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Utilization of Magrove Muds In the Kuala Langsa as A Source of Electricity

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ABSTRACT

The economic potential of mangroves can be a provider of economic resources, preserving the ecological environment and providing environmental services. Mangrove soil in Kuala Langsa is important to study as the potential for carbon sequestration in the form of biomass, the social potential of the community in supporting the development of efforts. The purpose of this study was to determine how much electricity was generated by the Kuala Langsa mangrove mud soil and how the effect of variations in electrode material on the electricity produced by the Langsa mangrove mud soil. The method used is to use a series of voltaic cells. The results of this study obtained data that mangrove mud soil can be used as alternative energy by using variations of Cu-Zn and Cu-Al electrode pairs with a mangrove mud mass of 350 ml, at Cu-Zn electrode pairs the largest electric power obtained is 0,8736 **J/s**. with the lamp on while the Cu-Al electrode pair obtained an electric power of 0,1794 **J/s** with the lamp not lit.

Introduction

The economic growth of the world requires a significant supply of energy as its primary driving force. In 2014, global energy consumption increased to approximately 13 billion tons of oil, a 22% increase compared to 2004 and a 54% increase compared to 1994. The rapidly increasing demand has accelerated the exploitation of natural energy resources and has ultimately presented serious challenges in the form of energy scarcity and climate change. According to BP (British Petroleum) at the end of 2014, they stated that the reserves of oil, natural gas, and coal were estimated to last for approximately 53, 54, and 110 years, respectively. This has led to a growing global concern for the conservation of energy resources (G.Q. Chen et al., 2016). Electricity is the most practical form of energy and various conversion technologies are used to generate it, including combustion, gasification, and fermentation. However, technologies that rely on combustion and gasification have adverse effects on the depletion of fossil fuel reserves and the increase in CO2 emissions in the atmosphere. In contrast, the conversion of biogas into electricity has low efficiency, typically less than 40%. Therefore, the current electricity needs are expected to be met by efficient and environmentally friendly technologies (Bagus et al., 2014).

Langsa City is one of the cities in Aceh, Indonesia, which is directly adjacent to the Malacca Strait. The coastal area of Langsa city is home to a mangrove forest located in the Kuala Langsa area. Kuala Langsa is one of the villages located in Langsa City. Geographically, Kuala Langsa is situated between 04°24'35.68"-04°33'47.03" LU and 95°53'14"59-98°04'42'16" BT. The mangrove area in Kuala Langsa is part of the mangrove forest in Kota Langsa, accounting for 82% of the total mangrove area in Kota Langsa (Zurba, 2017).

The mangrove ecosystem has ecological functions such as carbon absorption, pollutant remediation, prevention of erosion, filtration, and storm

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protection (Wiryanto, et al., 2017). Additionally, it serves as a habitat for the growth and development of aquatic fauna (Matatula et al., 2019). Mangroves are habitats for various types of microorganisms that are tolerant of extreme environmental conditions (Retnowati, et al., 2017). Mangroves also play a role in conserving biodiversity (Husodo, et al., 2017). This makes mangrove forests essential in coastal ecosystems, encompassing ecological, social, and economic aspects (Basyuni, et al., 2018).

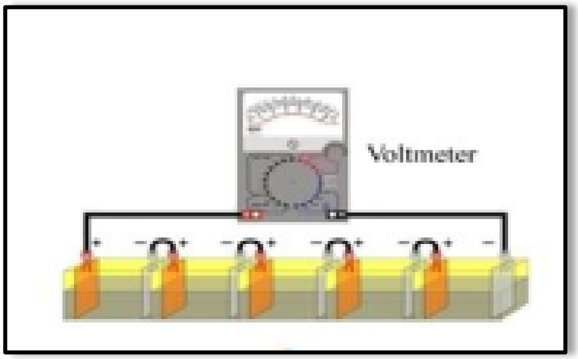
Mangrove soil is formed from sediments carried by river currents and materials brought in by the sea during high tides. Fine sediments and other suspended materials from river flow can settle in the mangrove area due to the lack of flow, turbulence, and coagulation caused by mixing with seawater. Mangroves, as an ecosystem, have a close relationship between soil quality and the diversity of organisms living in that soil (Soeroyo, et al., 1996).

Based on the description above, the researcher is attempting to use mangrove mud in Langsa City to determine the amount of electrical power generated by the mangrove mud and the impact of variations in Cu-Zn and Cu-Al electrodes.

Methods

This research was conducted in Mey 2021 in Kuala Langsa, Kota Langsa District. Data collection was performed using a digital multimeter for each pair of electrode circuits. The electrode plates used had a cross-sectional area of 15 cm².

