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ET-LOK: EFFECTIVENESS TEST OF VARIOUS TYPES OF CHARCOAL AND $AgNO_3$AS BATTERY ALTERNATIVES USING SWAGELOK

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Abstract

The pressing issue of dangerous compounds in smoke has prompted a shift towards eco-friendly solutions, notably electric vehicles, to mitigate transportation-related greenhouse gas emissions. Capitalizing on the versatility of coconut byproducts, a study explores the potential of coconut shell charcoal, a byproduct of the revered "tree of life," in battery construction. Investigating various charcoal types—coconut fiber, husk, and coconut shell fiber—in combination with silver nitrate ($AgNO_3$), the study reveals husk charcoal's superior electrical performance. Multimeter tests indicate a significant 50 mV difference in voltage and current, highlighting enhanced conductivity. The addition of $AgNO_3$ further boosts battery conductivity by facilitating electron transfer and promoting electrochemical reactions, leading to increased power output. FTIR analysis categorizes all samples as "polymeric" OH stretch materials with characteristic Aromatic Rings, Alcohol Compounds, and Methyne Skeletal vibrations. Notably, husk charcoal stands out with a lower number of C-H bonds and wavenumbers within the carbon double bond's absorption band. The presence of C=C double bonds in husk charcoal enhances electrical conductivity, making it a promising candidate for high potential voltage and current generation. This research underscores the potential of coconut byproducts in advancing sustainable energy solutions.

***Keywords**: Charcoals, Silver Nitrate, Battery, Swagelok*

1. INTRODUCTION

1.1 Preface

The escalating global concern over climate change has spurred an urgent quest for sustainable energy solutions, driven by the imperative to mitigate the adverse effects of carbon emissions. The current predominant reliance on fossil fuels as a primary energy source has contributed significantly to the alarming levels of carbon dioxide in the atmosphere, exacerbating the greenhouse effect and accelerating global warming. The combustion of hydrocarbons, fundamental constituents of fossil fuels, not only releases copious amounts of carbon dioxide but also generates harmful byproducts, notably carbon monoxide. The detrimental impact of industrial activities further compounds the environmental challenges, underscoring the critical need for cleaner and more environmentally friendly

No	Fuel Type	CO_2 Emissions	Unit
1.	Petrol	2,33	kg/liter
2.	Diesel	2,64	kg/liter
3.	Coal	2,96	kg/liter
4.	LPG Gas	2,06	kg/m^3

energy alternatives. Electric vehicles are thought to hold the key to lowering transportation-related greenhouse gas emissions (Parinduri et al., 2018).

In the context of this pressing environmental crisis, electric vehicles have emerged as a promising solution to curtail emissions from the transportation sector. However, the broader objective transcends transportation alone, as researchers and scientists are intensively exploring alternative energy sources across diverse sectors. Fueled by concerns about the finite nature of fossil fuels and their cascading impact on the environment, the scientific community is increasingly turning its attention to biomass-derived materials as potential sustainable energy sources.

The coconut tree, often revered as the "tree of life" due to its myriad uses, takes center stage as a versatile and renewable source of energy materials. Among its various byproducts, coconut shell charcoal emerges as a particularly promising candidate for the development of environmentally friendly batteries. This research initiative seeks to harness the multifunctional attributes of coconuts and their derivatives to make a meaningful contribution to the ongoing efforts aimed at creating sustainable energy storage systems.

An essential aspect of this exploration revolves around understanding the pivotal role of charcoal in maintaining the stable and stationary state of the air electrode through the process of oxygen adsorption/desorption. The inclusion of macromolecular PEG-$(COOH)_2$ in the mixed complexes introduces an intriguing dimension to the study, impacting hydrodynamic volumes and ion mobility. Building upon these foundational insights, the research project systematically investigates the performance characteristics of coconut shell charcoal when integrated with silver nitrate ($AgNO_3$), with the ultimate goal of creating innovative bio-based batteries.The presence of macromolecular PEG-$(COOH)_2$ in the mixed complexes also increases the hydrodynamic volumes of the complexes, and thus reduces the ion mobility (Nagy et all., 2021)

In order to construct batteries, the paper looks into how well coconut shell charcoal works when paired with silver nitrate ($AgNO_3$). The purpose of this study, known as "ET-LOK" (Effectiveness Test of Various Types of Charcoal and $AgNO_3$), is to assess the total performance, efficiency, and energy storage capacity of these bio-based batteries.

