Development of an Electrolytic Cell Using Coconut (*Cocos Nucifera*) Water as an Electrolyte for Perimeter Lighting

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***Abstract*—The study is about a device that is used to convert electrolysis into electrical energy. On the other hand, it is used to harness energy thru fermented *buko* juice in order to recharge the battery and restore electrical energy. This study presents the design and development of a typical lamp supplied by a non-conventional power source—a battery that uses *buko* juice as electrolyte solution. With the use of fermented *buko* juice, the user can make the device provide lighting. The development of an electrolytic cell using coconut (*Cocos Nucifera*) water as an electrolyte for perimeter lighting is a new type of emergency lamp that relies on the spontaneous redox reactions taking place in the galvanic cells of the battery as the electrical power source. The generated energy of the fermented *buko* juice battery depends on the number of electrolytes, the size of the electrodes, their distance from each other, and the variety, concentration, and time length of fermentation of *buko* juice. This device serves as an alternative source of energy that is cheap, actually almost free, clean, and accessible to everyone—almost everyone—in the Philippines, there are many coconut trees. This can be used, of course, during emergencies, like storms and other calamities, but is also beneficial even during ordinary days, when the user just wants to save electricity consumption.**

Keywords*—*Electrolyte, fermented buko juice

INTRODUCTION

Background of study

A fuel cell is an electrochemical cell that changes over compound energy from fuel into power through an electrochemical response of hydrogen-containing fuel with oxygen or another oxidizing agent. Fuel cells are unique in relation to batteries in requiring a constant wellspring of fuel and oxygen to manage the substance response, while in a battery, the devise energy originates from chemicals in the battery. Energy units can deliver power ceaselessly for whatever length of time that fuel and oxygen are provided. Rural electrification is frequently thought to be the foundation of the country's economy.

As indicated by Faraday, the law of electrons in the outer circuit was combined with the stream of charged species in the electrolyte, the decidedly charged particles (cations) flow towards the cathode and the contrarily charged ions (anions) stream towards the anode. This unconstrained response, which is the invert of water electrolysis (an energy component), is proportional to the substance ignition of hydrogen to deliver water; however, with the additional and appealing element of power era.

Provincial essential needs incorporate energy for cooking and essential lighting. There are still areas in the Philippines that do not have power supply. The absence of power supply hinders said communities to light their homes and roads during the evening.

Philippines has an abundant supply of coconut trees. The researchers intend to make an option for the supply of energy with the utilization of coconut water maturation. Acids can produce power with the utilization of electrolysis. Matured coconut water has a corrosive substance or acid content which can be used to generate power. Country zones which have bounteous wellsprings of coconut trees and get their day-by-day needs or work with coconut items can profit from this research. Coconut water, which they consider as waste, can be utilized to produce energy for power supply.

Problem statement

The proponents undertook the study to address the following problems:

- One of the issues in the Philippines is the unavailability of power supply in some areas. These communities cannot light their homes and roads during the night;
- Using different combinations of metals, the anode and cathode will give different results to the voltage output; and
- The acidity of fermented coconut water will differ in terms of time of fermentation (months).

Objectives of the study

General objective

To design and develop a device that is capable of generating electricity through fermentation of coconut water. This is to prove that any element that has acid can generate electricity with the use of electrolysis.

Specific objectives

- To determine the time of fermentation of coconut water that will give researchers the amount of ph level closest to zero value;
- To be able to choose a specific metal rod such as copper, aluminum, zinc, or graphite that will serve as electrodes to use in the battery; and
- To generate power with the use of coconut water with the use of electrolysis that can light up a 3-watt bulb.

REVIEW OF RELATED LITERATURE

Rice wash powered emergency lamp with USB charging hub

An emergency lamp is a device that is used to convert electrical energy into radiant energy. Its output depends on the source that is used to supply it with electrical power. On the other hand, a charging hub is used to harness energy through a USB or other kinds of ports from an electricity source in order to recharge a device that has battery that can store and restore electrical energy. This study presents the design and development of a typical emergency lamp and charging hub supplied by a non-conventional power source—a battery that uses rice wash as electrolyte solution.

Lead-acid battery

The lead-acid battery system has many of these characteristics. The charge-discharge process is essentially reversible, the system does not suffer from deleterious chemical action, and while its energy density and specific energy are low, the lead-acid battery performs reliably over a wide temperature range. A key factor for its popularity and dominant position is its low cost with good performance and cycle-life.

Current through electrodes

When current enters the metal plate from an external circuit, diffusion to and from the metal still leaves a net negative charge on the plate but the process is no longer self-limiting. Electrons flow out of the plate to the external circuit, and there is a corresponding flow of positive ions from the metal to the electrolyte. This flow of ions is no longer balanced by the deposition of ions from the solution; when charge flows into the metal plate, the metal dissolves. The rate at which the metal dissolves is controlled by the current.

