JUSTEK : JURNAL SAINS DAN TEKNOLOGI
http://journal.ummat.ac.id/index.php/justek
ISSN 2620-5475
Vol. 9, No. 1, March 2026, pp. 37-43

The Effect of Seawater and Sea Sand Composition Ratio on the Characterization of Voltage and Electric Current

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ARTICLE INFO

Article History:

Received : 20-01-2026
Revised : 02-03-2026
Accepted : 12-03-2026
Online : 25-03-2026

Keywords:
Electrical energy;
Renewable energy;
Sea water;
Sea sand;
Tongachi beach.

ABSTRACT

The limited availability of fossil fuels and their environmental impacts have encouraged the development of more environmentally friendly alternative energy sources. One of the methods of renewable energy is to utilize seawater and sea sand. This research aims to analyze seawater and sea sand in generating electrical energy. Source of seawater and sea sand from Tongachi Beach Bangka Belitung Indonesia. The research method was mixing seawater and sea sand with a ratio of 100:0%, 70:30%, 50:50%, 30:70%, dan 0:100%. Measure the seawater according to the percentage 100%, 70%, 50%, 30% and 0%. Then Weigh the sea sand according to the percentage ratio 0%, 30%, 50%, 70% and 100%. Add the seawater and sea sand to the mixing container according to the weighed ratio. The electrical energy generated is determined by observing the current flow and power are seen on the multimeter. The results showed that the composition ratio of 100:0 % seawater and sea with a voltage of 0.67 V, an electrical current of 0.2 mA and a power of 0.134 watts. It has of the analysis of the composition of seawater and sea sand can potentially be used as a source of electrical energy.

A. INTRODUCTION

Many of the world's current energy and environmental issues might be resolved with the help of renewable energy. Various nations' governments have established goals for the proportion of energy generated from renewable sources in the upcoming decades (Zhong & Bollen, 2021). Given the problems facing both fossil and nuclear fuels, renewable energy represents a promising solution to a number of energy and environmental problems currently facing the world (Moriarty & Honnery, 2012) (Zhong & Bollen, 2021).

Hybrid renewable energy systems, especially those that include biomass, hydropower, wind, and solar power have become more prevalent because of growing concerns about climate change. Because fossil fuels are concentrated in a small number of countries, those countries have influence over energy supply and pricing (Fathi et al., 2025). Sea sand resources have drawn interest in a number of nations recently due to their abundance, easy to mine, and low cost. Benefits of sea sand include firm particles, good gradation, low

mud content and appropriate particle size (Zhang et al., 2024). Seawater is considered an electrolyte solution because it can conduct electricity (Nengsih, 2020). The mixture of seawater and sea sand increases the salt content in electrochemical processes.

For electricity users, renewable energy can be utilized of electricity energy generated from natural sources such as flowing water, wind, solar energy, biomass, and other sources, including wave energy and hydrogen (Zhong & Bollen, 2021). Electrical energy is a primary form of energy needed to operate various electrical equipment and as energy stored in electric current (Morais et al., 2018). Electrical energy plays a vital role in daily life, as nearly all human activities involve the use of electrical energy, both in households and other environments. To generate electricity, the electrolyte is composed of a substance that contains positively charged ions that push electrons to move via the external circuit to the load (Ang et al., 2022).

Bangka Belitung, an archipelago situated off Sumatera's eastern coast, stands out for its distinctive culinary heritage deeply embedded in its maritime traditions (Kusumah, 2025). Bangka Island covers an area of 11,693.54 square kilometer. Its unique feature, compared to other islands, is its gently sloping white sandy beaches, adorned with stretches of granite (Isnawijayani, 2021). Sungailiat is located in Bangka Regency, Bangka Belitung boasting natural beauty that is truly captivating. Recognizing its potential, including its beaches, diverse marine life, and vibrant cultural history, these should be nurtured and shared with a broader audience, both nationally and internationally. One of the beaches in Sungailiat is Tongachi Beach (Afandi et al., 2025).

