into the balloon to launch are studied.

Keywords: hydrogen, STHG, electrolysis, flame, balloon

1. INTRODUCTION

Hydrogen does not occur freely in nature. It can be modified by fossil fuel or by natural gas. The usage of Hydrogen will affect significant social, economical and environmental which will impact.

Hydrogen is a chemical element with chemical symbol H and atomic number 1 with an atomic weight of 1.008. Hydrogen is the lightest element on periodic table. Its monoatomic form (H) is the most abundant chemical substance in the Universe, constituting roughly 75% of all baryonic mass. Hydrogen gas is highly flammable and will burn in air at a very wide range of concentrations between 4% and 75% by volume. At standard temperature, hydrogen is a nontoxic, nonmetallic, odourless, tasteless, and colourless. The explosion of hydrogen is stronger than the other fuels.

Electrolysis is the decomposition of water (H₂O) into oxygen (O₂) and hydrogen (H₂) due to an electric current being passed through the water. The reaction has a standard potential difference of - 1.23V, meaning it ideally requires a potential

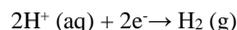
difference of 1.23 volts to split water. The technique can be used to make hydrogen fuel (hydrogen gas) and breathable oxygen; though currently most industrial methods make hydrogen fuel from natural gas instead.

A DC electrical power source is connected to two electrodes or two plates (typically made from some inert metal such as platinum, stainless steel or iridium) which are placed in water. Hydrogen will appear at the cathode (where electrons enter the water) and oxygen will appear at the anode. The efficiency of electrolysis is increased through the addition of an electrolyte (such as salt, an acid or a base) and use of electro catalysts.

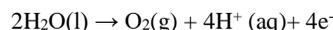
Equations



Reduction at cathode:



Oxidation at anode:



The hydrogen by electrolysis is the purest quality more than the other processes.

Table1. Methods of Hydrogen Production

Primary Energy	Hydrogen production method	Material Resources
Electrical Energy	-Electrolysis -Plasma arc decomposition	-Water -Natural Gas
Thermal Energy	- Thermolysis - Thermocatalysis - Thermochemical processes	- Water - H ₂ S cracking - Biomass conversion - Water splitting - Gasification - Reforming - H ₂ S splitting
Photonic Energy	- PV electrolysis - Photocatalysis - Photoelectrochemical method - Bio-Photolysis	- Water - Water - Water - Water

Even though hydrogen is very expensive to produce and to store, it is pollution-free energy and creates drinkable water. In the end result the usage of hydrogen and fuel cell technologies can enhance and improve different aspects.

The present work aims:

To produce hydrogen gas through the water electrolysis

Objectives are:

To construct Small Type Hydrogen Generators – STHG 1 and STHG 2

To operate electrolysis process using STHG 1 and STHG 2

To analyze the behavior of the evolved hydrogen gas

To apply the gas as the fuel to solve future energy needs

2. EXPERIMENTAL PROCEDURES

2.1 Design and Construction of STHG 1

To construct the STHG 1, plastic bottles are used for the feasible and economy. Its shape is chosen as a cylinder base and cone at the top. The diameter of the cylinder is about 9 cm and the length is about 45 cm. Two plastic bottles are used to get this type. For cylinder base, 37 cm of plastic bottle body is cut and 10 cm of cone shape is cut from the top of the other plastic bottle. These two pieces will be fitted after putting the anode and cathode nodes.

Electrolysis process can be used to generate hydrogen and so to run this process there will be needed cathode node and anode node in the STHG 1. For this work, razors (Topaz blades materials) are chosen and 30 blades are used for STHG 1. The conduction area per blade is about 19.4 cm². Plastic pipes are used to connect these blades. The distance between the razors, about 1 cm is suitable for the process.

To prepare the nodes, the blades are firstly unsharpened. And the wires are connected in each blade using the soldering iron for fastness. Later, the blades are fixed at the two pipes and then put them into the cylinder base bottle. Two ends of wires are also soldered at the outside of the body. These ends will be joined to the battery. After these steps, the top cone part is fitted to be the STHG 1. IV set is fit at the top of the cone for the emit hydrogen gas. For fastening the fitting, the glue gun is used and the joints are carefully sealed. The construction of STHG 1 is shown in Figure 2.1.

2.2 Design and Construction of STHG 2

For the use of electrolyte, sodium hydroxide NaOH, in the electrolysis process, STHG 2 is designed and constructed. Plastics box (12cm × 13cm × 19cm) is chosen and fitted with two L shape steel bars. One end of the bar is inside and the other is outside from openings of the bottom of box. These openings fitted with the L bars are sealed by using the glue gun.

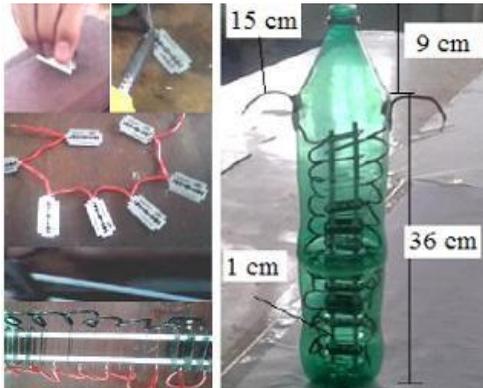


Figure 2.1 Construction of STHG 1

For the electrolysis process, the cathode and anode nodes are needed. Stainless steel plates are used for the nodes. 12 numbers of steel plates, 8cm × 3cm, are cut and lunched on them. For each node, 6 numbers of plates are used and joined to the L bar. 3 numbers of plates are placed on one side of L bar. These are fitted with the screw. Distance between the nodes is 8cm apart.

The two nodes are covered with the plastic bottles which cut the bottom. At the top of the bottle, IV set is fit for the emitted gas. Two plastic bottles are used for the capture of water vapour and other impurities in exit gases. The constructed STHG 2 is shown in Figure 2.2.

2.3 Production of Hydrogen

After constructing the hydrogen generators, test their performance for hydrogen production.

Before testing, electrolyte solution is prepared for the electrolysis.



Figure 2.2 Construction of STHG 2

2.3.1 Preparation of Electrolyte Solutions

Sodium chloride is weighed and mixed with the distilled water to get 3% sodium chloride solution. It is for the electrolysis process of STHG 1. Sodium hydroxide is also weighed and mixed with the distilled water to be 5 % sodium hydroxide solution.

2.3.2 Electrolysis Process in STHG 1

Sodium hydroxide solution is added to the STHG 1. And it is joined with the battery and started the electrolysis process. After 30 seconds, the gas bubbles are appeared in the STHG 1. Waiting 3 minutes, the hydrogen gas is emitted from the exit pipe.

2.3.3 Electrolysis Process in STHG 2

Sodium hydroxide solution is put into the STHG 2 and connected the cathode node to – terminal of battery and anode node to the + terminal of the battery. Hydrogen (H₂) is collected at the cathode node and oxygen (O₂) is collected at the anode node. The gas bubbles are appeared at the starting time of the analysis and they are collected with the balloon. The flowchart of the experimental studies is given in Figure 2.3.

STHG 1 and STHG 2 have the following parts/modules.

Electrolyser: Housing and Electrodes

Power Supply: Battery (12 volts)

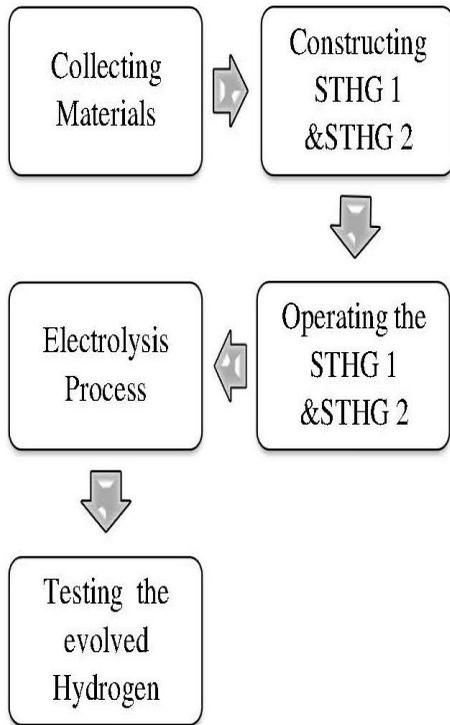
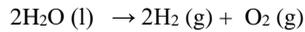


Figure 2.3 Flowchart of the Experimental Studies

The electrolyser housing is made up of plastic materials. The electrolyser contains the electrode for the process of electrolysis. The electrode for STHG 1 is prepared with the Topaz blades and small wires. For STHG 2, stainless steel plates are used to act as an electrode. Sodium chloride and sodium hydroxide are used as the electrolyte solution for the electrolysis process. Power supply used is the battery (12 volts). Hydrogen evolved from STHG 1 is tested as a flame and that from STHG 2 is put into the balloon to launch.

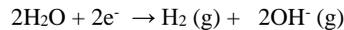
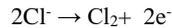
3. RESULTS AND DISCUSSION

In this project, STHG 1 is constructed for the use in the electrolysis process. One important use of electrolysis is to produce hydrogen. The reaction that occurs is:



Electrolysis of water can be achieved in STHG 1 where electricity from a battery is passed through a salt water solution. Electrolysis of an aqueous solution of sodium chloride produces the minute amounts of the aqueous sodium hydroxide and chlorine.

The following ionic equations may occur for the electrolysis of sodium chloride solution.



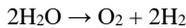
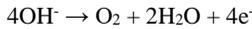
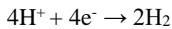
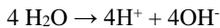
These equations show the oxidation at the cathode node of the STHG 1 and release of chlorine gas and the reduction at the anode node and release of hydrogen gas in STHG 1. From the overall ionic equation, the products are Cl_2 , H_2 and OH^- . Cl_2 and OH^- are soluble in water and so it may be estimated that the evolved gas from STHG 1 is Hydrogen gas only. To test this, the syringe is used to ignite the exit gas. The hydrogen gas flame from it can be seen in Figure 3.1. The flame is small at the 3 minutes after starting the process. The more times the gas evolved, the greater the flame. The sense of hydrogen to hand is cool.



Figure 3.1 Hydrogen flame from STHG 1

It can be seen that the deposit of the aqueous salt solution are increasing with the operating time. The color of the solution is changed from the transparent to nearly black. After running the electrolysis, the cathode and anode nodes of the

of the STHG 1 are covered with the deposit and the thickness of the blades are also decreased. The color changed problem is avoided by using other type of electrolyte solution. But the design of STHG 1 is prepared for the salt solution. It has one exit (opening) for hydrogen gas. When the other electrolyte solution such as sodium hydroxide is used in STHG 1, it may explode for combining with oxygen to evolved hydrogen gas. Sodium hydroxide solution is used as an electrolyte in STHG 2. The following reactions take place inside the STHG 2.



The node joined with the + terminal of the battery is named as cathode node and also the other node is called anode node. The hydrogen gas is collected at the anode node and the emit oxygen is at the cathode node. From the stoichiometric equation, the emitted hydrogen is about two times of the oxygen evolved. In testing the STHG 2, it can be seen clearly that the gases are not emitted at the same time. The gas bubbles are alternately appeared at the nodes.

The performance test of STHG 2 is shown in Figure 3.2. The estimated evolved gas rate of oxygen and hydrogen are 10 cm³/min and 20 cm³/min respectively and shown in Figure 3.3.



Figure 3.2 Performance test of STHG 2

Battery consumption of STHG 1 and STHG 2 during the electrolysis process is shown in Figure 3.4. Comparing these, STHG 2 is less

consumption of battery power than STHG 1. It may depend upon the type of the electrolyte solution and design of hydrogen generator.

For 30 min operation, about 4 volts of battery power is consumed by STHG 1 but STHG 2 is needed only about 1 volt.

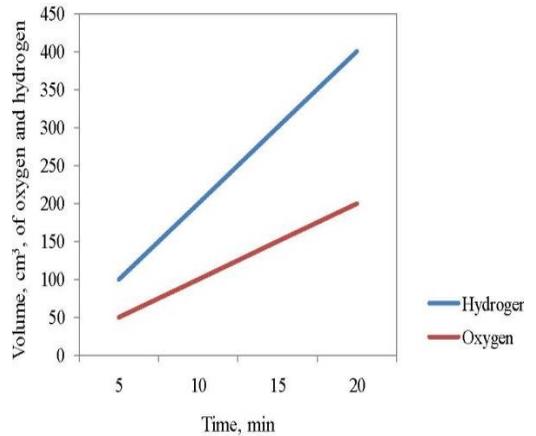


Figure 3.3 Volume of output gases from STHG 2

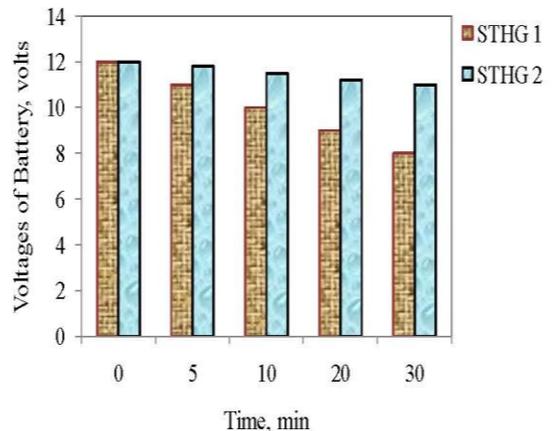


Figure 3.4 Battery consumption during the electrolysis process

4. CONCLUSION

Electrode is an important component in electrolysis process as it separate water molecules to hydrogen ions and oxygen ions. As well, the STHG 1 and 2 are designed to operate the electrolysis process. Using the Topaz blades for STHG 1 and the stainless steel plates for STHG 2, the electrodes are constructed to meet outlined specifications.

The key issues in the design, readily, easily and portability are considered. These generators are designed to produce hydrogen gas and STHG 1 contains the one opening for the evolved gas and so the product hydrogen gas is not pure, but STHG 2 has no problem.

Finally, electrolysis process operates to produce the hydrogen gas. During the process, it can be observed that the emitted gas depends on the amount of electrolyte and the conduction area of the electrodes.

Overall, the objectives of the project; to produce the hydrogen gas, are met. As well, experience is gained in the use of tools to design and construct the STGH 1 and STGH 2. Hence, the small types of hydrogen generators can be constructed to produce the hydrogen.

5. RECOMMENDATION

Recommendations for further research works are outlined as follow.

- The construction of large scale types of hydrogen generators to produce a lot of hydrogen gas
- Evaluating the properties of the hydrogen and Applying the hydrogen gas for the fuel requirements.

6. ACKNOWLEDGEMENTS

The authors are very grateful to all teachers, especially their supervisor, for guiding the knowledge, as well as invaluable experiences and other supports by kindness.

7. REFERENCES

- [1] T. Ohta, Photochemical and photo-electrochemical hydrogen production from water. Int J Hydrogen Energy, 1988. Ding, W. and Marchionini, G. 1997 A Study on Video Browsing Strategies. Technical Report. University of Maryland at College Park.
- [2] M. Wang, Z. Wang and Z. Guo, Int J Hydrogen Energy, 2010. Tavel, P. 2007 Modeling and Simulation Design. AK Peters Ltd.
- [3] <http://www.saltinstitute.org>

A Review of Trading Activity at ISX the Third Quarter 2018

Jaber Hussein Ali

Yousef AbdulZahra Atwan

Ibrahim Eyad

Ayat Raad

Abstract: The research aims to measure and analyze the volume of direct and indirect investment in the Iraqi market for securities, and to measure and analyze the trading indicators of the Iraqi market for securities, as well as measuring and analyzing the impact of foreign direct investment in the trading indicators of the Iraqi market for securities. The research conducted on the analysis of the annual data of the main trading indicators of the Iraqi market for securities and the main trading indicators for non-Iraqis and Iraqis for the period relating to Chapter III 2018. The research reached a set of conclusions of the most important, the results of the statistical test showed a significant effect of statistical significance between the main trading indicators of banks and indicators Main Trading in the Market We conclude from this that foreign direct investment has an important positive role in the movement of shares trading in the Iraqi market for securities, which calls for strengthening the volume of these investments in the future.

Keywords: Trading; ISX; third quarter 2018.

1. INTRODUCTION

This study presents the third chapter of 2018, which is one of the periodic reports issued by the Commission. The financial markets have become an important source of domestic and international financing as well, as it is the tool through which savings are mobilized from economic units with surplus funds and directed to the economic activities that need them and to play their role in stimulating economic growth and contributing to the performance of many financial and economic functions, One of the countries that seek to develop and modernize its financial market and make it more modern to keep abreast of financial developments, so the Iraqi Stock Exchange was established in an organizational manner (Fadel)(Zang 2011).

The Securities Authority is an organized regulator of the capital market established by Law No. (74) for the year 2004 and enjoys the financial and administrative independence. The purpose of its establishment is to protect investors with securities in the stock market and to regulate and develop the capital market to ensure fairness, May be subjected to and is based on the administration of the body and supervision of its affairs Council consists of five commissioners, including the President and Vice-President full-time (full-time) and the remaining members part-time (part-time) with experience and competence The Council has many tasks to achieve the goals and include the preparation of P laws and regulations and issuing instructions and approval of the internal instructions and regulations for financial markets and the center of the deposit and the granting of licenses for markets and brokerage firms and approval of the inclusion of securities in the market (2016 flap)(Flynn, Sakakibara et al. 1990).

2. THE PURPOSE

message of the movement of trading in the Iraqi market for securities To be an integrated financial market offering comprehensive and diversified financial services in accordance with the objectives of the law and the competition of financial markets(Powell 1998).

3. SIGNIFICANCE OF STUDYING

Providing financial market services with efficiency, efficiency and excellence in order to add value to the participants in the market and development of the capital market in Iraq (Hallett 2002).

4. METHODOLOGY

4.1 1. called the market "Iraq Stock Exchange"

4.2 2. According to the provisional law:

4.3 3. The main center of the market in Baghdad and there is nothing to prevent the opening of branches in other Iraqi cities.

4.4 4. Market liability shall be limited to assets owned by it and shall not include assets owned by members.

4.5 5. The Market shall not be liable for any obligations that may or may result from the Baghdad Stock Exchange.

4.6 6. The market is a non-profit moral entity administratively and financially managed by the Board of Governors and has the right to own movable and immovable property, including real estate. And comply with the instructions of the Securities Commission in accordance with the Temporary Securities Law or any other law replacing it.

4.7 7. The Market shall have the right to bring proceedings before the courts or investigative bodies or before any other authority to be represented by the Chairman of the Board of Governors or by a person authorized by him(Al-Hashimi and Al-hashimy 2019).

8. The market is a self-managed, independent, administratively and financially non-profit organization owned by members. And its commercial dealings with others in a commercial manner shall not be contrary to the temporary and permanent laws and these rules of procedure and other instructions of the Authority or the market. Upon liquidation, the market administration shall be based on temporary or permanent law or such regulation or other instructions of the Authority or the Market(Zott and Amit 2010).