In response to the need for more environmentally friendly energy sources, coconut shell charcoal provides a sustainable and renewable supply. The goal of this research is to make a contribution to the expanding field of environmentally friendly and sustainable energy storage systems by utilizing the multifunctional character of coconuts and their byproducts. Our ability to capture and store energy might be completely changed by the creation of ecologically friendly and efficient batteries, which would lessen our dependency on nonrenewable resources and lessen our environmental impact.

An important step towards the realization of economical and ecologically friendly energy alternatives is the "ET-LOK" research project. This work offers a fundamental basis for comprehending the possibilities of $AgNO_3$-based batteries and coconut shell charcoal in the context of a larger endeavour to maximize the benefits of nature while reducing its negative effects on the environment.

1.2 Problems

1. How well does the various types of charcoal-based battery with silver nitrate ($AgNO_3$) perform in terms of efficiency and energy storage capacity?
2. How can the use of various types of charcoal as a greener alternative energy source advance the development of sustainable energy storage systems and lessen their negative effects on the environment?

1.3 Purposes

1. To evaluate the total performance, efficiency and energy storage capacity of bio-based batteries that use various types of charcoal and silver nitrate ($AgNO_3$) as the main ingredients
2. To make a significant contribution to the development of environmentally friendly and sustainable energy storage systems.

1.4 Aim

1. Help the economy for local communities involved in the production and supply of charcoal.
2. Increase the usage of eco-friendly components.
3. Increase public knowledge about efficient techniques to reduce the effect of non-renewable energy.

1.5 BASIC THEORY

1.5.1 Charcoal

Carbon or charcoal is a porous solid that is produced when carbon-containing materials burn. The carbon in it is activated, either by immersion in chemicals or by hot steam flowing through the material, which causes the pores to open up and have different surface areas ranging from 300 to 2000 m2/G (Saputro et all., 2020). Aspiration properties are optional, and they depend on the size of the pores and their surface area. A significant amount of activated carbon—between 25 and 100% of the weight—is absorbed. By using a heat process known as pyrolysis, which reduces the size of the crushed material and causes it to burn, carbon, also known as charcoal, can be produced from biomass or cellulose materials like coconut or candlenut shells.

1. Coconut Fiber Charcoal

Coconut fiber is a waste produced from coconuts which, when carbonized and turned into active carbon, can have a high selling value. One use of coconut fiber is as active carbon. Coconut fiber can be used as active carbon because it contains the element carbon (C) and its structure is hard. Coconut coir consists of fiber and cork which connects one fiber to another fiber, where fiber is a valuable part of the coir. By utilizing this waste, an economically valuable product will be produced in the form of carbon which can then be further processed into active carbon (Dini Pertiwi and Welly Herumurti, 2013). Coconut fiber contains lignin (29.4%), cellulose (26.6%), nitrogen (0.1%), water (8%) and ash (0.5%). Based on research by Arif Dwi Putranto and Muh. Razif (2005) stated that the greatest phenol reduction efficiency was obtained by activated carbon with a ZnCh activator with a heating temperature of 600°C. for 1 hour was 96.9% to 98.5% with an initial phenol concentration of 300 mg/L. Meanwhile, based on research conducted by Dini Pertiwi and Welly Herumurti, coconut fiber activated carbon has the ability to reduce phenol by 98.49%. Meanwhile, commercial activated carbon is 98.28%.

2. Coconut Shell Charcoal

Activated carbon derived from coconut shells has a high and good storage capacity, making it a viable alternative fuel. To create premium activated carbon, use coconut shell as the primary material (Sulistyani et al., 2015). The primary element in charcoal and activated charcoal is coconut shell. The material coconut shell has a calorific value of around 6500–7600 kcal/kg. Cellulose (27.31%), hemicellulose (27.7%), lignin (33.30%), water (8.0%), extractive components (4.20%), uronic anhydride (3.50%), ash (0.23%), and nitrogen (0.1%) make up the chemical composition of coconut shells. The content suggests that coconut shells have a high carbon content, making them suitable for use as bio-cok.