Figure 1
The steps for data collection in research

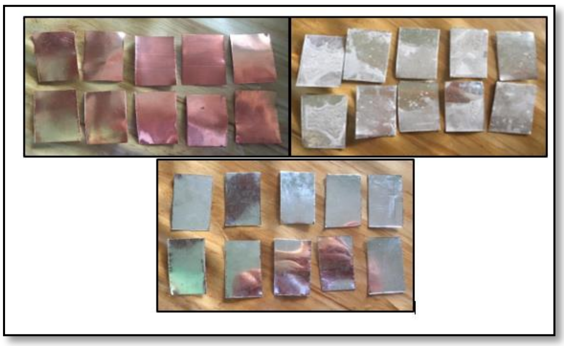


A voltaic cell consists of two electrodes that can generate electrical energy, resulting in a spontaneous redox reaction at these electrodes. This voltaic cell consists of a negative electrode and a positive electrode, where the negative electrode is where the oxidation reaction takes place, called the anode, and the positive electrode is where the reduction reaction occurs, called the cathode (Yani & Sandri, 2017).

Results and Discussions

Show exposure data analysis, consisting of descriptive statistics, test results of the assumptions, and results of hypothesis testing are presented sequentially or integrated; including an explanation of the results of research associated with the results of previous studies, critically analyzed and linked to relevant recent literature (number of pages approximately 30-40%).

Figure 2
Electrode plate size 15cm



This research uses different time intervals to observe at the same temperature, which is 33°C. The research data is then analyzed using the following Equation 1.

$$P = V \times I \qquad (1)$$

Description:
- P : Power (watt or W)
- V : Potential (Joules or J)
- I : Current (Amperes or A)

In principle, the working procedure of this research is as follows: (1) Prepare 350 ml of mangrove mud soil and place it into a square glass container with dimensions of 18 x 10 cm, (2) insert variations of electrode pairs, Cu - Zn and Al - Zn, which have been connected in series into the mangrove mud soil, (3) connect each pole to a multimeter, (4) the cross-sectional area of the electrode plate used is 15 cm², (5) observe and measure the current and voltage produced by the mangrove mud, then calculate the electrical power generated.

Figure 3
Cu – Zn electrode circuit

(a)

Figure 4
Al – Zn electrode circuit

(b)

Based on the research results that have been conducted, which involve the utilization of mangrove mud from Kuala Langsa as a source of renewable energy, the electrodes used are Cu-Zn and Cu-Al electrode pairs with a cross-sectional area of 15 cm². A mass of 350 ml of mud is used to determine the amount of electrical power generated by the Cu-Zn electrode pair. The data obtained is as follows:

Table 1
Electrical power of the Cu – Zn electrode pair circuit

Sample	Power (Watt)	Light on
1	0,6675	Not turning
2	0,6675	Not turning
3	0,6992	Not turning
4	0,6992	Not turning
5	0,6992	Not turning
6	0,7238	Not turning
7	0,8736	Turning
8	0,7238	Dim
9	0,8736	Turning
10	0,8736	Turning

In the Cu-Zn circuit experiment, the experiment was conducted 10 times to determine the amount of power generated by the mangrove mud. In experiments 1 and 2, an electrical power of 0.6675 J/s was obtained, and the LED lamp did not light up. In experiments 3, 4, and 5, an electrical power of 0.6992 J/s was obtained, and the LED lamp did not light up. In experiments 6 and 8, an electrical power of 0.7238 J/s was obtained, and the LED lamp did not light up. Experiment 7, 9, and 10 yielded the highest power output at 0.8736 J/s, and the LED lamp lit up.

Table 2
Electrical power of the Cu – Al electrode pair circuit

Sample	Power (Watt)	Light on
1	0,1394	No flame
2	0,1575	No flame
3	0,1394	No flame
4	0,1575	No flame
5	0,1575	No flame
6	0,1764	No flame
7	0,1764	No flame
8	0,1575	No flame
9	0,1764	No flame
10	0,1764	No flame

The experiment with the Cu-Al circuit was conducted 10 times to determine the amount of power generated by mangrove mud. In experiments 1 and 4, an electrical power of 0.1394 J/s was obtained, and the LED did not light up. In experiments 2, 3, 5, and 8, an electrical power of 0.1575 J/s was obtained, and the LED did not light up. In experiments 6, 9, and 10, the highest power was obtained, which was 0.1764 J/s, but the LED still did not light up. Therefore, the conclusion drawn is that mangrove mud can generate electricity, and the circuit combination that generated the most electricity is the Cu-Zn circuit pair.

Conclusions

The conclusion drawn from the results and analysis is that mud from the Kuala Langsa mangrove can generate renewable electrical energy using a voltaic cell setup with Cu-Zn and Cu-Al electrodes. The choice of electrode materials affects the voltage and current produced by the mangrove mud. When Cu-Zn electrodes were used with 350ml of mud arranged in a series-parallel configuration, the highest electrical power was generated, with the LED light remaining lit for the longest duration, approximately 0.8736 J/s for 20 minutes. In contrast, the Cu-Al electrode pair arranged in a series-parallel configuration generated lower electrical power, approximately 0.1794 J/s, and the LED did not turning up.