Due to Bangka Island being a coastal area with abundant seawater and sea sand, it has great potential for developing simple electrochemical energy innovations. The ocean is essential to both environmental and economic sustainability, as the need for renewable resources to reach net zero by 2050 grows (Yu et al., 2023). Seawater is an important alternative power source to generate low cost and green electricity for several needs (Susanto et al., 2017). Seawater is a mixture of 96.5% pure water and 3.5% other materials such as salts, dissolved gases, organic materials, and undissolved particles. Seawater is indeed salty because it has an average salt content of 3.5%. The salt content in each sea varies, so this research provides insight into the potential of Bangka seawater for electrical energy. Besides seawater, sand can has not yet been widely developed for the utilization of electrical energy sources. Meanwhile, the existence of sea sand is always coexisting with seawater. It is hoped that the use of these two materials will be able to produce alternative energy sources that can be used.

B. METHODS

This research is based on the principle of simple electrochemical cell that utilizes the potential difference between electrodes to generate electrical energy. This electrochemical system consists of two metal electrodes: Zinc (Zn 4 cm x 10 cm) and Copper (Cu 4 cm x 10 cm), then an electrolyte solution consisting of seawater and sea sand obtained from Tongachi Beach, Sungailiat, Bangka.

The mixture of the two raw materials was placed in an empty container based on the seawater to sea sand ratios of 100:0%, 70:30%, 50:50%, 30:70%, and 0:100%. The

previously prepared electrodes were placed into the container containing the seawater and sea sand mixture. The voltage and current readings were detected using a multimeter. The electrochemical cell used and the procedures in this research is shown in Figure 1 and 2.

Figure 1. Electrochemical cell circuit using seawater and sea sand

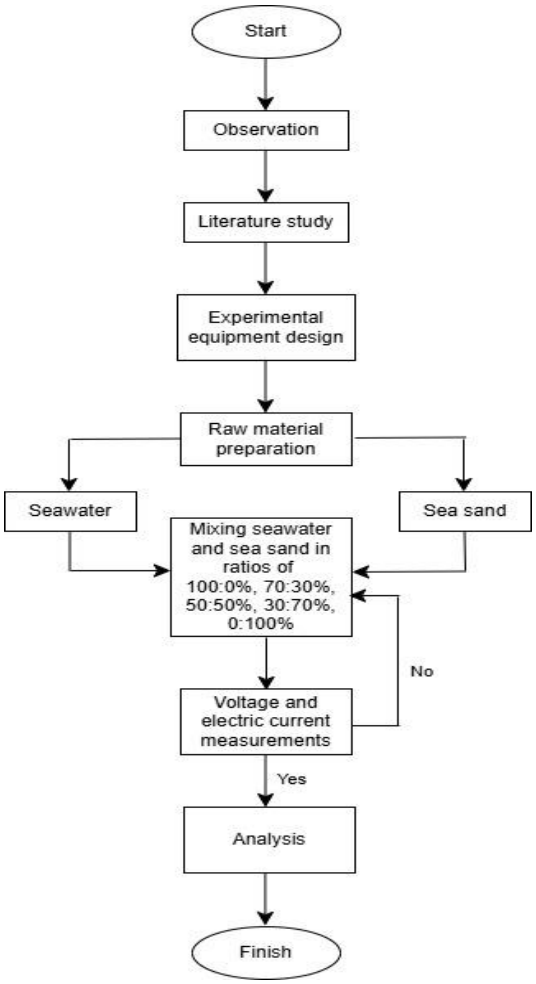

Figure 2. Research flowchart

In Figure 2, this research begins with initial observations of the phenomenon, problems and objects being studied to obtain an initial overview of what will be studied. Then, a literature study is conducted to strengthen the theoretical basis and methods to be used. Then, a simple research tool is designed. Raw materials in the form of seawater and sea sand are prepared, then each raw material is weighed with a predetermined ratio and then mixed. Once the mixture is ready, the voltage and electric current are measured on each combination of materials. After the measurements are carried out, there is a process of checking whether the data is sufficient or appropriate. If not, the mixture or measurement can be repeated, if so, the process continues to the next stage. The collected data is then analyzed for the relationship between the mixture ratio and the resulting voltage and electric current. All stages are completed and the research results have been obtained.

C. RESULT AND DISCUSSION

The research results show that a mixture of seawater and sea sand can produce an electric current, which can be used as renewable energy. The results of the composition comparison are presented in Table 1.

Table 1. The results presented represent an experiment using one circuit cell.