5. OBJECTIVES OF THE STUDY

- 4.8 1. The market aims to achieve the following:
- 4.9 2. Regulate and train its members and listed companies in a manner consistent with the objective of protecting investors and enhancing investor confidence.
- 4.10 3. Enhancing the interests of investors in a free market that is reliable, efficient, competitive and transparent(Flynn, Sakakibara et al. 1990).
- 4.11 4. Regulate and simplify securities transactions in a fair, efficient and orderly manner, including clearing and settlement transactions.
- 4.12 5. Organizing the transactions of its members with all related to the purchase and sale of securities and determining the rights and obligations of the parties and the means of protecting their legitimate interests.
- 4.13 6. Developing the capital market in Iraq to serve the national economy and assist companies in building the necessary capital for investment(Hussein, Kasim et al. 2015).
- 4.14 7. Informing Iraqi and non-Iraqi investors about the opportunities to invest in the market(Hasan, Zgair et al. 2015).
- 4.15 8. Collect, analyze and disseminate statistics and information necessary to achieve the objectives set out in this system(Hussain 2017).
- 4.16 9. Communicate with the stock markets in the Arab world and the international markets in order to develop the market(Arumugam, Hussein et al. 2013).
- 4.17 10. Carry out other necessary services and activities to support its objectives(Leonidou and Katsikeas 1996).

6. CONCLUSION

Securities are considered the main engine of economic growth as economic development is closely linked to the existence of a flourishing and sophisticated securities market. The increase in these securities, their diversity and the public's interest in them lead to increased dealing with the market of these securities in issue and trading. In terms of providing the laws and supervision of the march to ensure the rights of dealers and obligate them to their duties. These transactions are medium- and long-term. The offer comes from many categories of financial surpluses from savers who wish to invest their money for a long time. The demand comes from those with financial deficits who wish to invest these funds in long-term projects. This market is in the form of loans through bonds or in equity form through shares or other movable securities. These markets in developed countries have witnessed an important development in terms of their technologies and organizations, while they are still taking their first steps in the Arab world, which is seeking to develop their financial markets in an attempt to catch up with the developed countries. Hence the problem of research to determine the performance of the Iraqi market for securities The market is relatively new compared to the world markets, and has encountered many problems at the beginning of its establishment, so try in this research to identify the most important elements that support the work in the market as well as the most important means and methods to improve performance, while paying attention to the most obstacles that hinder the workflow and the solution And to its success



Figure. 1



Figure 2.

7. REFERENCES

- [1] Al-Hashimi, M. N. H. and H. N. H. Al-hashimy (2019). "Strategic Accounting in the Profitability of Construction Engineering Projects Management Companies in Iraq." *Journal of Engineering and Applied Sciences* 14(3): 941-944.
- [2] Arumugam, V., et al. (2013). "A Review and Model Development of the Factors that Affect Mobile Marketing Acceptance by Customers."
- [3] Flynn, B. B., et al. (1990). "Empirical research methods in operations management." *Journal of operations management* 9(2): 250-284.
- [4] Hallett, J. (2002). "Climate change 2001: The scientific basis. Edited by JT Houghton, Y. Ding, DJ Griggs, N. Noguer, PJ van der Linden, D. Xiaosu, K. Maskell and CA Johnson. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge. 2001. 881 pp. ISBN 0521 01495 6." *Quarterly Journal of the Royal Meteorological Society: A journal of the atmospheric sciences, applied meteorology and physical oceanography* 128(581): 1038-1039.
- [5] Hasan, L. M., et al. (2015). "A review of the factors that influence the adoption of cloud computing by small and medium enterprises." *Scholars Journal of Economics, Business and Management* 2: 842-848.
- [6] Hussain, H. N. (2017). Introduction to management skills must be available to accountants in Iraq.
- [7] Hussein, H., et al. (2015). "A review of creative accounting practices and its area, technique and ways of prevention." *International Journal of Science and Research* 4(10): 1377-1381.
- [8] Leonidou, L. C. and C. S. Katsikeas (1996). "The export development process: an integrative review of empirical models." *Journal of international business studies* 27(3): 517-551.
- [9] Powell, W. W. (1998). "Learning from collaboration: Knowledge and networks in the biotechnology and pharmaceutical industries." *California management review* 40(3): 228-240.
- [10] Zang, A. Y. (2011). "Evidence on the trade-off between real activities manipulation and accrual-based earnings management." *The Accounting Review* 87(2): 675-703.
- [11] Zott, C. and R. Amit (2010). "Business model design: an activity system perspective." *Long range planning* 43(2-3): 216-226.

Impact of Information Communication Technology on Business Firms

Sura Khalil Ibrahim

Department Of Computer Engineering Techniques
Al- Nisour University College
Baghdad, Iraq

Zainab Taha Jebur

Department Of Computer Engineering Techniques
Al- Nisour University College
Baghdad, Iraq

Abstract: The importance of using Information Communication Technology (ICT) such as enterprise resource planning (ERP) and electronic commerce (e-commerce) by business firms cannot be overstated. ICT applications have been the major interest of researchers and practitioners due to the benefits that can be generated from these applications. The purposes of this study are to find the impact of ICT technologies and application on business firms. An intensive literature review has been conducted to identify the trends and patterns of academic researches. Suggestions based on the review have been made. There are gaps in the literature pertaining to the role of e-commerce and ERP. More studies needed to fill the gaps. The finding shows that most of the studies have focused on adoption factors, benefits and barriers of e-commerce rather than using e-commerce in area such as productivity and cost. The relationship between ERP and productivity was found to be significant.

Keywords: information communication; Technology; Business Firms

1. INTRODUCTION

The use of ICT technologies and application has started since 1990s. However, in recent years ICT application such electronic commerce (e-commerce) and ERP has become indispensable for business to survive and thrive. The increased competition forced firms to find sources of competitive advantages and strengthen their competitiveness. The association between the production and e-commerce is new and only few studies have been conducted in this area (e.g. Salami, Marthandan, Nor Zaidi and Chong, 2009). E-commerce has the capabilities to reduce the cost of operations and maximize the revenues. Therefore, it can be applicable and usable in the production of goods and services. ERP is an integrated system that can bring together all the applications that a company needs in one single system. This enables companies to speed up the decision making process and respond faster to the changes in the market (Mediations, Chatzoudes and Tsiaris's, 2011).

2. METHODOLOGY

This paper aims to review the literature to find pattern and trends of using ICT applications in the business firms. The methodology that this research is using is intensive literature review, i.e. the research is using secondary data. The data collected from previous studies. The research objectives focused on e-commerce and ERP and their implications.

3. LITERATURE REVIEW

3.1 E-commerce

E-commerce has become a widely accepted method for business operation. Till 2005 most of the research in e-commerce was exclusively conducted in the western world (Molla, and Licker, 2005). The introduction of e-commerce in the business has participated effectively in reducing the cost and maximizing the revenues of firms. Even though most of the firms use e-commerce for online buying and selling, however, it can be used in other areas such as logistic outsourcing (Cho, Ozment and Sink, 2008). The performance

of e-commerce is dependable on many factors that can increase the deployment of e-commerce (Salwani et al., 2009).

3.2 Firm Performance with E-commerce

The use of e-commerce in the business world has benefited companies greatly. Cho et al, (2008) examines the relationship between logistic capability, logistics outsourcing and firm performance. They find a positive relationship between logistic capability and firm performance in the e-commerce market. Logistics outsourcing and firm performance were not found to be positively linked.

Following quantitative approach, Salwani et al., (2009) investigate the impact of e-commerce usage on business performance in the tourism sector in Malaysia. They use moderate variable and mediate ones. The results reveal that technology competency, firm size, firm scope, web-technology investment, pressure intensity, and back-end usage have significant influence on e-commerce usage. Among these variables, back-end integration is found to function as a mediator. E-commerce experience is found to moderate the relationship between e-commerce usage and business performance.

3.3 Enterprise Resource Planning

One of the new applications in business firms is the use of ERP system. ERP systems can be defined as an integrated software package composed of a set of standard functional modules such as production, sales, human resources, finance, etc., which can be adapted to the specific needs of each organization (Laudon and Laudon, 2012). In this section, the use of ERP by business firms and the factors that enhance the adoption of ERP is highlighted.

3.4 ERP and Productivity

Nurmilaakso, (2009) in his study investigated the relationship between labor productivity and ICT applications such as: standardized data exchange with the trading partners, enterprise resource planning (ERP) system, and customer

relationship management (CRM), a website on the Internet, and supply chain management (SCM). The findings reveal that Internet access, standardized data exchange with the trading partners, ERP system, and CRM system contribute significant increases in labor productivity, whereas a website on the Internet, or SCM system do not result in a significant increase.

Another study conducted by Martinez-Caro and Ciara-Navarro (2010) to find the relationship between capital productivity, and internet-based applications, groupware applications, and collective systems. The findings reveal that the relationship between groupware application and collective systems with capital productivity is positive and statistically significant.

The use of ERP in mass customization was investigated by Hong, Dobrzykowski and Vonderembse (2010). They investigated the relationship between lean practices and IT use represented by ERP, e-procurement, and e-commerce. The finding indicates that lean practices, e-commerce, and e-procurement have strong relationships with mass customization performance. However, enterprise resource planning has no relationship with mass customization performance (Arumugam, Hussein et al. 2013).

3.5 ERP Successful Implementation

Mediations et al., (2011) investigate the factors that lead to effective implementation of ERP system. They find that consultants support, knowledge transfer, effective communication, conflict resolution are significant factors for the implementation of ERP. Top management support, user support has no significant relationship (Al-Hashimy 2018).

Similarly, Deodar and Aiming (2011) investigate the factors that lead to ERP successful implementation and they disagree with Mediations et al (2011). Their findings reveal that top management support, training and education, and enterprise wide communication have a positive and significant relationship with ERP implementation success. Another study conducted by the same authors Deodar and Aiming (2011a) but they use different variables. The findings of the study reveal that the relationship between project management and team composition with ERP implementation success is significant.

3.6 ERM and Supply Chain

Shatat and Udin (2012) investigate the relationship between SCM performance and the components of an ERP system which are integration, material management, production planning, controlling, and workflow management. The findings show that there is a positive and significant relationship between integration, material management, production planning, and controlling and SCM performance. The workflow management does not have a significant relationship with SCM performance.

4. Data collective

To achieve the objectives of the study, data were collected on the extent of the application of CRM in small and medium tourism companies in Egypt over three months. The quantitative methodology was used by designing a questionnaire to measure the study variables. The questionnaire design was based on a good review of previous

studies. The validity of the questionnaire was tested through a preliminary study by presenting the questions to academic professors in the field, to ensure that the meanings of the questions are clear and easy to understand. The questionnaire was also tested by postgraduate students of the Faculty of Tourism and Hotels, Alexandria University (Al-Hashimi and Al-hashimy 2019). Reference feeding has been used in the revision and language formulation of the questionnaire.

A total of 400 questionnaires were distributed to the small and medium-sized Egyptian tourism companies. The response rate was 64%. Two hundred and fifty-six valid questionnaires were obtained. This rate is scientifically acceptable for this type of study (Leek et al., 2006; Kingshott, 2006; Zhao and Cavusgil, 2006).

The questions were formulated on a Likert scale ranging from (1) which represents (not strongly agree) to number (5) which represents (strongly agree). The data were analyzed using the Statistical Package for Social Sciences (SPSS). The use of descriptive analysis to identify the characteristics of both front office staff (service providers) as well as customers. In addition, the mean and standard deviation of each variable was calculated as well as the Pearson correlation coefficient to test the relationships between the variables, as well as the Chi-squared tests used to determine the relationship between the descriptive variables (Hasan, Zgair et al. 2015).

To test the accuracy of the questionnaire and the consistency of its parts, Cronbach's alpha was calculated with positive results on an internal consistency scale ($\alpha = 0.887$) that is above the scientifically recommended score of 0.70 (Nunnally's, 1978). The questionnaire was divided into seven sections; The experience of the employee in the field of tourism as well as his experience in the company), and the second section deals with the implementation of CRM (the existence of a database of customers and the proportion of customers dealing with the company, as well as the main benefits of CRM applications) The main factors that may hinder the engagement of customers in Relationship Marketing Programs The fourth section deals with the quality dimensions of customer relationship management. The fifth section deals with the type of services that the customer requests continuously from the company. Through the relationship with the company, as well as most of the services actually purchased by these customers, and sections VI and VII inquiring about the characteristics of the client, who repeated several times with the company, in addition to the reasons behind the decision of the company to target a group of customers and retain them. As well as the reasons that may lie behind the company's lack of one

The analysis of the questionnaire showed that about 55% of respondents work in their companies for a period of one to five years. The rest of the sample is equally divided between three equal categories (about 15%) who work in the company for less than a year, from 5 to 10 years and more than 10 years (Hussain 2017).

As for the experience of the respondents in the field of tourism, such as 43.9% of those sample who have experience in the field of tourism work from one to five years. (10.6%), 5-10 years (21.2%), and more than 10 years (24.2%).

An analysis of the data collected shows that with regard to the implementation of the CRM policy, 71.2% of the respondents agreed that their companies have a customer database. And

57.5% of them agreed to have a private database only with their customers, although 40.95% agreed that they have a database of their customers in a non-institutional way (Hussein, Kasim et al. 2015). These results indicate that most employees of Egyptian tourism companies collect information to help companies to recognize and bring back their best clients, but sometimes with personal effort and in an informal way. Moreover, most respondents believe that most of their clients are already engaged in long-term (long-term) relationships with the company. Where 43.9% of the respondents said that the proportion of these customers ranges between 20% and 50%, while 40.9% of respondents said that the proportion of these customers more than 50%. This result confirmed that the majority of employees believe that they have CRM with the majority of their customers. As for the benefits of CRM, the greatest benefit was to reduce the negative impact of crisis times and accounted for 60.6% (with a mean of 3.64 and a standard deviation of 1.028). Followed by the importance of covering the basic and fixed costs of the company by 56% (with a mean of 3.55, standard deviation 0.911). Followed by 51.5% reduction of marketing expenses (3.32 mean, and standard deviation 1.006). Finally, the company's minimum expenses are 50% (with an average of 3.52 and a standard deviation of 0.977). This is consistent with previous studies on the positive returns of customer relationship management (Xu and Walton, 2005; Sivaraks et al., 2011). This result is very important; because Egypt has suffered in recent years from various crises that have a negative impact on the economic sectors. Especially the tourism sector, so efforts should be made to take care of customer relationship management to reduce the negative impact during crises and reduce marketing expenses and thus increase the profits of tourism companies. This result highlights the importance of applying CRM in Egyptian and small and medium-sized tourism companies. This idea is in DRA Of (O'zgener and Iraz, 2006).

And to calculate the correlation coefficient (Pearson correlation coefficient) to verify the existence of a relationship between each of the company's practical experience and experience in the field of tourism with a database of clients $r = -0.1$ (sig (2 tailed) = 0.941) $r = 0.169$ (sig) tailed) = 0.214, which means that there is no statistically significant relationship between both business experience in the company and experience in the field of tourism with the possession of the database. Similarly, to verify the relationship between the number of years of work in the company and the number of customers who have been configured. For successful relationships with them, the Pearson correlation coefficient $r = -0.068$ (sig (2 tailed) = 0.619) was also calculated, which also means that there is no relationship between the two variables. These results confirm that the company's business experience and overall experience do not affect CRM implementation.

An analysis of Enova with Cochran's Test was also used to test the existence of a difference or impact on the company's experience. The value of Cochran's Q was 566.419 at a mean level of 0.000 indicating that there was no effect on the existence of a database.

As for the nature of customers who prefer to start the company in the management of relationships with them, 80.3% of the employees that they prefer to start the relationship management with customers who have been dealing with the company for a long time. Although 39.3% of them agreed to start a relationship with customers who buy

more than one service even once. This result shows that employees are more interested in customers who have been dealing with the company for a long time. This finding confirmed that employees prefer a long-term relationship when taking a decision to manage relationships with their clients. This is confirmed by some previous studies that the pace of shopping is an important indicator when designing relationship shopping programs (Ashley et al., 2011)

With regard to the characteristics and quality of the customers whom the employee is keen to include in his database; 66.6% of the employees were keen to include customers who deal with the company (Al-Hashimi and Al-hashimy 2019)

5. CONCLUSION

This study was a literature review study and real data. Based on the review, e-commerce is an effective application for business firms to acquire raw material effectively and to use it for logistic purposes. There are many factors that can significantly enhance the performance of e-commerce (e.g. technology competency, firm size and etc.). However, more studies can be done to discover more about e-commerce. Reviewing the literature, it is found that most of the studies pertaining to e-commerce related to adoption factors, benefits and barriers. There is a need for more studies in another area for example, productivity and cost.

ERP is one of the ICT applications which have been widely used recently. The association between ERP and productivity was found to be positive regarding capital and labor productivity. However, a negative relationship was found between mass customization and ERP. This is a conflicting result. Mass customization can be described as labor and capital productivity because customization required capital as well as labor. Therefore, more study in this regard can be done to investigate the relationship between the terms.

The success factors of ERP were having mixed results. While some they claim that top management support is very important, other disagree and find that top management has no significance. A research can be conducted in this area to clarify this issue.

6. REFERENCES

- [1] Cho, J. J. K., Ozment, J., & Sink, H. (2008). Logistics capability, logistics outsourcing and firm performance in an e-commerce market. *International Journal of Physical Distribution & Logistics Management*, 38(5): 336-359.
- [2] Dezdar, S., & Ainin, S. (2011a). Examining ERP implementation success from a project environment perspective. *Business Process Management Journal*, 17(6): 919-939.
- [3] Dezdar, S., & Ainin, S. (2011b). The influence of organizational factors on successful ERP implementation. *Management Decision*, 49(6): 911-926.
- [4] Hong, P. C., Dobrzykowski, D. D., & Vonderembse, M. A. (2010). Integration of supply chain IT and lean practices for mass customization: benchmarking of product and service

focused manufacturers. *Benchmarking: An International Journal*, 17(4): 561-592.

[5] Hwang, D. W., & Min, H. (2013). Assessing the Impact of ERP on Supplier Performance. *Industrial Management & Data Systems*, 113(7): 6-16

[6] Laudon, K. C., & Laudon, J. P. (2012). *Management information systems: managing the digital firm* (Vol. 12). Pearson.

[7] Maditinos, D., Chatzoudes, D., & Tsairidis, C. (2011). Factors affecting ERP system implementation effectiveness. *Journal of Enterprise Information Management*, 25(1): 60-78.

[8] Martínez-Caro, E., & Cegarra-Navarro, J. G. (2010). The impact of e-business on capital productivity: An analysis of the UK telecommunications sector. *International Journal of Operations & Production Management*, 30(5): 488-507.