References

Ahmad, G, F., Randha, K, A., Amir, S., Sri, W, S., Arif, S., Junaidi., & Warsito. (2018). Desain dan Realisasi Akumulator Elektrolit Air Laut dengan Penambahan Sodium Bicarbonate ($NaHCO_3$) sebagai Sumber Energi Alternatif. *Jurnal Fisika,*8 (2): 78-85

Basyuni, M., Gultom, K., Fitria, B.A., Susetya, I. E., Wati, R., Slamet, E., Balke, & Bunting, P. (2018). Diversoty and habitat caharteristics of macrozoobenthos in the mangrove forest of :ubuk Kertang Village, North Sumatra, Indonesia. *Biodiversitas*, 19: 311-317

Bagus, N, A., Adi N., Alit., Ajeng. (2014). Analisis Potensi Sedimen Hutan Bakau Sebagai Sumber Energi Listrik Dengan Menggunakan Teknologi Sediment Microbial Fuel Cell (SMFC)". *Seminar Nasional FMIPA Undiksha"* 1(4).

Bird, T. "Kimia Fisik Untuk Universitas". PT Gramedia Pustaka Utama. Jakarta

Dogra, S. " Kimia Fisik dan Soal-soal". Universitas Indonesia Jakarta

Surya dengan Konfigurasi Tube *Serpentine* Berkapasitas 100 Liter. *Jurnal Teknik,* 1 (1): 30-39

Retnowati, Y., Sembiring, L., Moeljopawiro, S., Djohan, T. S., & Soetarto, E. S. (2017). Diversity of antibiotic-producing actinomycetes in mangrove forest of Torosiaje, Gorontalo, Indonesia. *Biodiversitas,* 18: 1453-1461

Soeroyo & Suyarso. 1996. " Sifat-Sifat Kimia Tanah Mangrove". Faperta.IPB.Bogor

Sucianti, SW., Warsito., Amir., Arif., Giri., & Gurum (2018). "Karakteristik Kelistrikan Air Payau dan Air Sungai Sebagai Bahan Elektrolit". *Jurnal Fisika dan Aplikasinya*, 3(1): 47-56

Wiryanto., Sunarto., & Rahayu, S, M. (2017). Biodiversity of mangrove aquatic fauna in

Firdaus, M,S., Fahizha, A. (2016). "Potential biolectricity generation from mangrove sediments'. *Journal of Advanced Research in Materials Science,* 25(1): 10-17.

G.Q. Chen & X.F. Wu. (2016) "Energy overview for globalized world economy: Source, supply chain and sink". Renewable and Sustainable Energy Reviews, 735–749

Hiskia, A. "Elektrokimia dan Kinematika Kimia". PT Citra Aditya Bakti, Bandung. Kepmen LH no 201 tahun 2004

Husodo, T., Pallabi, S. D.G., Abdoellah, O,S., Nurzaman, M., Fitriani, N., & Partasasmita, R. (2017). Short communication: Seagrass diversity and carbo sequestion: Case study on Pary Islang, Jakarta Bay, Indoneisa. *Biodiversitas,* 18(4): 1596-1601

Matatula, J., Poedjirahajoe, E., Pudyamoko, S., & Sadono, E. (2019). The spatial spread of mangrove forest environmental condition at Kupang seashore. *Journal of NaturalResource and Environmental Management*, 9: 467-482

Rusmayardi, H., Rita, M, V., & Edy P. (2018). Rancang Bangun Alat Pemanas Air Tenaga Purworejo, Cetral Java, Indonesia. *Biodiversitas,* 18: 1344-1352.

Yani, E., & Sandri, K, D. (2017). Kaji Ekperimen Limbah Cair Detergen Sebagai Sumber Energi Alternatif. *Jurnal Sistem Mekanik Termal*, 1 (2): 109-116.

Young, H.D. &Freedman, R.A. 2000. *Fisika Universitas.* Edisi 10. Jilid I. Jakarta: Erlangga

Zuraidah, S. "Aspek Fisika Tanah Mangrove Rzihopora sp. di Kawasan Mangrove Kabupaten Aceh Jaya. *Journal of Aceh Aquatic Science,* 1(2): 101-108

Zurba, N., Effendi, H., & Yontvitner (2017). "Pengelolaan Potensi Sumber Daya Ekosistem Mangrove di Kuala Langsa,Aceh*".* 9(1). *Jurnal Ilmu dan Teknologi Kelautan Tropis,* 9(1): 281-300