3. Husk Charcoal

The rice husk was carbon-ised continuously, resulting in continuous carbonisation. The low fixed carbon 18.32% (by weight) of rice husk resulted in approximately low fixed carbon 44.89% (by weight) of charcoal. The volatile matter of rice husk is very high 51.91% (by weight) while charcoal is 12.75%(by weight).

1.5.2 Silver Nitrate

Silver nitrate is an organic compound with the chemical formula of $AgNO_3$. It consists of an ionic bond between the silver cation (Ag+) and the nitrate anion (NO3–). Due to the ionic nature of this compound, it readily dissolves in water and dissociates into its constituent ions. In its solid form, silver nitrate is coordinated in a trigonal planar arrangement. It is often used as a precursor to other silver-containing compounds. It is used in making photographic films, and in laboratory setting as a staining agent in protein visualization in PAGE gels and in scanning electron microscopy.

1.5.3 Battery

A battery is an electric cell that has a reversible electrochemical process with a high level of efficiency. The electrochemical process is the process of converting chemical energy into electrical energy which occurs during the battery discharging process and the process of converting electrical energy into chemical energy which occurs during the battery charging process .Generally there are two types of batteries.

1. Primary battery

Primary batteries are batteries that are only used once, where this type of battery cannot be recharged when the power in the battery has run out. This primary battery is made from electrochemical cells that can be used once, an example of a widely used primary battery is an alkaline battery. Primary batteries come in several forms, including coin cells and AA batteries. Primary batteries always have high specific energy with the system used to consume low power, so the battery can last a very long time.

2. Secondary battery

Secondary batteries are batteries that can be used repeatedly using a charge system. This battery has an electrochemical cell whose chemical reactions can be reversed and have a certain voltage, so that the power in the secondary battery can be recharged and reused. Secondary batteries are used in electronic equipment that uses high power, so it is not practical to use primary batteries which can only be used once. Secondary batteries with small capacities are used to power portable electronic devices. Meanwhile, large capacity batteries are used for heavy-duty electronic equipment such as electric vehicles.

1.5.4 Swagelok Tube Fitting

The Swagelok Tube Fitting is designed to provide a leak-tight seal for pressures up to the suggested allowable pressure rating of the tubing. The two-ferrule, mechanical-grip, hinging-colleting type connection consists of a fitting body, a nut, a front ferrule, and a back ferrule. Applications that can benefit from this feature include HVAC environmental controls, temperature monitoring systems inside buildings, equipment, or machinery, and process monitoring and control systems.

2. METHOD AND EXPERIMENTAL DETAILS

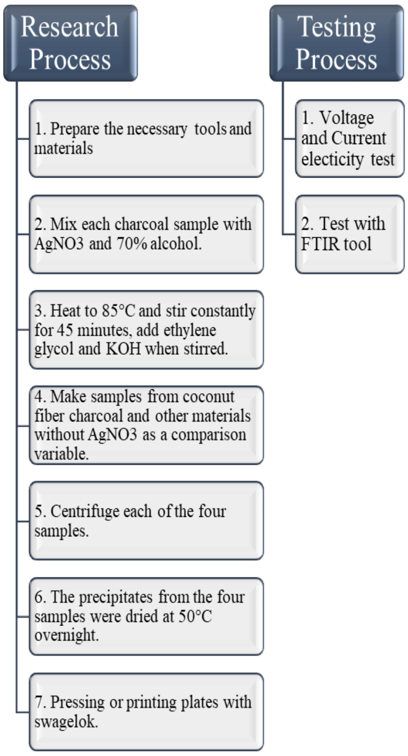
2.1 Method

This study investigates the potential applications of $AgNO_3$ and different kinds of charcoal as battery substitutes using qualitative research methods. The performance, efficiency, and energy storage capacity of batteries based on biomass are the main topics of description and interpretation. To find patterns and links, data was gathered through observation, interviews, and document analysis. Qualitative analysis was then used to analyze the data. It is anticipated that this approach will yield comprehensive understandings of the possible real-world uses of this technology.