[9] Molla, A., & Licker, P. S. (2005). E-Commerce adoption in developing countries: a model and instrument. *Information & Management*, 42(6): 877-899.

[10] Nurmilaakso, J. M. (2009). ICT solutions and labor productivity: evidence from firm-level data. *Electronic Commerce Research*, 9(3): 173-181.

[11] Salwani, M. I., Marthandan, G., Norzaidi, M. D., & Chong, S. C. (2009). E-commerce usage and business performance in the Malaysian tourism sector: empirical analysis. *Information Management & Computer Security*, 17(2): 166-185.

[12] Shatat, A. S., & Udin, Z. M. (2012). The relationship between ERP system and supply chain management performance in Malaysian manufacturing companies. *Journal of Enterprise Information Management*, 25(6): 576-604.

[13] Al-Hashimi, M. N. H. and H. N. H. Al-hashimy (2019). "Strategic Accounting in the Profitability of Construction [12] Engineering Projects Management Companies in Iraq." *Journal of Engineering and Applied Sciences* 14(3): 941-944.

[15] AL-Hashimy, H. N. H. (2018). "The Effect of Tax System on Shareholder Decisions when Choosing a Accounting Principles." *Journal of Reviews on Global Economics* 7: 21-27.

[16] Arumugam, V., et al. (2013). "A Review and Model Development of the Factors that Affect Mobile Marketing Acceptance by Customers."

[17] Hasan, L. M., et al. (2015). "A review of the factors that influence the adoption of cloud computing by small and medium enterprises." *Scholars Journal of Economics, Business and Management* 2: 842-848.

[18] Hussain, H. N. (2017). Introduction to management skills must be available to accountants in Iraq.

[19] Hussein, H., et al. (2015). "A review of creative accounting practices and its area, technique and ways of prevention." *International Journal of Science and Research* 4(10): 1377-1381.

An Experimental Approach on the Study of Purple Sweet Potato (Myanmar Origin): Proximate Composition and Phytochemical Analysis

Thant Zin Soe
MFT Student
Department of Chemical Engineering
Yangon Technological University,
Myanmar

Si Si Win
Supervisor,
Department of Chemical Engineering
Yangon Technological University,
Myanmar

Abstract: Fresh purple sweet potato (PSP) contains moisture 66.40%, crude protein 1.26%, crude fat 0.08%, ash 1.08%, crude fibre 1.10%, and total carbohydrate 30.08%. The biologically active compounds present in PSP sample (phytochemicals) are found in the screening test as; carbohydrate, glycoside, phenolic compound, anthocyanin, amino acid, saponin, flavonoid, reducing sugar and starch except alkaloid, tannin, steroid, terpenoid and cyanogenic glycoside which were totally absent in it. This paper mainly deals with the collection of PSP, the extraction of active compounds from the dried PSP powder, and qualitative analysis of phytochemicals in screening tests, as part of the research work of PSP wine production. The experimental data demonstrates that PSP present in Myanmar is one of the potential plant (tuber) for therapeutic use and provide health benefits for human.

Keywords: PSP, phytochemicals, cyanogenic glycoside

1. INTRODUCTION

Sweet potato (*Ipomoea batatas* (L.) Lam), a fairly drought-tolerant crop is widely grown throughout the world, primarily in the tropics and subtropics. In addition, it has various skin and flesh colour from white to yellow, orange, light purple to deep purple. Sweet potato ranks the sixth most important crops after rice, wheat, potatoes, maize and cassava. Globally, the annual sweet potato production accounts up to more than 105 million metric tons[1].

Purple sweet potato contains carbohydrates, minerals, vitamins, anthocyanins, dietary fiber and has a Glycemic Index (GI) is low. In terms of its chemical composition, PSP potentially

be used as a source of carbohydrates, vitamins, minerals and antioxidants such as phenolic acids, tocopherols, anthocyanins and β -carotene[2].

Purple sweet potato (PSP) is a special type of sweet potato, and there is high content of anthocyanin pigments in the roots of some sweet potato cultivars[3]. It contains relatively high acylated anthocyanins, with mainly cyanidin or peonidin as the aglycone. It is suggested that anthocyanins as natural pigments may provide beneficial health effects. Studies proved anthocyanin provide physiological functions such as antihyperglycemic, antiinflammatory and anticarcinogenic and antioxidant[1].

Fruits and vegetables are good dietary sources of natural antioxidants for dietary prevention of degenerative diseases. The main contribution to the antioxidant capacity of a fruit or vegetable is likely to come from a variety of phytochemicals other than vitamin C. Fruits and vegetables contain many antioxidants such as phenolics, thiols, carotenoids and tocopherols, which may protect us against chronic diseases[4].

The medicinal value of these plants lies in some chemical substances that produce a definite physiological action on the human body. The most important of these bioactive constituents of plants are alkaloids, tannins, flavonoids, and phenolic compounds[5].

Phytochemicals are the chemicals that present naturally in plants. Now-a-days these phytochemicals become more popular due to their countless medicinal uses. Phytochemicals play a vital role against number of diseases such as asthma, arthritis, cancer etc. unlike pharmaceutical chemicals these phytochemicals do not have any side effects. Since the phytochemicals cure diseases without causing any harm to human beings these can also be considered as “man-friendly medicines”. This paper mainly deals with collection, extraction, qualitative analysis of phytochemicals[6].

2. MATERIALS AND METHODS

Purple sweet potato samples were selected, collected and prepared for analysis as follow.

2.1 Collection of PSP Samples

Fresh purple sweet potato (sound and healthy tubers; Thai variety) were selected and procured from Thirimingalar market.

2.2 Cleaning of PSP

After PSP collection, the collected samples have to be cleaned properly. Cleaning has to be done by hands in order to get better results.

2.3 Drying of PSP

PSP samples have to be dried immediately as soon as the collection or this will lead to spoilage of sample materials. Drying can be done either by natural process (sun drying) or by artificial process (i.e. driers).

The most common drying method was done in this work with the help of mechanical driers.

2.4 Powdering of PSP

After complete drying of PSP samples, they have to be powdered well by a grinder for further analysis.

2.5 Compositional Analysis

PSP samples were analyzed for moisture, ash, crude protein, crude fat, total carbohydrate reducing sugar, brix^o and starch using AOAC methods (2000) and fiber by Filter Cup method.

2.6 Phytochemical Screening Test

Sample extracts (aqueous, ethanol and methanol as soaking solvents) are prepared for screening procedure.

2.6.1 Test for Alkaloid

5ml of the extract was added to the 2ml HCl. To this acidic medium, 1ml of Dragendroff's reagent was added. An orange or red precipitate produced immediately indicates the presence of alkaloids.

2.6.2 Test for Amino acids

1ml of the extract was treated with a few drops of Ninhydrin reagent. Appearance of the colour shows the presence of amino acids.

2.6.3 Test for Flavonoids

1ml of the extract was added with, a few drops of dilute sodium hydroxide. An intense yellow colour was produced in the plant extract, which become colourless on addition of a few drops of dilute acid indicates the presence of flavonoids.

2.6.4 Test for Glycosides

The extract was hydrolysed with HCl for a few hours on a waterbath. To the hydrolysate, 1ml of pyridine was added and a few drops of sodium nitroprusside solutions were added and then it was made alkaline with sodium hydroxide solution. Appearance of pink to red colour shows the presence of glycosides.

2.6.5 Test for Saponins

The extract was diluted with 20ml of distilled water and it was agitated in a graduated cylinder for 15 minutes. The formation of 1cm layer of foam showed the presence of saponins.

2.6.6 Test for Terpenoids

1ml of the extracts was dissolved in 10ml of chloroform and equal volume of concentrated sulphuric acid was added by sides of the test tube. The upper layer turns red and sulphuric acid layer showed yellow with green fluorescence. This indicates the presence of steroids.

2.6.7 Test for Tannins

5ml of the extract was added with a few drops of 1% lead acetate. A yellow precipitate was formed, indicates the presence of tannins.

2.6.8 Test for Reducing Sugar

1g of water extract was mixed with deionized water and filtered. The resulting solution was boiled with Fehling's solution for about 5 minutes. Brick red precipitate indicates the presence of reducing sugar.

2.6.9 Test for Steroids

3g of dried sample was extracted with ethanol for 24 hours and filtered. The ethanol extract, thus obtained, was evaporated to dryness. The ethanol residue was treated with a few drops of acetic anhydride, followed by the addition of concentrated sulphuric acid with care. The test solution turned to pink indicating the presence of steroids.

2.6.10 Test for Carbohydrates

A small amount of water extract was boiled with 10ml of deionized water and filtered. A few drops of 10% α - naphthol solution were added into the filtrate that contained in test tube and shaken. This test tube was kept inclined at any position and 1ml of concentrated sulphuric acid was slowly introduced along the side of the test tube. A red ring indicated the presence of carbohydrates.



Fig1. Purple Sweet Potato Plant with Tuber (Kazun-U)

3. RESULTS AND DISCUSSION

The compositional analysis was done and the finding results are described in Table 1.

Table 1: Proximate Composition of Puple Sweet Potato Tuber Sample*

Sr. No	Test Parameter	Test Method	Result
1.	Moisture	AOAC-2000 (934.01)	66.40 %
2.	Ash	AOAC-2000 (940.26)	1.08%
3.	Crude Protein	AOAC-2000 (920.152) (Kjeldahl Method)	1.26%
4.	Crude Fiber	AOAC-2000 (978.10) Fiber Cap Method	1.10%
5.	Crude Fat (ether extract)	AOAC (Buchi Soxhiet Method)	0.08%
6.	Total Carbohydrate	By Difference	30.08 %
7.	Energy Value (kcal/100g)	Calculation Method	125
8.	Brix°	ABBE Refractometer	7.50
9.	Starch	Lane & Eynon Titration Method	22.84 %
10.	Reducing Sugar	□	1.79%

*FIDSL Lab

In the screening test, ethanol and water mixtures are commonly used for the extraction of phenolic compound from plant materials for identification qualitatively. This is because water had its limited ability to extract oil-based components (such as phenolic compound). This is proved that some bioactive compounds were only soluble in organic solvent were not present and detected in aqueous extract in the above result. Phytochemicals commonly found in plants have some possible health benefits and functions are shown in Table 2.

Table 2: Phytochemicals and its Functional Properties

No.	Phytochemicals	Possible Health effects/ Functions
1.	Alkaloids	Anti-inflammatory effect, Antimicrobial, Antiseptic, Anticarcinogenic
2.	Glycosides	Hypoglycemic activities
3.	Reducing sugar	Energy given
4.	Phenolic compounds	May prevent cancer, inflammation, antioxidant activity, antimicrobial, antitumor
5.	Flavonoids	May inhibit inflammation and tumor growth, may aid immunity, boost production of detoxifying enzymes in the body ; antioxidant agent

6.	Saponins	Hypocholesterolemic , anti-diabetic properties, slow cancer cell growth, bone health
7.	α - amino acid	To promote growth
8.	Carbohydrate	To give energy in the body
9.	Steroids	Anti-inflammatory effect, analgesic effect
10.	Tannin	Hypoglycemic activities
11.	Terpenoids	Decrease in blood sugar level [8]; Antimicrobial, Antidiuretic, anti-inflammatory

Source: Lee Weng Foo et al.,2015 [7]

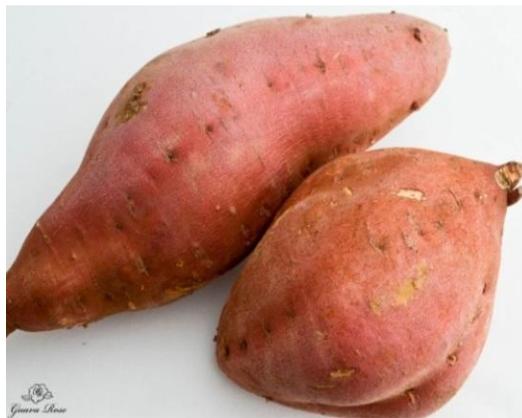


Fig 2. Purple Sweet Potato (Kazun-U)

The preliminary phytochemical test was performed with the extract of dried PSP samples. The experiments show the presence of carbohydrate, glycoside, phenol, amino acids, saponin, flavonoid, reducing sugar and starch in the given sample, as shown in Table (3).

Table 3. Phytochemical Examination of Dried PSP Sample

No.	Type of compound	Extract	Reagent used	Observation	Results
1.	Alkaloid	1% HCl	Mayer's reagent	No ppt.	-
			Wagner's reagent	No ppt.	
			Dragendorff's reagent	No ppt.	
			Hager's reagent	No ppt.	
2.	Carbohydrate	H ₂ O	10% α -naphthol & H ₂ SO ₄	red ring	+
3.	Glycoside	H ₂ O	10% Lead acetate solution	White ppt.	+
4.	Phenolic compounds	H ₂ O	5% FeCl ₃ solution	Brownish black ppt.	+
5.	α -amino acid	H ₂ O	Ninhydrin reagent	Purple colour	+

6.	Saponin	H ₂ O	H ₂ O	Persistent foam	+
7.	Tannin	H ₂ O	1% Gelatin & 10% NaCl solution	No ppt.	-
8.	Flavonoids	70%EtOH	Mg ribbon & Conc. HCl	Red colour.	+
9.	Steroid	Petroleum ether	Acetic anhydride & Conc. H ₂ SO ₄	-	-
10.	Terpenoids	Petroleum ether	Acetic anhydride & Conc. H ₂ SO ₄	-	-
11.	Anthocyanin	70%EtOH	Dil HCl	Purple red	+
			Dil NaOH	Green	
			Dil HCl	Red colour reappear	
12.	Reducing sugar	H ₂ O	Fehling's solution	Brick red ppt.	+
13.	Starch	H ₂ O	Iodine solution	Deep blue ppt.	+
14.	Cyanogenic glycoside	Fresh sample	H ₂ O, Conc. H ₂ SO ₄ , sodium picrate paper	No colour change	-

*DCPT Lab , (+) = presence; (-) = absence; EtOH = ethanol; ppt = precipitate

4. CONCLUSION

In the present study, it was found that, the preliminary phytochemical screening show the presence of carbohydrate, glycoside, phenol, α -amino acid, saponin, flavonoid, reducing sugar and starch in the extracts of PSP. It is suggested that the presence of phytochemical content in PSP have antioxidant activity or has the ability to capture free radicals so as to provide a good influence on human health ie. as a promising tool for antioxidant.

5. ACKNOWLEDGEMENTS

The author would like to thank Department of Chemical Engineering, YTU; his supervisor Daw Si Si Win, FIDSL lab, DCPT lab and DRI lab and everybody who helps in this experiments.

6. REFERENCES

- [1] Siti Nurdjanah et.al.2017. Physico Chemical, Antioxidant and Pasting Properties of Pre-heated Purple Sweet Potato Flour, Journal of Food and Nutrition Sciences, 5 (4): 140 – 146.
- [2] Y Rhamawati et al.2006. Effect of Processing Techniques on Color and Active Components Amount of Sweet Potato(*Ipomoea Batatas*. L) Flakes, IOP Conf. Series: Materials Science and Engineering, 128, 012043.
- [3] Ramesh C.Ray et al.2011. Proximate Composition and Sensory Evaluation of Anthocyanin- rich Purple Sweet Potato (*Ipomoea Batatas*.L) Wine, International Journal of Food Science and Technology,

Institute of Food Science and
Technology

- [4] Guanghou Shui and Lai Peng Leong. 2005. Residue from Star Fruit as Valuable Source for Functional Food Ingredients and Antioxidant Nutraceuticals, *Food Chemistry*, 97, pp 277-284.
- [5] H.O. Edeoga, D. E. Okwu and B.O Mbaebie.2005. Phytochemical Constituents of some Nigerian Medicinal Plants, *African Journal of Biotechnology*, Vol 4(7), pp. 685-688.
- [6] K. Sahira Banu and L. Cathrine. 2015. General Techniques Involved in Phytochemical Analysis, *International Journal of Advanced Research in Chemical Science (IJARCS)*, Vol.2, Issue 4, pp 25-32.
- [7] Lee Weng Foo et al. 2015. Extraction and Qualitative Analysis of Piper Betle Leaves for Antimicrobial Activities, *International Journal of Engineering Technology Science and Research(IJETSRS)*, Vol2, Special Issue, p.3,5.

Synthesis of Coating Resin from Mahua Oil by Using Alcoholysis Method

Mar Mar Thi

Department of Fuel and Propellant Engineering
Myanmar Aerospace Engineering University
Meikhtila, Myanmar

Saw Doo Nay Htoo

Department of Fuel and Propellant Engineering
Myanmar Aerospace Engineering University
Meikhtila, Myanmar

Abstract: Non-drying oil-modified coating resin having acid value (10.8) was prepared from mahua oil (a non-drying oil), phthalic anhydride and glycerol. Crude mahua oil was obtained by crushing whole or decorticated seed in expeller. The experiment was started with investigating the optimum conditions for neutralization of the crude oils. Non-drying oil modified coating resin was prepared by using alcoholysis method in excess of glycerol and phthalic anhydride in the presence of 0.1% (wt %) lead II oxide catalyst. Then, the properties (colour, acid number, hardness) of the prepared coating resin were characterized. The chemical resistances of coating resin were also determined.

Keywords: non-drying oil, coating resin, alcoholysis, mahua, neutralization

1. INTRODUCTION

One of the coating resin or alkyd is today normally used to cover those resins used in the paint and allied industries which are based on phthalic anhydride or some similar acid condensed with a polyalcohol and modified with a drying or non-drying oil, resin acid, etc. The fundamental and most important constituents of surface coating materials, such as oil paints and oleoresinous varnishes that “dry” by the action of oxygen in the air, are the drying oils. These oils are mostly obtained from the vegetable kingdom (renewable resources), where they occur in many fruits (in the seeds), and also from some animal life living in water. The chemical constitutions of all the different oils have very strong similarities, for example they are essentially glycerol triesters of fatty acids containing 18, or about 18, carbon atoms, hence their common name of “triglycerides”. It is clear that the difference between various drying oils depend largely on the constituent fatty acids. The industrial value of vegetable oil generally depends of its constituent fatty acids and the ease with which it can be modified or combined with other chemicals. Several physical and chemical modifications of the oil enhance their initial quality have been evolved over the years. Chemical transformation of vegetable oil to fatty acid alkyl esters called transesterification or alcoholysis is one of the methods of modifying the quality of vegetable oils. Raw vegetable oils are composed of glycerol, esters of fatty acids and various amounts of solubilized impurities such as pigments, vitamins, sterols, phospholipids, etc, which may compromise the quality of the finished alkyd or coating resins.

2. EXPERIMENTAL PROCEDURES

2.1 Preparation of Raw Material

2.1.1 Collection of Raw Materials

The large amounts of mahua seeds were obtained from the village in Kyaukse Township, Mandalay Division. Laboratory grade phthalic anhydride (PA), glycerol (G) and the required catalysts are also obtained from the local chemical groups.