Coconut water vinegar: New alternative with improved processing technique

Vinegar fermentation is essentially a two-step process comprising the anaerobic conversion of sugars to ethanol and the aerobic oxidation of ethanol to acetic acid. Alcoholic seed broths which were prepared from the fermentation of *Saccharromyces cerevisiae* in coconut water, coconut sap, and pineapple juice were used for acetic acid fermentation. This study helped the researchers to have knowledge on fermenting coconut water.

How to make a potato battery

In an experiment by Hannah Wahlig, she used a potato, galvanized nails, and pennies to create a battery. This battery is used to light a small light bulb. Potato contains high levels of phosphoric acid, which is an electrolyte, this acid helps transport ions from the zinc source (galvanized nails) to the copper source (pennies). The chemical reaction inside the potato creates an electric current between the metal electrodes and that is able to illuminate a small light bulb when connected.

METHODOLOGY

IPO chart and discussion

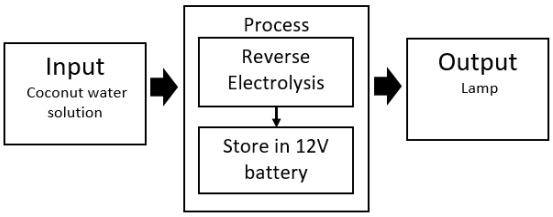

Figure 1. IPO chart for the research

The proponents used this Input-Process-Output (IPO) chart as guide. This chart helped the researchers to analyze and properly design the device and how it should work. The IPO chart demonstrates the interactions and connections of the hardware. Parts of the project design and how the parts work in generating the required power and the operation of the lamp.

Conceptual framework/theoretical framework

A lamp that is powered by coconut water was produced with the theoretical basis that water conducts electricity very well because of its impurities, and increasing those impurities will enhance its conductive property. Water is not really a good conductor of electricity without its impurities, i.e. the dissolved nutrients and minerals in it.

These findings were used as foundation of developing the research project. The problems that were encountered in this research's prototype were the choice of electrodes that must be used—they must be long lasting and not rapidly decay chemically that helps the procedures to be more understandable.

PHYSICOCHEMICAL PROPERTIES OF VINEGAR			
Months of fermentation	5-6	8-9	≥ 12
Titratable acidity (%)	0.089	0.076	0.061
ph	4.78	5.34	5.71

Rice Variety Used to Make Rice Wash	Voltage Output Reading (in millivolts)		
	1st Reading	2nd Reading	3rd Reading
Sinandomeng	590	490	491
Maharlika	510	490	488
Dinurado	493	465	469

Figure 2. Comparison between rice wash vs fermented coconut water

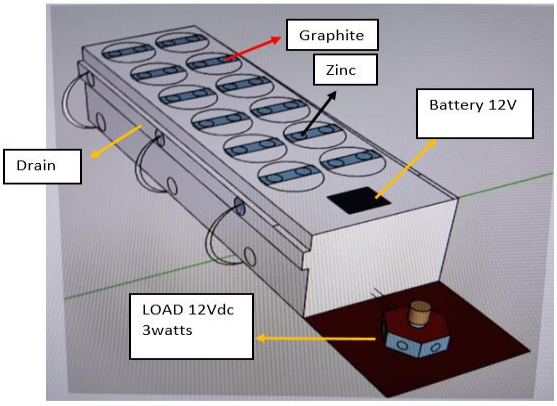

Figure 3. Pictorial diagram for the research

The pictorial diagram provides a better view of the connections and purpose of each component. A photo of each component is presented in the diagram and the red and black flow lines illustrate the power flow and system flow consecutively.

Hardware specification

Zinc rods

Figure 4. Zinc rods

A bluish-white metal that is very common and used specially to make brass and as a protective coating for things made of iron and steel.

Graphite rods

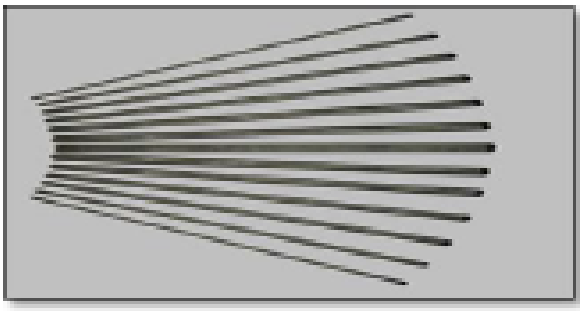

Figure 5. Graphite rods

A graphite rod has a high temperature strength, very high thermal and electrical conductivity, and low thermal expansion. The electrodes used in this device were those recycled from discharged batteries.