2.2 Time and place

This study was held from July 2023 - October 2023. This research was carried out at the Faculty of Animal and Agricultural Sciences of Diponegoro University, Analytical Chemistry Faculty of Science and Mathematics of Diponegoro University, and SMA Negeri 3 Semarang's Chemistry Laboratory.

2.3 Researchb Design



2.4 Research Variable

Study variables can be divided into two groups: independent variables or input variables, is variables that are not affected by anything. Dependent variable or output, that is, affected variable.

1. Free Variables

The free variables in this study were the types of the charcoal that used, they were coconut fiber charcoal, husk charcoal, and coconut shell fiber. Also, the use of $AgNO_3$ at the sample, there are samples that were treated with $AgNO_3$ and not.

2. Dependent Variable

The dependent variable in this study was the result of potential voltage and current electricity, also the bonds were made from the reaction.

2.5 Testing Analysis

1. Potential of Voltage and Current Electricity Test Analyze

In this research, an important stage is the analysis of electric current and potential voltage. The materials' electrical conductivity varied significantly, according to the results. By knowing this, we can choose the materials that will work best for applications involving sustainable energy and comprehend how these materials work electrically. Significant information about the creation of upcoming energy solutions is provided by this analysis.

2. FTIR Test Analyze

An FTIR (Fourier Transform Infrared Spectroscopy) spectrum's absorption bands are patterns that are produced when molecules interact with an infrared light beam. Every absorption band in an FTIR spectrum corresponds to a shift in energy that takes place in a molecule's chemical bond. The wavelength of infrared radiation absorbed by molecules is measured by wavenumber, which is expressed in cm^-1. A molecule's chemical bonding characteristics are reflected via absorption bands, which are visible at particular wavelengths. Absorption bands, for instance, between 3400 and 3500 cm^-1 generally denote NH (amine) bonds, whereas bands in the range of 2800 and 3000 cm^-1 are frequently linked to CH bonds in hydrocarbons. These bands help researchers identify and understand the composition and molecular structure of compounds analyzed using FTIR technology. Esters, carboxylic acids, and ethylene glycol are known to have C-O bonds, which are linked to the C-O band (1000–1300 cm^-1). In amines and nitriles, C-N bonds are related to the C-N band (1000–1400 cm^-1). In compounds such as thiols and disulfides, C-S bands indicate C-S bonds, whereas the C-C band (1000–1200 cm^-1) describes C-C bonds in cyclic or aliphatic hydrocarbons. These bands are useful for locating organic compounds' chemical functional groups

3. RESULT AND DISCUSSION

3.1 Result

1. Voltage and current electricity test

Table of electrical voltage

No.	Coconut Fiber	Husk	Coconut Shell	Cconut Fibe without $AgNO_3$
1.	27 mV	80 mV	28 mV	13 mV
2.	27mV	71 mV	29 mV	12 mV
3.	26 mV	74 mV	30 mV	11 mV
4.	26 mV		32 mV	10 mV
Average	**26,5 mV**	**75 mV**	**29,75 mV**	**11,5 mV**

Table of electrical current

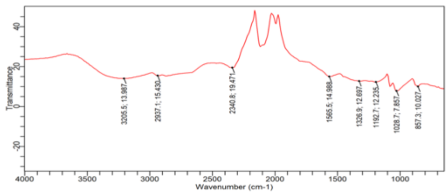
No.	Coconut Fiber	Husk	Coconut Shell	Cconut Fibe without $AgNO_3$
1.	0,01 µA	0,06 µA	0,01 µA	0,04 µA
2.	0,02 µA	0,08 µA	0,01 µA	0,03 µA
3.	0,01 µA	0,07 µA	0,01 µA	0,03 µA
Average	**0,0133 µA**	**0,07 µA**	**0,01 µA**	**0,0333 µA**

This table shows that husk charcoal performs better in terms of voltage and current, with a nearly 50 mV difference. This indicates that husk charcoal has a higher electrical conductivity than the other two types of charcoal. Test results on coconut fiber and coconut shell charcoal show similar results in the range of 27-30 mV and 0.01 µA.