2.1.2 Preparation of Crude Mahua Oil

The mahua oil was extracted from the kernel of the fruit. The kernels were taken out from the smooth chestnut colored pericarp by being bruised, rubbed and subjected to moderate pressure. They were then ground and the oil obtained by expression or the kernels were pounded and boiled and then wrapped up in two or three-folds of cloth and the oils were there-after expressed.

2.1.3 Neutralization of Crude Mahua Oil

The obtained crude mahua oil contains the variable amount of nonglyceride impurities, principally of free fatty acid. Highly content of free fatty acid (FFA) and impurities preclude some of the undesirable effects. In order to remove free fatty acid and small amount of other impurities, alkali refining or neutralization method was used. These method effects an almost complete removal of free fatty acids, which are converted into oil-insoluble soap.

In the method of removing the fatty acids, the required amount of crude mahua oil with the calculated amount of strong (1N) caustic soda solution were agitated to carefully regulate the temperature of the oil. After completion of neutralization, the temperature of 90 °C NaCl solution was added to the mixture to ensure adequate salting or graining out of soap stock. When the mixture was put into the separating funnel at least three hours, the soda solution combined with the free fatty acids to form a soap, which falls to the bottom of the vessel and two different layers were appeared. Then, the lower soap layer was drained out and the neutralized oil was run off from above and washed with hot water. After finishing washing step, the oil was dried at 100 °C in oven to evaporate the moisture. Drying and cooling carried out until the weight of dried mahua oil remained unchanged. The refined mahua oil was weighed to know oil loss and their free fatty acid content were determined.

2.2 Preparation of Coating Resin from Mahua Oil

Non-drying oil-modified coating resin was prepared from mahua oil, glycerol (G) and phthalic anhydride (PA) by using PbO catalyst. The preparation was carried out in a four necked bottom flask fitted with a motorized stirrer, a nitrogen inlet and a thermometer pocket and a tap for sampling.

In the production of coating resin, two stages were involved. To prepare the coating resin the calculated amount of raw materials were weighed firstly. The weight of raw materials for coating resin preparation was shown in (Table 1). The coating resin was prepared by using a synthesis of two stages, in which the first one stage is alcoholysis. In the alcoholysis, to be obtained glyceride, the calculated amount of oil was placed to the flask and heated with the agitation speed of (700 rpm) and inert atmosphere (N₂ sparging rate of about 0.06 ft³/sec) at 230-240 °C. Glycerol and PbO catalyst was added and reaction was carried out at 230-240 °C for 30 minutes intervals. The reaction condition was determined by testing the mixture sample with anhydrous methanol. When the sample dissolved in the anhydrous methanol and gave clear solution, the reaction was complete. After alcoholysis reaction was completed, the reaction mixture was cooled to 140 °C.

In the esterification stage, phthalic anhydride was added to the monoglyceride mixture at 140 °C also with 500 rpm of agitation speed and 0.01 ft³/sec of inert atmosphere and reheated to 230-240 °C. The samples were taken out every 30 minutes and determined the iodine value of the samples. The reaction was monitored by periodic determination of the acid value of the mixture. When the acid value of sample dropped to nearly 10, the reaction was stopped and the coating resin was obtained.

Table 1. Weight of Raw Materials for Mahua Oil-Modified Coating Resin

Raw Materials	Weight (g)	Weight (%)
Mahua oil	45.63	54.022
Glycerol (G)	22.7487	26.933
Phthalic anhydride (PA)	16.0868	19.045
Total	84.4655	100

The physico-chemical properties of the coating resin samples (color, refractive index, acid value, iodine value) and the chemical resistance of resin film were determined according to the India standard method.

3. RESULTS AND DISCUSSION

3.1 Characteristic of Crude Mahua Oil

The characteristics of crude mahua oils are shown in (Table 2). In this table, although the specific gravity and iodine value of the crude oils were in the range of India standard specification limits. Free fatty acid (FFA) is undesirable in resin formulation. Therefore, neutralization method was used to reduce free fatty acid from the crude oils. In the neutralization of oils, FFA content of oils was converted to oil soluble soaps. Neutralization process can remove some of materials consist of phosphatides, carbohydrates and carbohydrate derivatives, protein fragments and various

resinous and mucilaginous materials and the greater part of nonglyceride portions.

Table 2. Characteristic of Crude Mahua Oil

Characteristics	Crude mahua oil	Mahua oil (India Standard Specification)
Free fatty acid	3.00	1.0
Refractive index, 28°C	1.4636	1.459-1.461
Specific gravity, 15°C/15°C	0.917	0.862-0.875
Viscosity, 40°C, stoke	1.48	-
Iodine value, wiji's	58.96	58-70

3.2 Characteristic of Refined Mahua Oil

The characteristics of refined mahua oils are shown in (Table 3). According to this table, the neutralization process can reduce the FFA content of the crude mahua oil from 3.00% to 1.00%. The other properties of the refined oils such as refractive index, specific gravity, viscosity and iodine value were also slightly reduced. The characteristics of refined mahua oil were in the range of India Standard Specification. The characteristic of refined mahua oil was suitable for preparation of coating resin.

Table 3. Characteristic of Refined Mahua Oil

Characteristics	Refined mahua oil	Mahua oil (India Standard Specification)
Free fatty acid	1.00	1.0
Refractive index, 28°C	1.4633	1.459-1.461
Specific gravity, 15°C/15°C	0.8885	0.862-0.875
Viscosity, 40°C, stoke	1.16	-
Iodine value, wiji's	61	58-70

3.3 Coating Resin Preparation from Refined Mahua Oil

The first stage alcoholysis reaction condition of resin preparation for mahua oil is described in (Table 4). The percentage of reaction completion for non-drying oil coating resin is presented in (Table 5).

The alcoholysis reaction was carried out with different amount of PbO catalyst of (0.01% and 0.03%) for 3 hours, the sample mixture did not completely soluble in anhydrous methanol. The reaction with the largest percentage (0.1%) of catalyst was complete at the reaction time of 2.5 hours.

In the esterification stage, it was observed that the longer the reaction time, the more viscous the mixture is. In this process, adequate agitation was necessary for complete mixing of mono-glyceride mixture and phthalic anhydride. Unless adequate mixing was supplied in this stage, the un-qualify coating resin would be resulted. So, the N₂ sparging rate was increased in order to remove liberated reaction product and to increase the heat and mass transfer of chemical reaction. The non-drying oil-modified coating resin with acid number of 10.8 was obtained after the esterification reaction was carried out for 150 minutes. It should not try to proceed the reaction after the acid number of coating resin had dropped to 10.8, because the reaction was closed to gel point.

Table 4. First Stage Alcoholysis Reaction Conditions for Coating Resin

Raw oils	Alcoholysis catalyst	Weight % of catalyst	Reaction time (hr)	Completing of alcoholysis reaction*
Mahua oil	PbO	0.03	3	Not complete
		0.05	3	Not complete
		0.1	2.5	Complete

*It was determined by testing the solubility of sample mixture in anhydrous methanol

Table 5. Yield of Mahua Oil-Modified Coating Resin

Initial wt (g)	Final wt (g)	Yield (%)	Initial acid value	Final acid value	% of reaction completed (p)
84.47	62.95	74.53	316.15	10.8	96.58 %

AN initial charge = 561000 (0.476)/84.466 = 316.15

$P = [(initial\ acid\ number - final\ acid\ number)/initial\ acid\ number] \times 100$

According to the (Table 4) and (Table 5), degree of completion of the reaction for the mahua oil-modified coating resin was completed at 96.58% when the final acid value of non-drying oil-modified coating resin was 10.8.

3.4 Characteristic of Crude Mahua Oil Modified Coating Resin

The characteristics of coating resins are presented in (Table 6) and the chemical resistances of coating resin are shown in (Table 7).

Table 6. Characteristics of Mahua Oil-Modified Coating Resin

Properties	Mahua oil modified coating resin	Rubber seed oil-modified coating resin
Acid value	10.8	13.8
Iodine value	51.45	71.69
Color	Brown	Brown
Refractive index	1.4664	1.5018
Gouge hardness	HB	HB
Starch hardness	B	B

In (Table 6), there is no common standard to compare coating resins. Each coating resin has its own properties. It was found that acid value of the coating resins was 10.8. The coating resin that has acid number of less than 15 is suitable for application of paint, according to the literature.

Table 7. Chemical Resistance of Mahua Oil-Modified Coating Resin

Resins	Media	Immersion time (hrs)	Appearance of Films*
Mahua Oil-modified coating resin	water	24	Not effect
		7	Whitening
	3N NaOH	15	Blistering
		24	Removal

* It was examined after the films were air dried for 30 minutes.

The resistance of coating film was determined in two media, distilled water and NaOH solution. According to (Table 7), although the immersion of coating film in water for 18 hours was sufficient time to examine the water resistance, it was found that the mahua oil-modified coating film were no effect after immersion in distilled water for 24 hours. Then, the coating film was immersed in strong alkali solution, 3N NaOH.

The alkali resistance of this coating resin was the immersion time of whitening was 8 hours, blistering time was 16 hours and removal time was 24 hours. Therefore, the above results show that the prepared coating resin has high chemical resistance.

4. CONCLUSION

The characteristic of refined mahua oil was found to be standardized with India Standard Specifications. Therefore, this oil was suitable to carry out the next step. The alcoholysis of mahua oil by also using 0.1% of the PbO₂ catalyst, the reaction completed after 2.5 hours. The mahua oil-modified coating resin was prepared by using alcoholysis method from mahua oil, glycerol and phthalic anhydride with the help of 0.1% PbO catalyst and its acid value was 10.8. The physicochemical properties and high chemical resistance of coating resin showed that the non-drying oil modified coating resin in stoving finish.

5. RECOMMENDATIONS

Recommendations for further research works are outlined as follow.

- Coating resin should be prepared from other non-edable oil (linseed oil, tung oil, rubber seed oil).
- The reaction of kinetic of coating resin preparation should be explored.
- The synthesized coating resins should be enhanced for better results.

6. ACKNOWLEDGEMENTS

The authors wish to express their gratitude to all teachers, especially their supervisor, for guiding the knowledge, as well as invaluable experiences and other valuable kindness supports.

7. REFERENCES

- [1] Waters, R.T. 1955. Resins-Synthetic, Alkyd Resins. Section 2, Wyman and Sons, Ltd., London.
- [2] Greaves, J.H. 1955. Oils-Vegetable and fish, Section 1, Wyman and Son Ltd., London.
- [3] Pryde, E.H. and Rothfus, J.A. 1989. Industrial and non-food users of Vegetable oils. In Robbelen G, Downey RK, Ashri A (ed). Oil crops of the world. Mc Graw-Hill, New York. pp 87-117.
- [4] Solomon, D.H. 1977. The Chemistry of Organic Film Formers. R.E. Krieger Publishing Co., New York. p. 60.
- [5] Kildiran, G. 1996. In-situ alcoholysis of Soyabean oil. Amer Oil Chem Soc. 73(2): 225-8.
- [6] The wealth of India, A Dictionary of Indian Raw Materials and Industrial products, vol. I: A-C, Council of Scientific and Industrial Research, New Delhi.
- [7] Patel, R. P. And Raval, D. 2000. A. Alkyd resins from acylated prepolymerized rubber seed oil. Inter polym Matter. 38: 49-61.
- [8] Okieimen, F.E. and Okieimen, C.O. 2000. Utilisation of vegetable oils as alternatives on the thermal degradation of the PVC. J Sci Ind Res. 59: 563-8.
- [9] Okieimen, F.E. and Okieimen, C.O. Utilisation of vegetable oils as alternative diesel fuel. A review. Niger J Appl Sci. 102-8. 2000.
- [10] Marvin, W. 1965. Formo et al. Bailey's Industrial Fats and Oils Products. Vol 1, 4th Edition, John Wiley and Sons, Inc., New York.
- [11] Robert, L. Pecsok. 1980. Methods of Chemical Analysis. Second Edition, Interscience Publisher, Inc., John Wiley and Sons, Inc., New York.
- [12] Anonymous. Annual Book of American Society for Testing and Materials (ASTM), Part 27, 28, 29, Library of Congress Catalog Card Number. Md., U.S.A.
- [13] Solomon, D.H. 1977. The Chemistry of Organic Film Formers. R.E. Krieger Publishing Co., New York, p.60.
- [14] Patton, T.C. 1962. *Alkyd Resin Technology*, Interscience Publishers, Inc., A Division of John Wiley and Sons, Inc., New York.
- [15] Ogunity, D.S. and Njikang G.N. 2000. Preparation and Evaluation of Alkyd Resin from Castor Oil, 43(6) 378-380.
- [16] Anonymous. 2002. Journal of Science and Industrial Research, ISSN 0022-4456 CODEN JSIRAC, Vol. 61, n2, 110-116.

Removal of Sulfur from Myanmar Coals by Using Desulfurization Method

Mar Mar Thi
Department of Fuel and
Propellant Engineering
Myanmar Aerospace
Engineering University
Meikhtila, Myanmar

Ye Lin Tun
Department of Chemical
Engineerig
Defence Services
Technological Academy
Pyin Oo Lwin, Myanmar

Yan Naing Kyaw
Department of Chemical
Engineerig
Defence Services
Technological Academy
Pyin Oo Lwin, Myanmar

Abstract: The desulfurization of coal is a pre-processing in order to achieve clean fuel and reduce environmental impacts. In this research, the different coals from Myanmar were collected and each of them was grind and separated in various sizes. The obtained different mesh sizes of Myanmar Coals were leached with H_2O_2/H_2SO_4 at different temperatures (65°C, 75°C, 85°C and 95°C) and different leaching time (10 min, 20 min, 30 min, 40 min and 50 min). The samples after removing sulfur were tested how much sulfur content decrease. In this processes, effects of the leaching temperature, agitation time and particle size on the removal of different forms of sulphur from Myanmar coals were very significant. The optimum values of leaching temperature, agitation time and particle size of coal were obtained for this processes. The calorific values of coals which have leached were compared with that of Myanmar original coals. It can find how the leached coals effect to calorific values of it in burning.

Keywords: desulfurization, Myanma coal, leaching temperature, agitation time, calorific values

1. INTRODUCTION

Coal is the most important nonrenewable energy source of fossil origin. It is also the most common fuel in thermal power plants. In recent years, with the rising prices of crude oil and natural gas and shortage of oil and gas resources, worldwide energy industries have been focusing on accelerating the development of coal chemical industry. The coal chemical industry can make a significant contribution in the sustainable development of some countries' energy resources in the next twenty years. It will also reduce dependency on oil and gas as energy sources.

Coal usually contains significant quantities (normally more than 10%) of different impurities such as sulfur, silicates, carbonates, etc. Harmful effects on agricultural products, corrosion of metal structures and respiratory problems of humans and animals are undesirable effects of sulfur and its compounds in coal. Therefore, it is essential to reduce sulfur and mineral matter from coal.

Coal is also one of the main sources of energy on the world. Economic growth and industrialization in developing countries are leaching to a rapid increase in the demand for energy which is inexpensive and readily available, for electric power and process heat. When coal is burned generally 90% or more of the sulfur present in it is emitted into the atmosphere as sulfur oxides (mainly SO_2), if no desulfurization methods are used before, during and after combustion. It is well-known that SO_2 emissions are considered one of the main causes of acid rain, which leads to the acidification of soils, forests, and surface of water. The growth in coal-fired capacity has, therefore, led to increasing concern about environmental issues, such as increased emissions of SO_2 , nitrogen oxides (NO_x), trace elements, and particulates, although most effort has been directed towards the control of SO_2 emissions.

The reduction of SO_2 emissions in the use of coal, in particular from coal combustion, can be done by the following option: The use of coal having low sulfur content, pre-

treatment of coal for sulfur removal, sulfur capture during combustion and post-combustion treatment of flue gas.

Removal of sulfur techniques are classified as physical, chemical, thermal and biological. Such techniques are extensively applied for coal desulfurization prior to combustion. Most of research work on coal desulfurization has been focused on pyritic sulfur removal. Organic sulfur is more difficult to be removed by conventional processes since it is firmly bonded to organic units.

Coals are founded throughout the many places in Myanmar. They are got mainly in the upper parts of Mandalay Division, in the northern parts of Sagaing Division, and Shan State. They are found in a few places of Bago Division, Naypyitaw Division, Tanintharyi Division and eastern parts of Shan State.

Most of coals in Myanmar are only Sub-bituminous and Lignite coals. Few of Anthracite coal can be found in Kalaw region. Myanmar produces limited amounts of sub-bituminous coal and lignite from small-scale surface mines located primarily in the northern part of the country. The usage of coal in Myanmar is limited to domestic cement, steel and other industry requirements.

2. EXPERIMENTAL PROCEDURES

2.1 Preparation of Raw Coals

The solid types of various raw coals from Namma (Sagaing Division), Kyaukmel (Shan State) and Pinlebu (Sagaing Division) were analyzed to obtain the required size of raw materials by grinding machine and screening machine. The raw coal and screen analysis of various coals were shown in (Figure 1 and Figure 2).

There are five kinds of coal obtaining by screening machine. They are as follows:

- (1) Size No. (1), over 2000 micrometer
- (2) Size No. (2), between 2000 micrometer and 1000 micrometer
- (3) Size No. (3), between 1000 micrometer and 500 micrometer
- (4) Size No. (4), between 500 micrometer and 125 micrometer
- (5) Size No. (5), under 125 micrometer



Figure. 1 Myanmar raw coals



(a)



(b)



(c)



(d)



(e)

Figure. 1 Screen analysis of various coals

- (a) Coal Sample, Size No.1 (over 2000 μm)
- (b) Coal Sample, Size No.2 (between 2000 μm and 1000 μm)
- (c) Coal Sample, Size No.3 (between 1000 μm and 500 μm)
- (d) Coal Sample, Size No.4 (between 500 μm and 125 μm)
- (e) Coal Sample, Size No.5 (under 125 μm)

2.2 Characterization of Raw Coals

The characterizations of raw coals were determined to know the properties of the origin condition of raw.

The moisture content, ash content, volatile matter content, fixed carbon content, calorific values and chemical compositions of various raw coals from Namma, Kyaukmel and Pinlebu were determined and this results were shown in (Table 1).