Ratio (%)	Seawater (gr)	Sea sand (gr)	Voltage (V)	Current (mA)	Power (Watt)
100 : 0	200	0	0.67	0.2	0.134
70 : 30	140	60	0.66	0.2	0.132
50 : 50	100	100	0.65	0.2	0.130
30 : 70	60	140	0.64	0.2	0.128
0 : 100	0	200	0.66	0.2	0.132

The mixture of seawater and sea sand increases the salt content in the electrochemical process. The abundance of seawater and sea sand in Indonesia offers an alternative way to generate energy. However, with the presence of sea sand, this study aims to test whether the combination of seawater and sea sand can also generate electricity.

Table 1 shows that a composition of 100% seawater can produce 0.134 watts of power. According to (Ng et al., 2018) seawater has been gaining attention as a viable alternative to freshwater in the oil and gas industry. Then, according to (Fariya, Siti; Rejeki, 2015) seawater can be a solution to replace fuel oil or diesel fuel, due to the free particle charge of NaCl salt contained in seawater. The salt content in seawater is 3.5% of a mixture of pure water and salt. Meanwhile, the experimental results show that the power generated by 200 grams of sea sand or a variation of the composition of 100% sea sand in the mixture is lower by 0.132 watts compared to 100% seawater. This is because the salt content in sea sand is lower than that of seawater. However, it can still be identified that sea sand also contains salt, producing a voltage of 0.66 volts. In addition to its lower salt content, sea sand also contains silica dioxide (SiO_2) compounds.

Electrolytes are crucial in electrochemical energy storage system, electrolytes ensure proper performance of supercapacitor by faciliting charge transfer and equalization between the two electrodes (Kumar et al., 2023) (Anil et al., 2025). The interactions

between the electrolyte and electrode affects all electrochemical processes, which in turn affects the condition of the interface between the electrode and electrolyte as well as the internal structure of the active materials (Anil et al., 2025).

During the electrochemical process, the negatively charged ions in sea sand bind to the Cu metal ions, which are the copper cathodes used. This results in a reaction that reduces the copper metal ion content. The presence of these copper ions is used as a charge exchanger for the Na^+ and Cl^- ions in the cell to generate electric current.

The electric current generated comes from the electrochemical reaction of seawater. Seawater contains NaCl salt, which, when ionized, forms Na^+ and Cl^- ions. Similarly, sea sand contains a small amount of salt. When an electrode is dipped into a mixture of sea sand and seawater, it undergoes an exchange of positive and negative ions. The positive electrode, copper, attracts negative Cl^- ions, while the negative electrode, zinc, attracts positive Na^+ ions. This difference in charge between the positive and negative ions creates an electric current. The following reactions occur at the electrodes:

Reduction Reaction: $Cu^{2+} + 2e^- \rightarrow Cu$
Oxidation Reaction: $Zn \rightarrow Zn^{2+} + 2e^-$
Total Reaction: $Cu^{2+} + Zn \rightarrow Cu + Zn^{2+}$

Copper-zinc pair (Cu − Zn) is a pair of electrodes that are often used in sea water voltaic cells as a source of renewable electrical energy (Pauzi & Wicaksana, 2020). An oxidation reaction will occur at the Zn electrode, while a reduction reaction will occur at the Cu electrode. Electrochemical oxidation is a chemical reaction involving the loss of one or more electrons by an atom or a molecule at the anode when an electrical current is passed through the system (Sirés, I., et al, 2014) (Liu, C., et al, 2019) (Wang, F., et al, 2020). Electrochemical reduction, the complementary process to electrochemical oxidation, is a chemical reaction involving the gain of one or more electrons by an atom or a molecule at the cathode when an electrical current is passed through the system (Sillanpää, M., 2017).

D. CONCLUSION AND SUGGESTIONS

Based on the results of research can be concluded that seawater and sea sand can be used as electrolytes in a simple electrochemical cell system using zinc (Zn) and copper (Cu) electrodes. From the ratio of raw material composition, the best ratio of Seawater and sea sand is a combination of 100% Seawater and 0% sea sand with a voltage of 0.67 V, an electrical current of 0.2 mA and a power of 0.134 watts. This is because seawater as the primary electrolyte because it contains dissolved ions that conduct electricity well, but sea sand as a weak electrolyte that tends to increase the system resistance so that it can reduce the value of the voltage and electric current. Further research developments are as follows variations in the composition of seawater and sea sand are needed to more fully understand their effects on the resulting voltage and current. More precise measurements of current and power can be made with longer observation times. Then, use of other types of electrodes with larger potential differences can be considered to increase the electrical energy generated.

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