Buko juice

Figure 6. *Buko* juice

Fermented coconut water is one of the easiest probiotic drinks to make. It is also one of the best *candida* fighters in the market.

12V5Ah/20HR lead acid battery

Figure 7. 12V5Ah/20HR lead acid battery

The lead acid battery was invented in 1859 by French physicist Gaston Plante and is the oldest type of rechargeable battery. Despite having a very low energy-to-weight ratio and a low energy-to-volume ratio, its ability to supply high surge currents means that cells have a relatively large power-to-weight ratio.

12V DC 3-watt light bulb

Figure 8. 12V DC 3 watts light bulb

An incandescent light bulb, incandescent lamp, or incandescent light globe is an electric light with a wire filament heated to such a high temperature that it glows with visible light (incandescence).

Schematic diagram

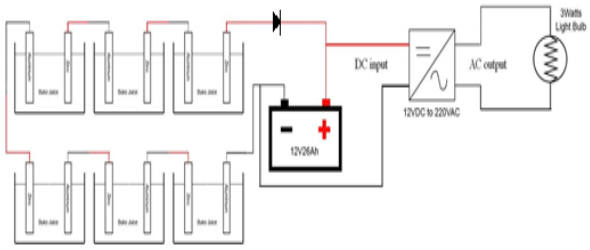

Figure 9. Schematic diagram for the research

Flow chart

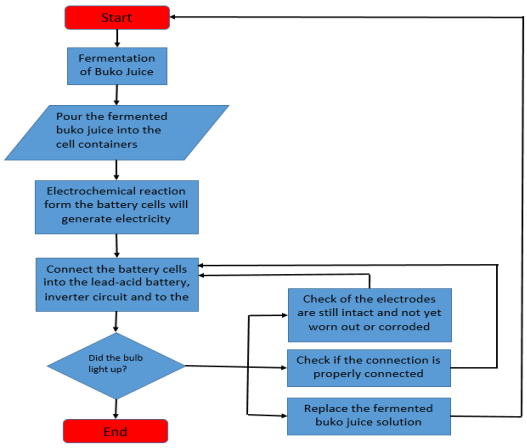

Figure 10. Flow chart for the research

DATA AND RESULTS

The proponents constructed the hardware and performed simulations in order to gather data and results.

Figure 11. Casing

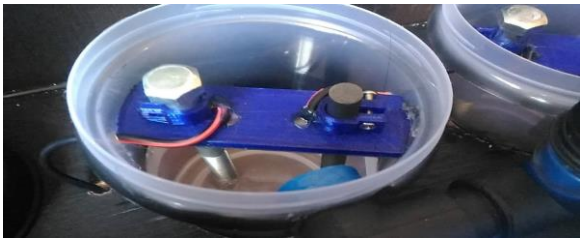

Figure 12. Rods placement

Figure 13. Finalization

It is composed of two compartments: the battery and the load compartment. The battery is composed of 12 galvanic cells, connected in series to increase the voltage. On the other hand, the load compartment is composed of a 12-volt light bulb. This research sought to find a way to give coconut water better utilization, in the form of power generation. It also sought to determine the time of fermentation needed to give enough level of acidity to perform electrolysis, the electrodes of the cell that will give it a better amount of generated power.

CONCLUSION

In order to make the battery produce the desired power for the operation of the prototype, certain parameters and materials had to be considered for its construction. The concentration of the fermented coconut water is considered. The researchers found that there is a relationship between the concentration and voltage production. It takes three months to ferment coconut water and produce approximately 1.2 Volts per container, using graphite and zinc as electrodes. On the other hand, the researchers found that a concentration of 1:1 is the best to produce power.

Another parameter to consider is the electrode to be used. The researchers conducted a test to find out which is the best to be used. According to their findings, graphite and zinc, as the cathode and anode, respectively, produced the highest voltage, followed by copper and zinc. It is therefore concluded that the former pair is the best to use.

Upon choosing the combination of electrodes to be used and fermenting coconut water in three months, the researchers were able to light up a 3-watts, 12-Volt DC bulb. Charging through the battery is possible but there is a limitation. It can only charge for 76 hours and 16 minutes and then it stops. On the

other hand, the lamp can operate continuously for 19 hours and five minutes before it fully discharges.

RECOMMENDATION

Based on the findings and conclusions of the study, the following recommendations were given:

1. Enlarge the power output, especially the current so charging will be improved. It may be done through the use of a circuit, multiplication, or enlargement of cells, or by introducing a new set of electrodes.
2. Charging through battery should be sustained for a longer time so the prototype will be more reliable.
3. For future researchers who will attempt to improve the operation of this device, it is suggested that there should be a deeper focus on the effects of corrode rods against the output of the battery.