Table 1. Characterization of different Myanmar coals

Sr. No	Composi-tions	Namma Coal	Kyaukmel Coal	Pinlebu Coal
1.	Moisture content (%)	12.90	10.06	4.213
2.	Ash content (%)	11.31	9.49	54.86
3.	Volatile Matter (wet) (%)	39.55	52.37	8.607
4.	Fixed Carbon (%)	36.24	28.08	32.32
5.	Hydrogen content (%)	4.160575	4.44485	1.926813
6.	Nitrogen content (%)	1.11698	1.061	0.75617
7.	Carbon content (%)	59.55672	62.18	33.43611
8.	Oxygen content (%)	8.30284	10.26863	1.967724
9.	Sulfur content (%)	0.531	0.581	0.807
10.	Others content (%)	2.11989	1.91452	2.03318
11.	Calorific Value (Btu/lb)	10393.25	10810.83	5685.33

2.3 Preparation of Solvent Solution

For chemical leaching method, 98% sulfuric acid, 97% hydrogen peroxide and distilled water were mainly used for removal of any form of sulfur in coal. In this process, to obtain 0.08 N solution the required amount of concentrated sulfuric acid was weighed and mixed with distilled water. The temperature of the dilute solution was increased in the mixing time, for exothermic reaction. The increased temperature was gradually decreased to the normal condition with increasing time. 97% hydrogen peroxide was also weighed and added to the dilute solution in this normal condition.

2.4 Removal of Sulfur by Chemical Leaching Method

2.4.1 Preparation of Coal Sample

In the method of sulfur removal from coal, the required amount of Namma coal was weighed and put into a beaker. And then, the prepared solution was added to the beaker, drop by drop by using a burette. When the solution was added, the reaction temperature was increased and the foam was formed very rapidly. After finishing the mixing, the temperature was decreased to the normal stage slowly. The preparation of coal sample was shown in (Table 2).

Table 2. Raw materials for sulfur removing process

2.4.2 Heating and Agitation

Raw Materials	Weight, g	Weight Percentage, %
Coal	20	14.02
H ₂ SO ₄	73.6	51.61
H ₂ O ₂	29	20.33
H ₂ O	20	14.02
Total	142.6	100

After finishing the preparing of coal sample, the beaker was put onto the heater and agitated with stirrer about 200 rpm and the agitation temperature was 65 °C for one hour. The reaction was completed in one hour agitation time. To determine the optimum temperature, the similar process was done in various agitation temperatures (75 °C, 85 °C and 95 °C, respectively).

2.4.3 Washing and Filtration

After finishing heating and agitation, the sample coals were washed with distilled water. Over 6 liters of distilled water was used for washing process. In washing step, it is needed to wash again and again until the spent water maintains about pH 7. It is very important for the results in the determination of sulfur content may be false because of sulfuric acid. After washing the sample, it is filtrated with filter paper

2.4.4 Drying

After finishing the above steps, the samples are needed to remove their moisture content. Therefore, the samples were dried at 120 °C in oven for 12 hours to evaporate the moisture. After cooling and drying, the desulfurized coal was obtained. It is shown in (Figure 2.)



Figure. 2 Myanmar desulfurized coal

In the desulfurization process, various reactant temperatures, various mesh sizes of sample and various reaction times were used to determine the optimum condition.

The desulfurization of coals from Kyaukme and Pinlebu were also made as above procedure.

2.4.5 Methodology for Sulfur Removing Process

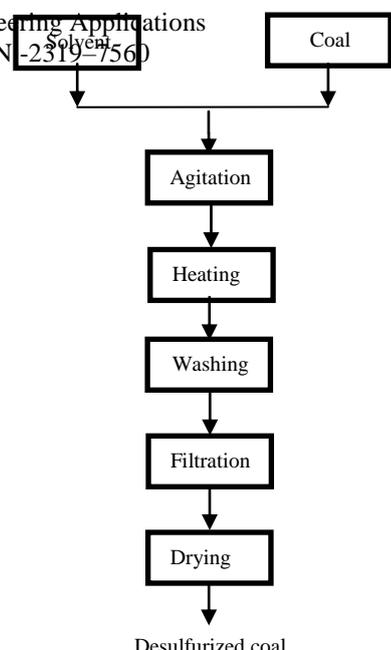


Figure. 3 Block diagram of sulfur removal of coal by solvent leaching method

3. RESULTS AND DISCUSSION

3.1 Determination of Sulfur Content from Different Desulfurized Coals

The total sulfur contents in the different raw coals from Namma, Kyaukme and Pinlebu were determined by the high temperature combustion method, according to ISO- R 351.

The optimum reactant temperature, optimum size of samples and optimum reaction time were obtained by this method.

The optimum conditions for desulfurization of Kyaukme coal and Pinlebu coal were obtained by the similar method.

The theoretical percentage of completion of desulfurization of different coals is shown in (Table 3).

Table 3. Theoretical percentage of completion of desulfurization of different Myanmar coals

Raw Material	Sulfur percent in initial coal	Sulfur percent in final coal	Percentage of completion of desulfurization
Namma Coal	0.531%	0.1535%	71.09%
Kyaukme Coal	0.581%	0.1595%	72.55%
Pinlebu Coal	0.807%	0.1585%	80.36%

3.2 Characterization of Different Myanmar Coals

(Table 4) show the compositions and calorific values of different Myanmar coals.

Table 4. Compositions and calorific values of different Myanmar coals

According to the (Table 1), the compositions of various coals were different with different places. The moisture content and

ash content of Namma coal were greater than the two others. The presence of carbon content in Kyaukmel was the greatest in all coals and the calorific value of that coal was the highest, therefore the rate of combustion of that coal was the best condition in all coals. Pinlelbu coal, more present of sulfur content and less percent of carbon content were found in this result.

Sr. No	Compositions	Namma Coal	Kyaukmel Coal	Pinlelbu Coal
1.	Moisture content (%)	12.90	10.06	4.213
2.	Ash content (%)	11.31	9.49	54.86
3.	Volatile Matter (wet) (%)	39.55	52.37	8.607
4.	Fixed Carbon (%)	36.24	28.08	32.32
5.	Hydrogen content (%)	4.160575	4.44485	1.926813
6.	Nitrogen content (%)	1.11698	1.061	0.75617
7.	Carbon content (%)	59.55672	62.18	33.43611
8.	Oxygen content (%)	8.30284	10.26863	1.967724
9.	Sulfur content (%)	0.531	0.581	0.807
10.	Others content (%)	2.11989	1.91452	2.03318
11.	Calorific Value (Btu/lb)	10393.25	10810.83	5685.33

3.3 Measuring of Sulfur Content from Different Myanmar Coals

To study the effect of temperature on sulfur removal from coal, the samples were leached for 1 hour at 65 °C, 75 °C, 85 °C and 95°C. The change of the percentage of removed sulfur at different reactant temperatures is shown in (Figure 4).

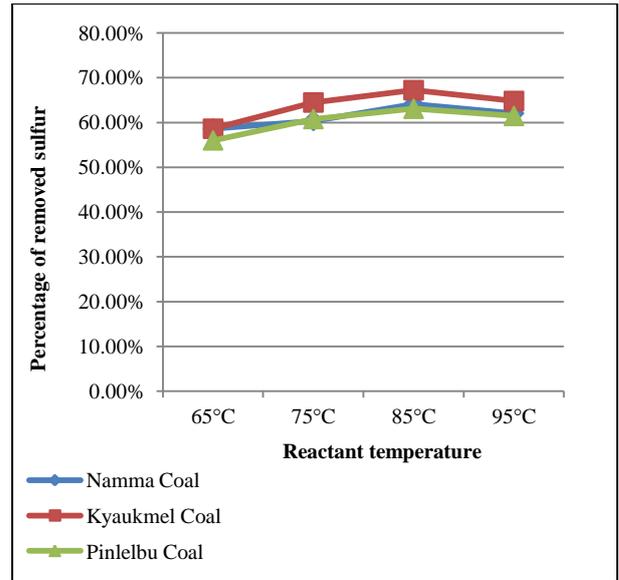


Figure 4 Change of the percentage of removed sulfur at various reactant temperatures

In (Figure 4), the best conditions for desulfurization of different coals were obtained at various reactant temperatures with acceptable percentage of sulfur removed. The reactant temperature of desulfurization of 85 °C was the best condition to reduce sulfur contents for all coals. In the desulfurization of different coals the removal of sulfur content were reduced at 65 °C, 75 °C and 85 °C, respectively, but the percentages of removed sulfur content were decreased at 95 °C. Therefore, the above results show that the desulfurization process was depend on the reactant temperatures, and control-temperature was very important for removal of sulfur in coals. Generally, rate of extraction is proportion to the reactant temperature.

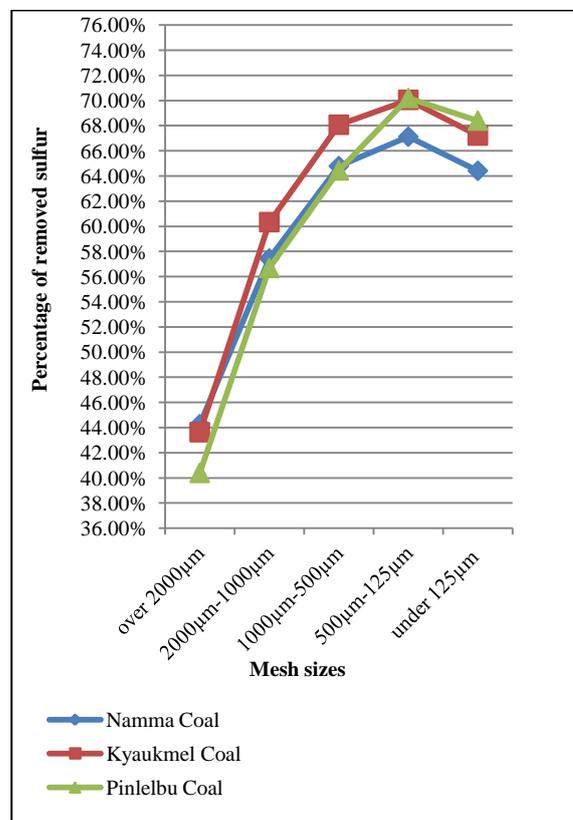


Figure 5 Change of the percentage of removed sulfur at various mesh sizes

To study the effect of the particle size on sulfur removal from coal, samples of various particles sizes (+2000, +1000, +500, +125 and -125 mesh sizes) were leached at the optimum reactant temperature, 85 °C for 1 hour. (Figure 5) represents the change of the percentage of removed sulfur at different mesh sizes.

According to the (Figure 5), the results show that rate of extraction increases as mesh size decreases but after specific mesh size, the rate of leaching decreases. Particle size influences the extraction rate in a number of ways. Therefore, the percentage of removed sulfur increased from over 2000 μm to 500-125 μm, but the mesh size under 125 μm decreased the removed sulfur content for different coals. Because the smaller the particle size, the greater is the interfacial area between the solid and liquid, and therefore the higher is the rate of transfer of material and the smaller is the distance the solute must diffuse within the solid as already indicated. On the other hand, the sulfur may not be so effectively used with a very fine material if circulation of the liquid is impeded, and the separation of the particles from the liquid and drainage of the solid residue are made more difficult. It is generally desirable that the range of particle size should be small so that each particular, the production of a large amount of fine material should be avoided as this may wedge in the interstices of the larger particles and impeded the flow of the solvent.

To study the effect of mixing reaction times on sulfur removal from coal samples of -500 +125 μm (optimum size) were leached at 85 °C for 10 min, 20 min, 30 min, 40 min and 50 min. The change of the percentage of the removed sulfur at various reaction times is shown in (Figure 6).

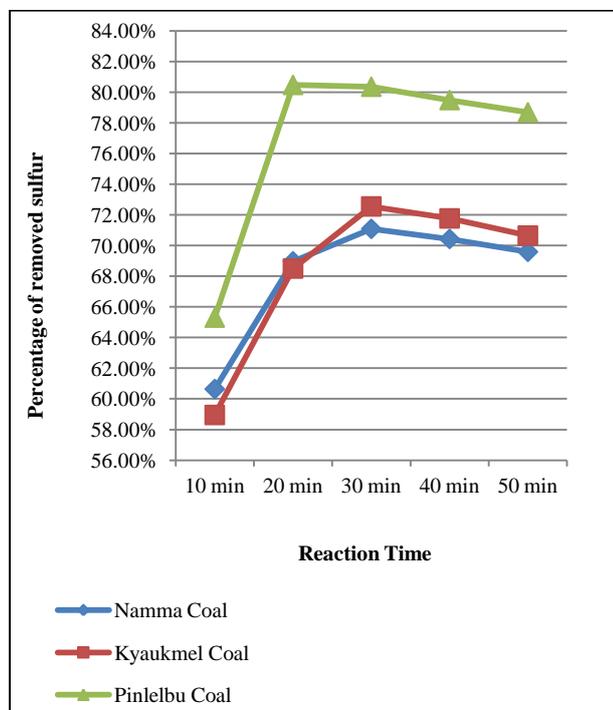


Figure 6 Change of the percentage of removed sulfur at various reaction times

In (Figure 6), it was observed that all different coals with the change of the percentage of removed sulfur at various reaction times and the maximum condition of removed sulfur contents could be obtained at the proper reaction time.

3.4 Compositions and Calorific Values of the Different Desulfurized Coals

The composition and calorific values of the different desulfurized coals are presented in (Table 5) by comparing with the data for before desulfurization and that of after desulfurization.

Table 5. Composition and calorific values of the different desulfurized coals

Compositions	Namma Coal		Kyaukmel Coal		Pinlelbu Coal	
	Before	After	Before	After	Before	After
Moisture content (wt;%)	12.90	2.83	10.06	3.81	4.213	4.78
Ash content (wt;%)	11.31	47.36	9.49	57.14	54.86	59.05
Volatile Matter (wet) (wt;%)	39.55	25.31	52.37	17.55	8.607	13.49
Fixed Carbon (wt;%)	36.24	24.5	28.08	21.5	32.32	22.68
Hydrogen content (wt;%)	4.16	2.729981	4.44485	2.119961	1.926813	1.921016
Nitrogen content (wt;%)	1.12	0.73347	1.061	0.60945	0.75617	0.56769
Carbon content (%)	59.56	39.20973	62.18	30.96886	33.43611	14.48481
Oxygen content (wt;%)	8.30	7.128	10.26863	2.08998	1.96772	5.86033
Sulfur content (wt;%)	0.53	0.1535	0.581	0.1595	0.807	0.1575
Others content (wt;%)	2.12	3.5865	1.91452	3.98606	2.03318	3.98806
Calorific Value (Btu/lb)	10393.25	6843.292	10810.83	5579.365	5685.33	2170.558

According to the (Table 5), most of the compositions from different coals were reduced from their original composition after desulfurization. And the other such as ash and other content were increased often this process.

The calorific values for all coals were decreased from their initial value. Chemical leaching method is quite effective for removal of sulfur content from coal but this cause reduce in calorific value of as shown in (Table 6).

Table 6. Comparison of calorific values for initial coals and final coals

Raw of Coal	Calorific Value (Before Desulfurization)	Calorific Value (After Desulfurization)	Decreased percentage
Namma Coal	10393.25 Btu/lb	6843.292 Btu/lb	34.16%
Kyaukmel Coal	10810.83 Btu/lb	5579.365 Btu/lb	48.39%
Pinlelbu Coal	5685.33 Btu/lb	2170.558 Btu/lb	61.82%

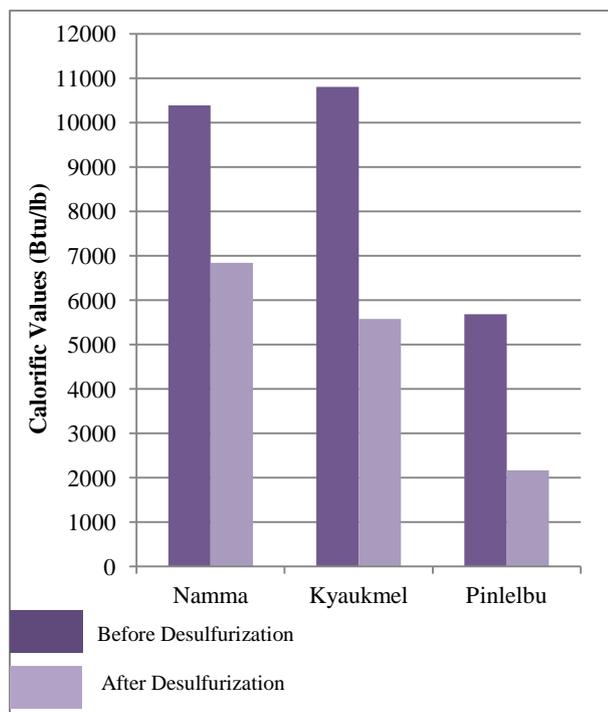


Figure 7. Changes for calorific values of different coals in before and after desulfurization

The calorific values for all coals were decreased from their initial value. Chemical leaching method is quite effective for removal of sulfur content from coal but this cause reduce in calorific value of as shown in (Figure 7).

4. CONCLUSION

According to the determination of characterization of different raw coals (Namma coal, Kyaukmel coal and Pinlelbu Coal), the sulfur contents of their coals were not different each other. Although the sulfur contents of each coal were not present in large amount, it was needed to remove for application and modification of coals. Therefore, sulfur removal process was carried out by using solvent leaching method. Firstly, Namma

coals were used as raw material. In this method, 98% H₂SO₄, 97% H₂O₂ and distilled water used as a leaching solvent. Various reactant temperatures, various mesh sizes and various reaction times were done in the desulfurization process. In the same way, Kyaukmel coals and Pinlelbu coals were used to remove sulfur content from it. The rate of sulfur removal increased with increasing reactant temperature, reactant time and mesh number (decrease in particle size). Although the calorific values of the desulfurized coals were decreased, the percentages of removed sulfur were good in this process. Therefore, the obtained desulfurized coals were suitable for various applications and modifications.

Finally, in this research, the optimum conditions were got for desulfurization from different places of Myanmar. But, it can be seen that this desulfurization method is not only more costs but also occurs decreasing in heating values of coals, like other desulfurization methods. However, desulfurization of coal is absolutely necessary for the health of all human-beings and to maintain the green environment.

5. RECOMMENDATIONS

The following further works are recommended to do.

- (1) The desulfurization process should be tested with other techniques (for example, physical techniques and biological techniques). Especially, biological methods should be tested if it will have enough time, because these methods are more effective in long period.
- (2) In the leaching process, instead of sulfuric acid, other concentrate acids should be used since it is needed to wash again and again until the spent water maintains about pH 7 after leaching because of sulfur content in sulfuric acid.

6. ACKNOWLEDGEMENTS

The authors wish to express their gratitude to all teachers, especially their supervisor, for guiding the knowledge, as well as invaluable experiences and other valuable kindness supports.