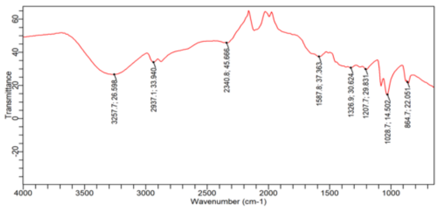
Electrodes containing $AgNO_3$ produce higher voltages and currents than electrodes without$AgNO_3$. This is because $AgNO_3$ is an electrolyte containing silver ions (Ag+), so adding $AgNO_3$ to the carbon electrode in the battery improves the conductor properties. Ag+ ions in $AgNO_3$ have high ionic mobility and increase the ionic conductivity of battery cells. In addition, $AgNO_3$ improves the ability of the charcoal electrode to participate in the electrochemical reaction, acting as an electronic intermediate and promoting the electron transfer between the electrodes. This improves the overall conductivity of the battery cells and the overall performance of the battery, resulting in higher power.

2. FTIR test

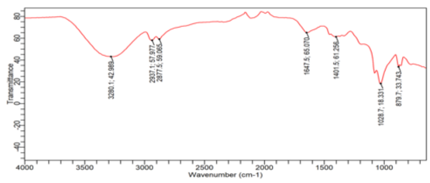
Coconut fiber charcoal without $AgNO_3$



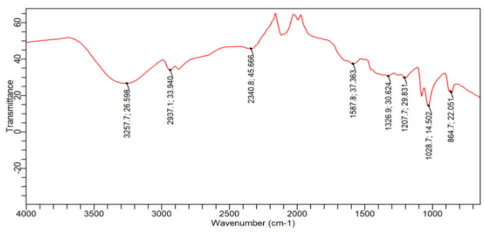
Coconut fiber charcoal + $AgNO_3$



Husk charcoal + $AgNO_3$



Coconut shell charcoal + $AgNO_3$



Component	Wavenumber					
	-OH	-CH	-C-O	-C-N	-C-C	**-C=C**
Coconut fiber charcoal without $AgNO_3$	3205.51054	2937.14222	1192.74811	1326.93227	1028.74524	
Coconut fiber charcoal + $AgNO_3$	3212.96522	2877.50481	1200.20278	1326.93227	1028.74524	
Husk charcoal + $AgNO_3$	3280.05730	2937.14222			1028.74524	1647.48 32
Coconut shell charcoal + $AgNO_3$	3257.69327	2937.14222	1207.65746	1326.93227	1028.74524	

Based on this chart, it can be observed that all the samples are Aromatic Ring or Aryl from the C-H stretch, Alcohol or Hydroxyl Compound from the -OH stretch, and Methyne Skeletal C-C vibrations type. The data shows that they are classified as normal “polymeric” OH stretch.

While hydrocarbons often form the same dense molecular structure, C-H and C-C bonds are generally the same. However, the lowest number of C-H bonds is found in nut fiber charcoal, which is approximately 2800.

Husk charcoal is the kind having the best qualities of charcoal. This is because the wavenumbers it produces fall between 1500 and 1600, which corresponds to the range of the carbon double bond's C=C absorption band (Alkenyl strech). Better carbon characteristics are typically seen in materials with C=C bonds rather than CH or CC bonds. This is a result of the C=C double bond enhancing porosity by generating more free space within the molecule. The high potential voltage and current produced by husk charcoal are caused by this C=C bond. Within alkenes, the C=C double bond is a covalent π (pi) bond capable of supporting electrical conduction. Alkenes are electrical conductors due to the high mobility of the π electrons in double bonds, though not as much as metals

4. CONCLUSION

1. Husk charcoal emerges as the top-performing variant, exhibiting nearly 50 mV higher voltage and superior current, indicating enhanced electrical conductivity. Coconut fiber and coconut shell charcoals demonstrate consistent results with voltages in the 27-30 mV range and a 0.01 μA current. Electrodes incorporating $AgNO_3$show improved performance, attributed to silver ions (Ag+), enhancing conductivity and leading to higher battery power.
2. The utilization of various charcoal types as a greener alternative energy source holds promise for advancing sustainable energy storage systems. By mitigating negative environmental impacts associated with traditional storage methods, charcoal-based batteries contribute to a more environmentally friendly approach. The classification of all samples as "polymer" materials underscores their potential as eco-friendly energy storage solutions. The distinct qualities of coconut fiber and shell charcoal further highlight the potential for tailored, efficient, and environmentally conscious energy storage solutions.

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