7. REFERENCES

- [1] Ali Ahmed & Naseer Ahmed, 2008. *Coal Desulfurization by Solvent Leaching Method*, Journal of Faculty of Engineering & Technology.
- [2] American Coal Foundation, *Types of Coals*, December 15, 2005. Available: <http://www.types>
- [3] Anonymous, *Coal*, Wikipedia, the free encyclopedia, January 2, 2009. Available: <http://www.En.Wikipedia>
- [4] Anonymous, *Coal Analytical Methods Blackwell Scientific Press*, 1984. <http://www.Coal assay.pdf>
- [5] Anonymous, Homeland security: U.S. Brown field, *Power Engineering Volume.106, No.6*, June, 2002.
- [6] Bruce G. Miller, *Coal Energy Systems*, Elsevier, Inc., October 29, 2004.
- [7] Coal_ Review.pdf February, 2003. Available: <http://www.MARSTON SoutheastAsia>
- [8] Dr. C. Otto, March, 1969.. *Report on Tests and Studies for the Production of Merallurgical Coke From Kalewa Coal*, No. (1) Iron and Steel Industry, Myanmar.
- [9] E.Bolat, S. Saglam and S. Piskin, 1998.. *Fuel Processing Technology 57*.
- [10] Energy.gov/education/energy lesson/coal_cct2.html, 2008. Available: <http://www.fossile>
- [11] George Granger Brown, 1958. *Unit Operations*, Modern Asia Edition, John Wiley & Sons, Inc., New York, & Charles E. Tuttle Co., Tokyo.
- [12] K. Komnitsas & C. September, 2001. Stouraiti, *Sulfur removal from Coal Beneficiation Wastes*, 7th CEST Conference, Syros, Greece.
- [13] S. Mukherjee and P.C. Borthakur, 2003. *Fuel Processing Technology*,

- [14] Warren L. McCabe: 1993. *Unit Operations of Chemical Engineering*, 5th Edition, McGraw-Hill, Inc., New York..

Effect of Amylolytic Enzyme Treatment on Banana Juice Preparation, Yield and Clarification: A Preliminary Approach

Khant Khant Win Shwe
Department of Food Technology
Yangon Technological University
Yangon, Myanmar

Si Si Win
Department of Food Technology
Yangon Technological University
Yangon, Myanmar

Abstract: The enzymatic clarification of banana juices from three cultivars (HPEE GYAN, THEE HMWE, NGET PYAW CHIN) of Myanmar origin was studied as a preliminary lab scale. Full ripe bananas of maturity stage 7 (completely yellow and speckled with brown spots) were treated with commercial α -amylase. As a result of the enzymatic treatment (0.1, 0.2, 0.4ml), it was found that no extracted juice volume in HPEE GYAN and THEE HMWE, except NGET PYAW CHIN gave 26.7 (v/w%), respectively. This study revealed that the role of α -amylase during clarification, NGET PYAW CHIN gave a little more yield among others. Depending on maturity, the effect on clarity, viscosity, pH and Brix on all three types of banana shows no significant changes in the experiments.

Keywords: enzyme; clarification; banana; liquefaction; α -amylase

1. INTRODUCTION

Banana (*Musa* spp.) juice is nutritionally important beverage in the tropical and subtropical world and is rich in calories and minerals such as potassium, magnesium, phosphorus, etc. Clear banana juice, with its widely appreciated flavour and aroma can be used in various foods and drinks.

Generally, fruit juices are extracted by simple crushing and or grinding of fruits. However, in case of banana this process results in a sticky, lumpy mass with no juice. Bananas are usually too pulpy and pectinaceous to yield juice by simple pressing or centrifugation. Of the problems associated with banana pulp processing, a high viscosity seems to be the most severe. The turbidity and viscosity of banana juice are caused mainly by the polysaccharides in the juice such as pectin and starch [1].

Pectin makes the clarification process harder because of its fibre-like molecular structure. Starch is also a common problem for juice processors. Polymeric carbohydrates like starch may make filtration difficult and cause post process cloudiness. Application of enzymes such as pectinase and amylase improved the clarification process for banana fruit juice [2] [3].

Enzymatic treatment for juice extraction and clarification is most common nowadays. Enzymatic liquefaction of banana juice increases soluble components, which offer a number of advantages in producing juice, such as aroma, flavour, viscosity, turbidity, quality and yield [4].

Enzymatic hydrolysis of the cell walls increases the extraction yield, reducing sugars, soluble dry matter content, galacturonic acid content and titratable acidity of the products. The resultant pulp has a lower viscosity and the quantity of waste is reduced. Enzymatic degradation of the biomaterial depends upon the type of enzyme, incubation time, incubation temperature, enzyme concentration, agitation, pH and use of different enzyme combinations [5] [6].

Banana juices have been produced locally for several years in the banana-producing areas. Though not yet commonly available on

the market, clarified banana juice has been studied by different researchers using various approaches [7].

In Myanmar, at least 25 species of banana varieties are grown though 150 species in the banana family. The popular strains are Hpee gyan, Hnget pyar, Byat pyeith, Thange zar, Rakhine ngapyaw, Thee hmwe, Nget, pyaw chin, Nanthabu, Htawbhat, Shweni, Wakmalwut. Main production areas of banana in Myanmar are Yangon Division, Mandalay Division, Ayeyarwaddy Division and Sagaing Division.

The purpose of the present study was to produce high-value clarified banana juice, to get high yield, to facilitate natural, highly nutritious and high quality of banana juice as a preliminary study to use α -amylase enzyme.

2. MATERIALS AND METHODS

2.1 Collection of Samples

Three cultivars of Banana (HPEE GYAN, THEE HMWE, NGET PYAW CHIN) purchased from a local market was used in this study.

Table1. Maturity Stages of Banana

Stage 1	All green
Stage 2	Light green (green with faint hints of yellow)
Stage 3	Turning yellow, green tips (more green with yellow)
Stage 4	More yellow than green
Stage 5	Yellow with green tips
Stage 6	Yellow (completely)
Stage 7	Completely yellow and speckled with brown spots



Figure 1. HPEE GYAN, *Musa sapientum*



Figure 2. THEE HMWE, *Musa arakanensis*, Ripely



Figure 3. NGET PYAW CHIN, *Musa sapientum* L.var.champa Baker

2.2 Selection of Samples

Banana samples used in this experiments are sound and healthy, lacking noticeable defects (bruise), when turned to maturity stage 7. (Table 1)

2.3 Processing of Banana Juice

The detailed work plan is shown in figure 4.

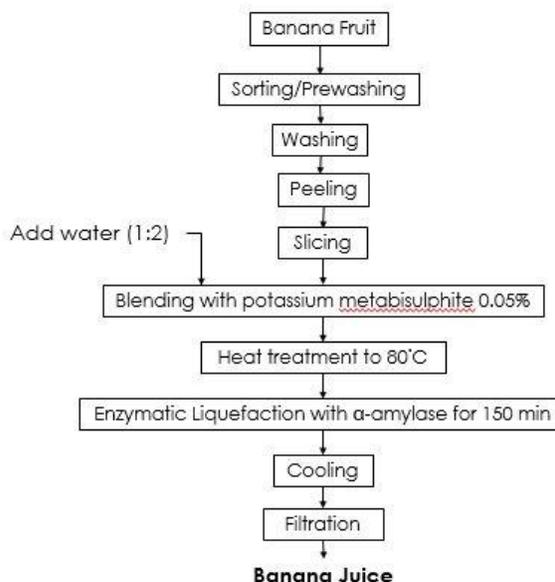


Figure 4. Process Flow Diagram of Banana Juice by α -amylase treatment

Procedure

Fresh and ripened bananas and their juices of weighed amount were extracted with the help of blender, filter with muslin cloth and crude juice filtrate measured and stored at 4°C.

The α -amylase (SpeZyme ALPHA) with activity, 13.775 AAU/g (minimum), pH 6.0 with specific gravity 1.15-1.19 was used for this study.

The bananas fruits were washed, peeled manually and cut into small pieces. Pieces were then pulped using a kitchen blender for 2 mins into pulp. For each experiment 300 g pulp was subjected to various concentrations (0.1 ml, 0.2 ml, 0.4 ml) vol/wt % of α -amylase treatment conditions as shown in Figure 4.

The required quantity of α -amylase enzyme was added to 300 g batches of banana pulp and incubated at 80°C and 150 min. At the end of the treatment, the enzymes in the pulp was inactivated by heating at 90°C for 5 min and immediately cooled to room temperature. The supernatant was filtered through a fine mesh nylon cloth spread on glass funnel and juice was collected and measured with cylinder and stored at 4°C.

3. RESULTS AND DISCUSSION

The physicochemical properties of three banana cultivars (samples) were analysed and the resulting data are shown in Table 2.

In the experimental work, it had examined that raw banana juice is turbid, viscous and gray in colour if not used with 0.05% potassium metabisulphite solutions. It is the most effective

method to inactivate polyphenol oxidase (PPO) to inhibit browning and ensure colour stability. This work was initiated to study the enzymatic clarification of banana juice using α -amylase.

Banana juice of three cultivars was treated with α -amylase at various concentrations (0.1, 0.2, 0.4 ml) at the temperature 80°C, and time 150 min of treatment. The effect of these enzyme treatments on filterability, clarity, turbidity and viscosity of the juice were studied and compared with the resulting data of banana juice without enzyme treatment, as shown in Table 3 and 4.

Polyphenol oxidase (PPO) was very active in the treated juice and control juice, but was inactivated completely by the sulphite and heating treatments. Heating banana puree prior to juice extraction was the most effective method after sulfite treatment to inactivate PPO and ensure colour stability. Heating whole bananas was very effective in inactivating PPO, but the colour was comparatively unstable. This was apparently due to non-enzymatic browning, which could be due to migration of oxidizable compounds (such as certain phenolics) from the banana peel into the pulp during heating.

Findings of the above experiments are:

- α -amylase (starch degrading enzyme) gave a little effect on the clarity and viscosity of banana juices.
- All three types of banana got small juice volume with 0.4 ml of α -amylase concentration.
- Treatment with α -amylase, only NGET PYAW CHIN gave extracted juice volume, 26.7%.

Viewing from the above facts, α -amylase has no significant effect on the yield, pH and Brix on all three types of bananas, as this factors depend on maturity and quality of bananas.

Table 2. Comparison Studies of Physicochemical Properties in Three Banana Cultivars

Sr. No	Test Parameter	HPEE GYAN	THEE HMWE	NGET PYAW CHIN
1.	Moisture	73.53%	71.53%	70.64%
2.	Crude Protein	0.82%	1.30%	0.92%
3.	Total Sugar	14.19%	15.95%	12.76%
4.	Reducing Sugar	14.30%	11.17%	7.61%
5.	Starch	0.19%	0.71%	11.42%
6.	Titrateable Acidity (ml of 0.1N NaOH per 100g sample)	74.38	50.92	77.68
7.	pH (at 25°C)	4.42	4.67	4.22

By FIDSL Lab

Table 3. Experimental Studies of 1:2 Ratio Banana Juice with α -amylase

Sample with various enzyme concentration	pH	Total soluble solids ('Bx)	Waste Residue	Extracted Volume
HPEE GYAN with 0.1 ml α -amylase	4.7	7	265g	410ml

with 0.2 ml α -amylase	5.0	7	221g	500ml
with 0.4 ml α -amylase	4.9	9	225g	520ml
THEE HMWE with 0.1 ml α -amylase	5.1	8	215g	430ml
with 0.2 ml α -amylase	5.0	9	135g	560ml
with 0.4 ml α -amylase	5.0	9	137g	590ml
NGET PYAW CHIN with 0.1 ml α -amylase	4.6	8	177g	630ml
with 0.2 ml α -amylase	4.8	9	80g	600ml
with 0.4 ml α -amylase	4.8	9	71g	680ml

With Potassium Metabisulphite 0.05%.

Table 4. Experimental Studies of 1:2 Ratio Banana Juice without enzyme

Sample	pH	Total soluble solids ('Bx)	Waste Residue	Extracted Volume
HPEE GYAN	4.9	7	500 g	200 ml
THEE HMWE	5.1	8	269.4 g	450 ml
NGET PYAW CHIN	4.7	8	412.4 g	350 ml

4. CONCLUSION

High juice yield is an important goal for juice manufacture. Many modern process for tropical fruit juice production employ enzymes as important processing aids to obtain high yields and clarity. The above study clearly indicates that juice appearance is not improved by α -amylase clarification and also physical quality characteristics in terms of reduced viscosity, decreased turbidity, and improved filterability. To overcome through, research using enzymes such as pectinases for maceration is required to use.

5. RECOMMENDATIONS

Based on the findings,

It is recommended as

- Banana has high sugar content and had been recognized for its desirable flavour, banana syrup can then be an alternative for utilization of the disqualified (maturity > 7) banana.
- Banana are usually too pulpy and pectinaceous to yield juices. One of the most effective methods is enzymatic liquefaction by pectinase.
- For maturity stage 7, no or a little starch is included in banana. It is not appropriate to use with amyolytic enzyme treatment on banana juice preparation.

6. ACKNOWLEDGEMENTS

The author thanks to all her teachers in Department of Chemical Engineering, Yangon Technological University, Myanmar.

7. REFERENCES

- [1] Charles A.Sims and Robert P. Bates. 1994. "Challenges to Processing Tropical Fruit Juices: Banana as an Example", Proc. Fla. State Hort. Soc. 107, pp. 315-319.

- [2] Tapre, A.R and Jain, R.K. 2014. “Optimization of an Enzyme Assisted Banana Pulp Clarification Process”, International Food Research Journal, Vol. 21, No.5, pp. 2043-2048. <http://www.ifrj.upm.edu.my>.
- [3] Byaruagaba-Bazirake GW, Van Ransburg P and Kyamuhangire W.2012. “Characteristics of Enzyme-Treated Banana Juice from Three Cultivars of Tropical and Subtropical Africa”, African Journal of Food Science and Technology, Vol.3, No.10, pp. 277-290.
- [4] Ahmed B, Uddin M.B and Jubayer M.F. 2014. “Extraction and Standardization of Selected Fruit Juices by Enzymatic Process”, Peak Journal of Food Science and Technology, Vol. 2, No.2, pp. 18-27. <http://www.peakjournals.org/sub-journals-PJFST-html>.
- [5] Harsh P. Sharma, Hiral Patel and Sugandha Sharma. 2014.“Enzymatic Extraction and Clarification of Juice from Various Fruits- A Review”, Trends in Post Harvest Technology. Vol.2, No.2, pp.1-14.
- [6] Aiyer, P. V. (2005). Amylase and their application. African Journal of Biotechnology.
- [7] Lozano, L. N. (2001). Amylase for apple juice processing.

Biodiesel Preparation with Alcohol and Base Catalysed

Phyu Phyu Win
Department of Fuel and
Propellant Engineering
Myanmar Aerospace
Engineering University
Meikhtila, Myanmar

Dr. Daw San Myint
Department of Chemical
Engineering
Yangon Technological
University
Yangon, Myanmar

Daw Moe Moe Kyaw
Department of Chemical
Engineering
Yangon Technological
University
Yangon, Myanmar

Abstract: Refined palm oil was neutralized with CaO (0.017 N) solution and to prepare the transesterification reaction with NaO and methanol. The experimental results: (i) the highest yield (98%), (ii) very low content % FFA (0.05%), (iii) kinematic viscosity was obtained with methanol to oil 3:1, reaction time 30 min and temperature at 60 °C.

Keywords: biodiesel; calcium oxide; FFA; methanol; catalyses

1. INTRODUCTION

Biodiesel and bimethanol are good for the environment because they add fewer emissions to the atmosphere than petroleum-based fuels. Biodiesel is the perfect fuel for buses and trucks. Biodiesel is a biodegradable and non-toxic diesel fuel substitute that can be used in late-model. Biodiesel is actually good for diesel engines.

Biodiesel obtained from energy crops produces favourable effects on the environment, such as a decrease in acid rain and in the greenhouse effect caused by combustion. Due to these factors and to its biodegradability, the production of biodiesel is considered an advantage to that of fossil fuels. It is also known that emissions from the combustion of these fuels such as carbon dioxide, carbon monoxide, nitrogen oxides and sulphur-containing residues are the principle causes of global warming and many countries have passed legislation to arrest their adverse environmental consequences.

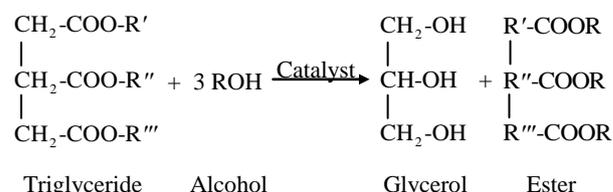
Biodiesel is an alternative fuel for diesel engines that can be produced from renewable feedstocks such as vegetable oil and animal fats. These feedstocks are reacted with an alcohol to produce alkyl monoesters that can be used in conventional diesel engines. Biodiesel is safe to handle and burns at a relatively high temperature.

Biodiesel actually degrades about four times faster than petroleum-based diesel fuel when accidentally released into the environment. Because it is physically similar to petroleum-based diesel fuel, biodiesel can be blended with diesel fuel in any proportion. Many vehicles now use biodiesel blends in their diesel engines in United State. The most common blends is a mixture consisting of 20 % biodiesel and 80 % petroleum diesel called B20. The motive for blending the fuels is to gain some of the advantages of biodiesel while avoiding higher costs. Biodiesel is currently higher in price than conventional diesel fuel. Biodiesel is seen not as potentially replacing conventional diesel fuel, but as extending usefulness in situations where workers may be exposed to diesel exhaust for extended periods.

The chemical reaction for base catalyzed biodiesel production is depicted below. The short chain alcohol signified by ROH (usually methanol but sometimes ethanol) is charged in excess to assist in quick conversion. The catalyst is usually sodium or potassium hydroxide that has already been mixed with the methanol. R', R'' and R''' indicate the fatty acid chains associated with the oil or fat which are largely palmitic,

stearic, oleic and linoleic acids for naturally occurring oils and fats.

Biodiesel Reaction



The National Biodiesel Board does not get involved with commercial biodiesel production or the design and construction of biodiesel facilities, but we have provided an example of a simple production flow chart along with a short explanation of the steps involved to acquaint the reader with the general production process.

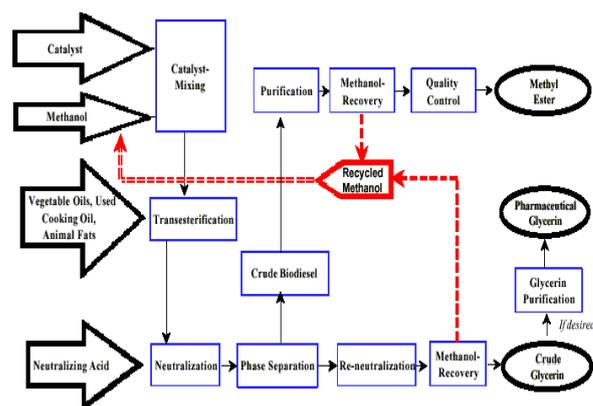


Figure 1.1 Flow Chart of Biodiesel Production Process

The base catalyzed production of biodiesel generally occurs using the following steps:

Mixing of alcohol and catalyst: The catalyst is typically sodium hydroxide (caustic soda) or potassium hydroxide (potash). It is dissolved in the alcohol using a standard agitator or mixer.

Transesterification is the reaction of a liquid with an alcohol to form esters and a by-product and glycerol. It is principle the

action of one alcohol displacing another from an ester, the term alcoholysis (cleavage by an alcohol).

Reaction: The alcohol / catalyst mix is then charged into a closed reaction vessel and the oil or fat is added. The system from here on is totally closed to the atmosphere to prevent the loss of alcohol. The reaction mix is kept just above the boiling point of the alcohol (around 60 °C) to speed up the reaction and the reaction takes place. Recommended reaction time varies from 1 to 8 hours, some systems recommend the reaction take place at room temperature. Excess alcohol is normally used to ensure total conversion of the fat or oil to its esters. Care must be taken to monitor the amount of water and free fatty acids in the incoming oil or fat. If the free fatty acid level or water level is too high it may cause problems with soap formation and the separation of the glycerin by-product downstream.

The present work aim:

To prepare biodiesel from CaO neutralized refined palm oil by transesterification process

Objectives are:

To replace the fossil fuel with biodiesel as an alternative energy

To save the foreign currency expenses in energy sector of our country.

2. EXPERIMENTAL PROCEDURES

2.1 Analysis of Refined Palm Oil

Free Fatty Acid (FFA) content was measured in refined palm oil by titration method. First, refined palm oil, alcohol, 0.02N oxalic acid, phenolphthalein indicator and methyl red indicator were prepared respectively. Then 0.02N NaOH solution was standardized with 10 ml oxalic acid and methyl red indicator. At the equivalent point, the titration was stopped and recorded this NaOH volume. Then calculation of this equation: At the equivalent point;

No of equivalent NaOH = No of equivalent of Oxalic Acid

Then 1 g of refined palm oil and 50 ml of alcohol was titrated NaOH solution. The end point was recorded and calculated with this equation;

No of equivalent FFA = No of equivalent of NaOH

In measuring viscosity, the size of viscometer is 150. Then the sample was filled into the viscometer until its limitation. This viscosity was immersed into the bath heating at the test temperature 40 °C. Suction was used to adjust the head level of the test sample to the position in the capillary arm of the instrument about 7 mm above the timing mark. With the sample flowing freely, measured, in second to within 0.1s, the time required from the first to the second time mark. This procedure was repeated to make three times measurement of flow time. The average of the time was calculated for kinematic viscosities.

The analysis data of density, viscosity and Free Fatty Acid (FFA) content of refined palm oil was listed in Table 2.1.

Table 2.1 Properties of Refined Palm Oil

Item	Result
Density at 32° C g/cm ³	.88
Viscosity at 32° C cp	80.05
Free Fatty Acid Composition	
Palmitic acid	0.3072
Oleic acid	0.3384
Lauric acid	0.24

2.2 Neutralization Process of Refined Palm Oil with NaOH and CaO

2N NaOH, 20 % NaCL solution and phenolphthalein indicator solution to be used in neutralization process were prepared. First, sodium hydroxide and distilled water (250 ml) were prepared respectively. Then 2N NaOH solution was standardized with 10 ml oxalic acid and methyl red indicator. Then calculation of this equation;

$$N = \frac{\text{Weight of FFA}}{\text{Equivalent weight of NaOH} \times \text{volume}}$$

Finally, distilled water (250 ml) is mixed with 20 g of NaOH, the solution is 2 N NaOH.

100 ml of refined palm oil was measured and put into beaker. Then the beaker was heated in a water bath with temperature controller and the temperature is set at 50 °C. And then 2 N NaOH solution in the burette was dropped from to the oil while stirring gently. One drop of the neutralized sample was taken in a test tube and put two drops of phenolphthalein indicator and shake well. If the sample change to pink colour, then the neutralization is completed. The mixture is transferred to separating funnel and add 20 % NaCL solution (90 °C) and shake the separating funnel gently and allow to settle until the two layer appear sharply.



Figure 2.1 Transesterification of NaOH Neutralized oil

The lower layer is drained out. Distilled water (90°C) is added to the upper layer in the separating funnel and sake vigorously. Settle to be sure that the two layers appear again sharply.



Figure 2.2 NaOH Neutralized Oil after Separating Distilled Water

The lower layer is drained out in a beaker and one drop of phenolphthalein indicator is added to the beaker. If the color do not change to pink, the excess NaOH is washed out of the sample is complete.



Figure 2.3 Neutralized Oil with NaOH

0.017 N CaO, 20% NaCl solution and phenolphthalein indicator solution to be used in neutralization processes were prepared First, distilled water (250 ml) and calcium oxide were prepared respectively. Then 2 N CaO solution was standardized with 10 ml oxalic acid and methyl red indicator. Then calculation of this equation;

$$N = \frac{\text{Weight of CaO}}{\text{Equivalent weight of CaO} \times \text{volume}}$$

Finally, distilled water (250 ml) is mixed with 14.02 g of CaO, but distilled water (250 ml) is really dissolved with 0.12 g of CaO , the solution is 0.017 N CaO.

100 ml of refined palm oil was measured and put into a beaker. Then the beaker was heated in a water bath with temperature controller and the temperature is set at 50 °C. And then 0.017 N CaO solution in the burette was dropped from to the oil while stirring gently. One drop of the neutralized sample was taken in a test tube and put two drops of phenolphthalein indicator and shake well. If the sample change to pink colour, then the neutralization is completed. The mixture is transferred to separating funnel and add 20 % NaCl solution (90 °C) and shake the separating funnel gently and allow to settled until the two layer appear sharply.



Figure 2.4 Transesterification of CaO Neutralized oil

The lower layer is drained out and distilled water (90 °C) is added to the upper sample layer in the separating funnel and shake vigorously. Settle to be sure that the two layer appear again sharply.



Figure 2.5 CaO Neutralized Oil after Separating Distilled Water

The lower layer is drained out in a beaker and one drop of phenolphthalein indicator is added to the beaker. If the colour do not change to pink, the excess CaO washed out of the sample is complete.



Figure 2.6 Neutralized Oil with CaO

2.3 Transesterification Process of CaO Neutralized Palm Oil

20 ml of CaO neutralized refined palm oil was poured into 250 ml conical flask with glass stopper and stirred and heated at temperature 50 °C for a short time on a magnetic stirrer with temperature controller. Then required amount of methanol and sodium hydroxide was completely mixed form sodium methoxide solution. The molar ratio of methanol to oil is 3:1. The sodium methoxide solution was added to the heated refined palm oil slowly and stirred it for 30 mm at 60 °C. And the two layers was observed when the stirring is stopped. The above experiment is conducted with different reaction time (1/2 hr, 1 hr, 2 hr respectively). After transesterification reaction, the product mixture was poured into the separating funnel and allowed to settle for overnight. After separation, the lower glycerol layer was drained out and the upper crude biodiesel layer was washed with warm water.

The preparation of biodiesel by the Batch Reactor is shown in Figure 2.7.



Figure 2.7 Batch Reactor for Preparation of Biodiesel

After separation, the lower glycerol layer was drained out and the upper crude biodiesel layer was washed with warm water. In washing step, warm water was added in crude biodiesel and then stirred gently and settled down until the two layers (oily layer and water layer) were separated. The upper layer was washed biodiesel and the lower layer was water-soap mixture. Then subsequent washings with warm water until the biodiesel was clear and the wash water showed to no pink colour. Washed biodiesel was dried to remove the trace water presentation the oil.

3. RESULT AND DISCUSSION

Density was measured using the density bottle (25 ml) and viscosity with viscometer (150). The analysis result are listed in Table 3.1.

Table 3.1 Properties of Refined Palm Oil

Item	Result
Free Fatty Acid, %	1.56
Density at room temperature, g/cm ³	0.905
Viscosity at room temperature, mm ² /s	0.3072

The above experiment is performed with 200 ml refined palm oil also. The results of the neutralization process with NaOH are listed in Table 3.2.

Table 3.2 Neutralization Process Data with NaOH

Volume of oil (ml)	Volume of 2N NaOH (ml)	Volume of 20% NaCL (ml)	Volume of distilled water for washing (ml)	Soap Volume (ml)	Volume of neutralized oil (ml)
100	2	20	350	40	60
200	4	40	400	60	140

The above experiment is performed with 200 ml refined palm oil also. The results of the neutralization process with CaO are listed in Table 3.3.

Table 3.3 Neutralization Process Data with CaO

Volume of oil (ml)	Volume of 0.017N CaO (ml)	Volume of 20% NaCL (ml)	Volume of distilled water for washing (ml)	Soap Volume (ml)	Volume of neutralized oil (ml)
100	30	20	650	25	75
200	70	40	800	40	160

The analysis data of Free Fatty Acid (FFA) content, density and viscosity of neutralized oil was described in Table 3.4. The neutralized refined palm oil is further used in the transesterification process.

Table 3.4 Comparison Analysis Results of Neutralized Oil

Item	Refined Palm Oil	
	Neutralized with NaOH	Neutralized with CaO
Free Fatty Acid, %	0.456	0.446
Density at room temperature, g/cm ³	0.885	0.875
Viscosity at room temperature, mm ² /s	30.45	30.245

The experimental procedure of transesterification process as same as the except varying the catalyst amount from (0.2 %, ..., 1 %) and the reaction time. The experimental results were mentioned in Table 3.5.

Table 3.5 Transesterification Data with Different Reaction Time and Different % Catalyst

Volume of oil (ml)	Volume of methanol (ml)	Reaction temperature (°C)	Reaction time	Catalyst wt. %	Amount of methyl ester (% yield)
20	6	60	10 min	0.04 g (0.2%)	15
20	6	60	20 min	0.04 g (0.2%)	17
20	6	60	30 min	0.04 g (0.2%)	19
20	6	60	10 min	0.08 g (0.4%)	14
20	6	60	20 min	0.08 g (0.4%)	16
20	6	60	30 min	0.08 g (0.4%)	17
20	6	60	10 min	0.12 g (0.6%)	15
20	6	60	20 min	0.12 g (0.6%)	16
20	6	60	30 min	0.12 g (0.6%)	18
100	30	60	10 min	0.4 g (0.4%)	85
100	30	60	20 min	0.4 g (0.4%)	92
100	30	60	30 min	0.4 g (0.4%)	98

The analysis data of Free Fatty Acid (FFA) content, viscosity and density of biodiesel was listed in Table 3.6.

Table 3.6 Properties of Product Biodiesel

Item	Result
Free Fatty Acid, %	0.05
Density at room temperature, g/cm ³	0.86
Viscosity at room temperature, mm ² /s	3.6

Free Fatty Acid (FFA) content of refined palm oil was 1.56, density at room temperature 0.905 g/cm³ and kinematic viscosity at room temperature 80.05 mm²/s.

The FFA content of neutralized refined palm oil with CaO decrease to 0.446 % and density is also reduce to 0.875 g/cm³ and kinematic viscosity drop to 30.245 mm²/s. The same trace is also resulted with neutralized palm oil with NaOH. In this study, although initial FFA content of the refined palm oil was 1.56 % neutralization process was performed before transesterification to get longer storage time of the biodiesel.

Neutralization process of refined palm oil was made with two alkali solution: (1) 2N NaOH solution and (2) 0.017N CaO solution.

Transesterification reaction at different reaction time and using different percent catalyst weight showed that best yield (0.4 %) was obtained with 0.4 % catalyst of CaO neutralized palm oil with transesterification reaction 30 min at 60 °C using volume of methanol to oil 3:1.

In the transesterification of unneutralized refined palm oil with NaOH and methanol solution higher yield was obtained with (0.6 %) NaOH and reaction time 1 hr at 60 °C (Transesterification process for the Preparation of Biodiesel).

Analysis data of product biodiesel listed in Table 3.6 showed that FFA content is 0.05 % and the viscosity at room temperature is 3.6 mm²/s which meets the specification of B100, Biodiesel. Furthermore, the colour of biodiesel prepared from CaO neutralized refined oil is very pale-yellow compared with the product from unneutralized oil. Analysis results of refined palm oil sample and neutralized palm oil sample showed that by neutralizing the purity of refined palm oil is improved.

4. CONCLUSION

This study to obtain very low FFA content (0.05 %) and low kinematic viscosity (3.6 mm²/s) refined palm oil have to be neutralized. Although the initial FFA content of the refined palm oil from the market is 1.56 %. Neutralization process also provided increase in yield and improve quality of biodiesel. However further scale up works need to be continued from this findings.

5. RECOMMENDATIONS

Recommendations for further research works are outlined as follow.

- Experiment with rapid study in transesterification process must have to be performed to reduce the reaction time.
- Experimental works on biodiesel preparation with high fatty acid need to be studied.
- Other base-catalyzed (NaOH, KOH, CaO and CaCO₃) should be tested to use for the preparation of biodiesel.

6. ACKNOWLEDGEMENTS

The authors are very grateful to all teachers, especially their supervisor, for guiding the knowledge, as well as invaluable experiences and other supports by kindness.

7. REFERENCES

- [1] Aynam Demribas, 2003. Biodiesel Fuel from Vegetable Oil via Catalyst and Non-catalyst supercritical Alcohol Transesterification and other Methods: a Survey. Department of Chemical Education, Koradeniz Technology University, PK 216, Trabzon 61035, Turkey, Energy Conversion and Management .
- [2] Gerhard Knothe, Roberd O.Dun and Marvin O Bagby . No Date . Biodiesel : The Use of vegetable Oils and Their Derivatives as Alternative Diesel Fuels . Oil Chemical Research , Agriculture Research Service , Peria ,IL 61604
- [3] Daniel mattys, Damalist n.v. November 2003, Production Biodiesel a Simple Affair, edited by ASA Europe, Ghent, Belgium.

Determining the Magnetic Properties of Weights by Susceptometer Method

H. H. Hassan
Physics
Department,
Faculty of
Science, Cairo
University
Giza, Egypt.

Alaaeldain A.
Eltawil
Mass, Density
and Pressure
Laboratory,
National Institute
of Standard
(NIS)
Giza, Egypt.

M. R. Hassan
Mass, Density
and Pressure
Laboratory,
National Institute
of Standard
(NIS)
Giza, Egypt.

Ahmed D. S.
Ahmed
Mass, Density
and Pressure
Laboratory,
National Institute
of Standard
(NIS)
Giza, Egypt.

A. S. Abdel-
Rahman
^aPhysics
Department,
Faculty of
Science, Cairo
University
Giza, Egypt.
^bEgypt Nano-
Technology
Center, (EGNC),
Cairo University
campus
Shiekh Zayed,
Egypt.

Abstract: Calibration of standard weights requires the determination of their magnetic properties which should be within specific limits. This research aims to study the manufacturing process that may influence the magnetic properties beside studying magnetic properties change of standard weights due to exposure to a magnetic field at calibration location. Estimation of uncertainty value in mass measurement is also discussed and magnetic properties of standard weights changing. The obtained results show that the magnetic properties lead to sufficient errors in mass measurements.

Keywords: Mass metrology, Magnetic measurement, Magnetic polarization, Magnetic susceptibility, Susceptometer.

1. INTRODUCTION

Kilogram is the mass unit of the international system of units SI and is defined today as the mass of the international prototype of the kilogram^[1]. The redefinition of it has been proposed and intended date of implementation is May 2019^[2]. After redefinition, the kilogram will be based on fundamental constant of nature, Plank's constant, but as any redefinition of the SI unit, there will be important impact on existing traceability chain^[3] therefore, the normal method of dissemination of the mass unit by National Metrology Institutes (NMIs) will remain as today, however change in the uncertainty of measurement is expected [3].

In the field of mass metrology, the dissemination of mass unit from national prototypes of the kilogram is performed by transferring the mass value of the prototype mass standards to secondary 1 kg stainless steel mass standards with relative uncertainties of the order of 2×10^{-8} [4]. The dissemination process is done by comparative weighing using high accuracy balances that work on the principle of electromagnetic force compensation (EMFC).

Now, weights manufacturing cannot be in line with the specified limits of OIML R111-1[5]. The main problem due to the manufactory process was not covered by the condition of magnetism which both the limits of magnetic polarization and magnetic susceptibility for standard weights. The stainless such as 304 or 316 were chosen as the material of the manufactured weight. In order to improve the technology in the standard weights manufacture, the study on the volumetric

magnetic susceptibility and magnetic polarization of weight due to its manufacturing process were done^[6].

The most variable of weight manufactured, OIML R111-1 for standard weights are magnetic permeability which is confined mainly to ferromagnetic materials. Ferromagnetism exists in a number of metals including iron, many forms of steel, nickel, and cobalt. A similar phenomenon occurs in certain non-metals known as ferrites, which are said to be ferromagnetic. These materials, which can be magnetized, are characterized by variations of magnetic permeability with magnetic field strength, generally in a nonlinear manner and giving rise to hysteresis [7].

It has been known for a long time that magnetism may lead to erroneous weighing results. It is therefore of the utmost importance to have sufficient knowledge about this problem. Magnetic force can adversely affect the weighing process since, without systematic investigation, these spurious forces cannot be distinguished from gravitational forces in the determination of mass. Magnetic force can arise from the mutual interaction of two standard weights, as well as between a standard weight, the mass comparator (MC) being used for the weighing, and other magnetic objects in the vicinity, therefore we have to measure the magnetic polarization of the weights. In addition, we have to know the magnetic susceptibility or the relative permeability of the weights [6,8,9].

Many methods and instruments exist to determine the magnetic properties of weights such as susceptometer and fluxgate magnetometer^[5], an instrument based on the

attracting method and Hall sensor [8]. In the OIML recommendation for weights R 111-1, there are specified magnetic requirements for weights[5]. No requirements on magnetism in the OIML recommendations exist for non-automatic weighing instruments (NAWI) R76 [10]. In this work we mainly used susceptometer, X-ray fluorescence (XRF) and mass comparator (MC). The susceptometer is used to determine the magnetic properties of weights. XRF is used to analyze the material component of weight. The mass comparator is used to determine the conventional mass error of weight. We discuss the effect of magnetic properties of weights on mass measurements.

2. EXPERIMENTAL WORK

2.1 XRF test

The material component of OIML weight class E₂ and samples under test were analyzed by XRF (AXIOS). The elemental components are shown in Table 1.

Table 1. XRF results of OIML weight and samples under test

Element component	Weight fraction of OIML weight class E ₂ (%)	Weight fraction of samples under test (%)
C	0.073	0.056
Si	0.120	0.382
S	0.007	0.025
P	0.031	0.034
Mn	1.501	1.731
Cr	17.811	17.825
Ni	10.154	10.143
Cu	0.359	0.492
V	0.063	0.068
Co	0.216	0.159
Nb	0.013	0.005
Mo	2.023	2.073
Fe	balance	balance

Table 1 shows that the (Cr) is the major alloying element, (Fe) is the base element and close up to the specification of stainless steel type (316) as a manufactured weight reference material, and this type is being commercial and available in markets. Due to comparison the XRF also achieved on the standard stainless steel type (316) and the obtained results are presented in Table 1.

2.2 Process of weights manufacturing

The procedures of preparing the sample material to weight manufacturing are summarized in the following steps:

- Dimensions of the samples were calculated using SolidWorks¹ package.
- The both rod and mark point of each piece were cutted with the control process.
- The final adjust of sample was being achieved by polishing process for improving the manufacturing process of weight.
- The dimensions of the samples were tested by the profile projector instrument (PJ-3010) with resolution equal 1 μm after final adjustment.

¹ <https://www.solidworks.com>

3. RESULTS AND DISCUSSION

3.1 Determination of conventional mass error for samples under test

The conventional mass errors^[5] for the weights from 1 g to 20 g were measured using mass comparator with readability of 1μg, maximum capacity of 20 g as shown in Fig. 1 and other weights were measured using mass comparator with readability of 10 μg, maximum capacity of 1 kg as shown in Fig. 2, the mass of these samples were measured and tabulated in Table 2.



Fig. 1. Mass comparator (AT-21)



Fig. 2. Mass comparator (AT-1005)

Table 2. XRF results of OIML weight and samples under test

Nominal mass (g)	Conventional mass error (mg)
1	0.403
2	0.489
5	1.134
10	-0.805
20	-1.511
50	-1.64
100	-2.41
200	-5.98
500	-10.69
1000	-20.32

3.2 Study the mass stability of samples under test

The standard weights were established from 1 g to 1 kg (10 pieces) traceable to the international prototype of the kilogram no.(58). The weights were cleaned with solvents such as alcohol or distilled water. They must be stabilized for the times according to OIML R111-1 and kept in a storing box to maintain their masses for a long time. The box is housed in an air-conditioned laboratory controlled within a temperature 23 ± 1 °C and within humidity 50 ± 3 % in the relative humidity according to OIML R111-1. Fig. 3(a-j) demonstrates that a set of stainless steel weights which were monitored in their stabilities of the masses from January to June with the maximum deviation about 25 μg as shown in Fig. 3. This change in mass because of surface exposure to atmospheric oxygen, therefore many layers formed on surface of samples such as sorption of water vapor, carbonaceous contamination and metal oxide^[11,12].

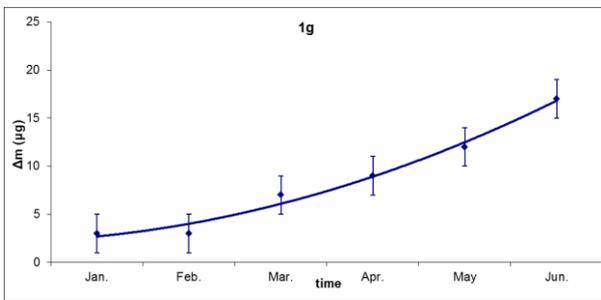


Fig. 3(a). Mass stability of samples under test (1g)

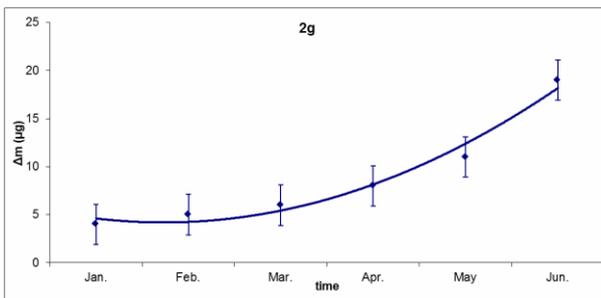


Fig. 3(b). Mass stability of samples under test (2g)

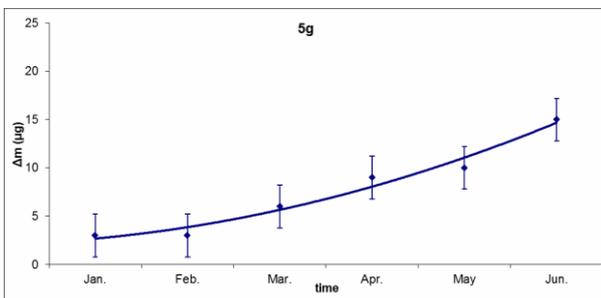


Fig. 3(c). Mass stability of samples under test (5g)

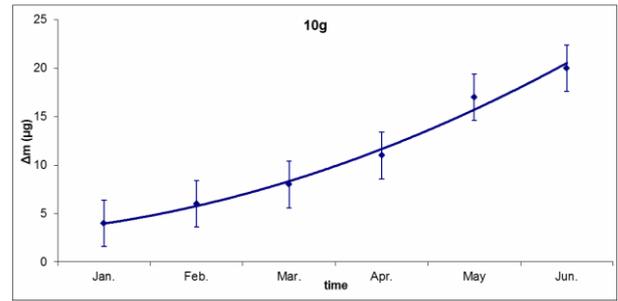


Fig. 3(d). Mass stability of samples under test (10g)

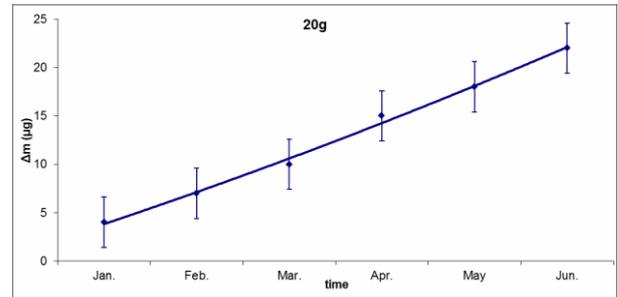


Fig. 3(e). Mass stability of samples under test (20g)

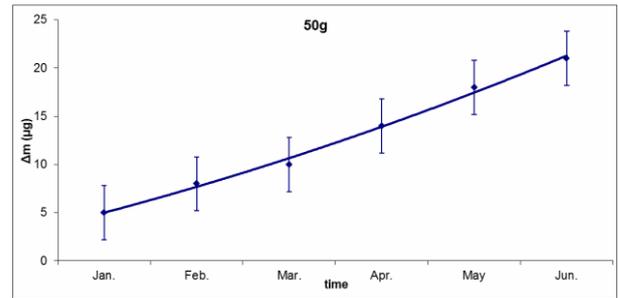


Fig. 3(f). Mass stability of samples under test (50g)

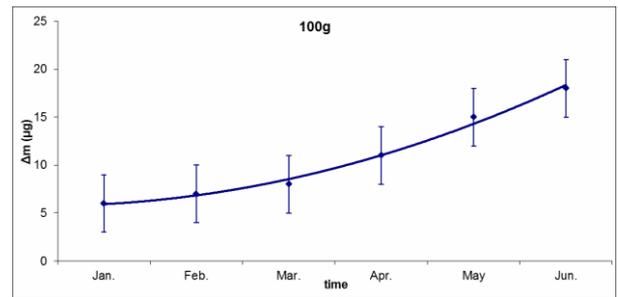


Fig. 3(g). Mass stability of samples under test (100g)

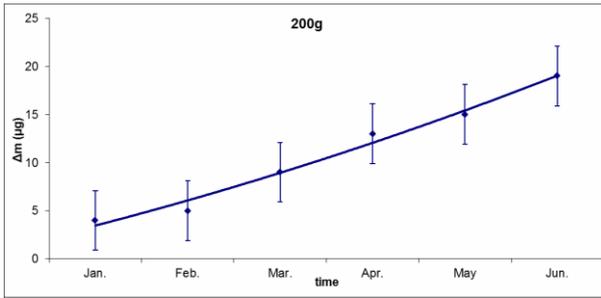


Fig. 3(h). Mass stability of samples under test (200g)

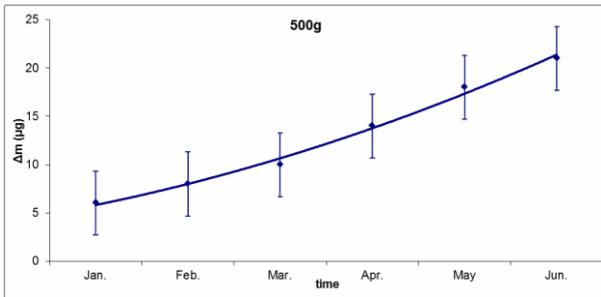


Fig. 3(i). Mass stability of samples under test (500g)

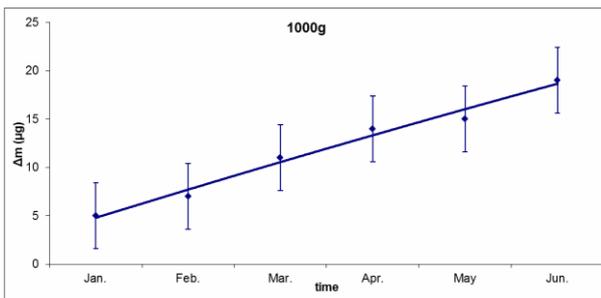


Fig. 3(j). Mass stability of samples under test (1000g)

3.3 Measuring magnetic properties of samples under test

3.3.1 The susceptometer method and instrument

The susceptometer method^[5] is used to detect the magnetic susceptibility and the magnetic polarization of weights pieces using a modified electronic microbalance with a permanent magnet on its pan. In the susceptometer method it is required to measure the attraction or repulsion force, which is exerted between a permanent magnet (with known magnetic moment) and the standard weight which follow to be tested. The susceptometer instrument is presented in Fig. 4.

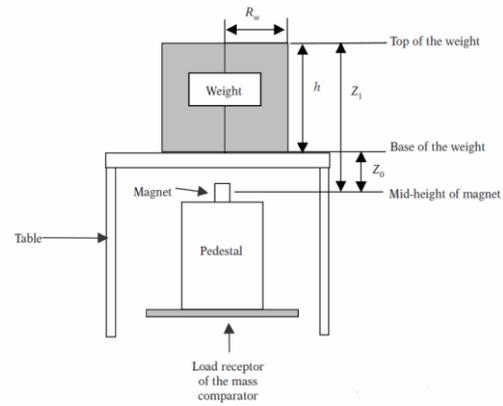


Fig. 4. Susceptometer

Where:

h : Height of weight

Z_1 : Distance from the top of weight to mid-height of magnet

Z_0 : Distance from mid-height of magnet to the base of the weight

R_w : Radius of the weight

Assuming that the susceptibility of air is always negligibly small, the magnetic susceptibility χ , is given by:

$$\chi = \frac{F_a}{I_a \times \frac{3\mu_0}{64\pi} \times \frac{m_d^2}{z_0^4} - 0.4F_a} \quad (1)$$

while the magnetic polarization $\mu_0 M$, is calculated using:

$$\mu_0 M = \frac{F_b}{\frac{m_d}{z_0} \times \frac{1}{4\pi} \times I_b} - \frac{\chi}{1 + 0.23\chi} \times B_{EZ} \quad (2)$$

where:

$$F_a = \frac{F_1 + F_2}{2} = -\frac{\Delta m_1 + \Delta m_2}{2} \times g \quad (3)$$

$$F_b = \frac{F_1 - F_2}{2} = -\frac{\Delta m_1 - \Delta m_2}{2} \times g \quad (4)$$

F_a : Average force used for the magnetic susceptibility.

F_b : Average force used for the magnetic polarization.

Z_0 : distance from center of magnet to the bottom of the weight.

$\Delta m_1, \Delta m_2$: mean differences of the indications of mass comparator.

I_a, I_b : geometric correction factors.

3.3.2 Before exposure to magnetic field

The susceptometer is used for determining the magnetic susceptibility and magnetic polarization of samples under test which is suitable for weights range from 2 g to 50 kg. The obtained results are presented in Table 3.

Table 3. The magnetic properties for samples under test

Nominal mass (g)	Magnetic susceptibility (χ)	Magnetic polarization (μOe) μT
2	0.01950	90.72
5	0.01750	90.83
10	0.03268	81.20
20	0.03821	96.76
50	0.03615	97.47
100	0.00485	4.40
200	0.01338	5.93
500	0.08375	11.41
1000	0.04568	20.34

3.3.3 After exposure to magnetic field

Magnetic field is created by using electromagnet and power supply as shown in Fig. 5, the magnetic field is measured by teslameter. When applied the magnetic field which is equal to 0.271 tesla on samples for two minutes, the results show a markable increase in magnetic properties of samples as shown in Table 4.



Fig. 5. Electromagnet.

Table 4. The magnetic properties for samples under test after exposure to magnetic field

Nominal mass (g)	Magnetic susceptibility (χ)	Magnetic polarization (μOe) μT
2	0.06178	272.65
5	0.09430	333.65
10	0.05329	195.47
20	0.07130	339.39
50	0.06365	243.47
100	0.00652	64.76
200	0.01807	50.33
500	0.08753	90.47
1000	0.06077	100.67

3.4 Calculation magnetic errors in mass metrology

By magnetic error, we mean an unsuspected vertical force F which is magnetic in origin. Such a force will be misinterpreted as a mass F/g , where g is the local acceleration of gravity in the place measurement. We may assume that high-quality mass standards are artifacts with volume magnetic susceptibility χ and magnetic polarization $\mu_o M$. Thus the unwanted magnetic force will, to a good approximation, be given by^[8,13,14].

$$F_z = \mu_0 \iiint_V (M + \chi H) \frac{\partial H}{\partial z} dV \quad (5)$$

3.5 Estimate uncertainty value of samples under test

3.5.1 Source of the uncertainty^[5]

a) Type “A”

Type A is called standard uncertainty of weighing process. It is the uncertainty of standard deviation of mass difference.

b) Type “B”

Type B evaluation is based on other knowledge than the statistical analysis of a series of observations. It can be evaluated according to:

- uncertainty due to reference standard, u_{rs}
- uncertainty due to air buoyancy correction, u_b
- uncertainty due to weighing instrument, u_d
- uncertainty due to drift of the mass of the reference standard, u_{drift}
- uncertainty due to magnetism, u_{mag}

3.6 Before exposure to the magnetic field

Applying Eq. 5 on samples results obtained previously^[15,16] to calculate the magnetic force. Such force will be consider as a source of uncertainty in the next calculation of uncertainty. The obtained uncertainty values are tabulated in Table 5.

Table 5. The uncertainty value for samples under test

Nominal mass (g)	$U_{\text{magnetic properties}}^{(1)}$ (mg)	Expanded uncertainty ⁽²⁾ at $k=2^{(3)}$ (mg)
2	±0.04	±0.08
5	±0.05	±0.10
10	±0.08	±0.16
20	±0.19	±0.37
50	±0.47	±0.94
100	±0.26	±0.52
200	±0.16	±0.32
500	±1.31	±2.63
1000	±2.72	±5.43

where:

(1) $U_{\text{magnetic properties}}$ is uncertainty due to magnetic properties of samples under test as calculated by Eq. 5.

(2) Expanded uncertainty is calculated according to OIML including the uncertainty due to magnetic properties of samples under test

(3) A coverage factor of $k = 2$ actually provides a coverage probability of 95.45% for a normal distribution. For convenience this is approximated to 95% which would relate to a coverage factor of $k = 1.96$.

3.7 After exposure to the magnetic field

Using the same procedure described in (3.5.1) to the samples after exposure to the magnetic field. The results are shown in Table 6.

Table 6. The uncertainty value for samples under test after exposure to magnetic field

Nominal mass (g)	$U_{\text{magnetic properties}}$ (mg)	Expanded uncertainty at $k=2$ (mg)
2	±0.05	±0.11
5	±0.16	±0.32
10	±0.19	±0.37
20	±0.64	±1.28
50	±1.15	±2.31
100	±0.59	±1.18
200	±0.97	±1.94
500	±4.87	±9.75
1000	±10.23	±20.45

It could be noticed that the increase of expanded uncertainty values due to exposure to magnetic field and this may be explained by the remnant magnetization inside the samples after the exposure to the magnetic field.

4. CONCLUSION

The process of manufacturing weights have influence the magnetic properties of weights; so the magnetic properties of weights must be measured after the manufacturing process. The magnetic forces have been effect on mass measurements. The force equation that describes the unwanted effects also describes the operation of the susceptometer which it is suitable for checking the magnetic polarization and magnetic susceptibility of stainless steel weights and similar nonmagnetic or weakly magnetic alloys. Stainless steel weights have high magnetic properties due to exposure to external magnetic field at calibration location. The experimental results show that the magnetic properties lead to errors in mass measurements.

5. REFERENCES

- [1] Girard G. 1994 The Third Periodic Verification of National Prototypes of the Kilogram (1988- 1992), Metrologia, vol. 31, pp. 317-336
- [2] BIPM 2013 Proposal for the Extraordinary Calibrations using the IPK. Presented to and approved by CIPM, http://www.bipm.org/cc/CCM/Allowed/14/30_REVISION_D_Agenda_10.2_BIPM_proposal_for_using_IPK_Stock.pdf , on 20 June 2013.
- [3] M. Glaser, M. Borys, D. Ratschko and R Schwartz 2010 Redefinition of the kilogram and the impact on its future dissemination, Metrologia, vol. 47, pp. 419-428,
- [4] E. Angelini, P. Bianco and M. Plassa 1998 Instability of Stainless Steel Reference Weights due to Corrosion Phenomena”, Corrosion Science, vol. 40, No. 7, pp. 1139-1148,
- [5] OIML R111-1 2004 Weights of classes E1, E2, F1, F2, M1, M1-2, M2, M2-3 and M3, Part 1: Metrological and technical requirements.
- [6] Rungsiya Sukhon, Rattapon Kongchana, Kusuma Khongsiri, Baramee Puntaratronnugoon, Veera Tulasombut 2010 A study on volumetric magnetic susceptibility of weight due to its manufacturing process Imeko TC3, TC5 and TC22 Conferences
- [7] Jack Blitz 1991 Electrical and Magnetic Methods of Nondestructive Testing, Adam Hilger, New York, pp. 35-37
- [8] Myklebust 1997 Mass metrology and magnetism Measurement Vol. 20, No. 1, pp. 13-21
- [9] R. S. Davis and J. Coarasa, 2005 Errors due to magnetic effects in 1 kg primary mass comparators”, Imeko - TC3
- [10] OIML R 76-1 2006 Nonautomatic Weighing Instruments. Part 1: Metrological and Technical Requirements Tests
- [11] F. E. Jones and R. M. Schoonover 2002 Handbook of Mass Measurement , Washington, New York
- [12] Alaaeldin. A. Eltawil, N. A. Mahmoud, Sayed. A. Emira, N. N. Nagib and M. M. Eloker 2018 Ellipsometric studies of surface layers formed on stainless steel mass standards , Al Azhar Bulletin of Science Vol. 29, No. 2 (December), pp. 1-6
- [13] J. Crangle 1991 Solid-State Magnetism, Edward Arnold
- [14] R. S. Davis 1995 Determining the magnetic properties of 1 kg mass standards, J. Res. Nat. Inst. Stand. Technol. 100 209–225
- [15] Guide to the Expression of Uncertainty in Measurement (Geneva: International Organization for Standardization) 1993
- [16] Stephanie Bell 2001 A Beginner’s Guide to Uncertainty of Measurement”, National Physical Laboratory, Issue 2, March