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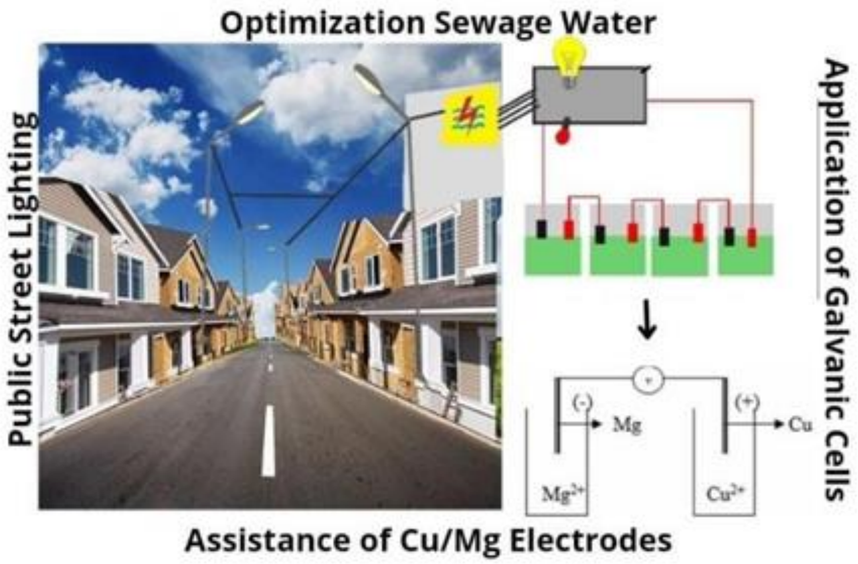
Optimizing sewage water of Perum Pesona Permata Gading with the assistance of Cu/Mg electrodes as public street lighting based on green technology electricity

Deni Ainur **Rokhim**[1,2+], Diana Novel **Smith**[3], Alfredo Radinal **Mukhtar**[4], Azzahra Zafira Putri **Koto**[5]

Abstract

Electricity in Indonesia uses fossil fuels as an energy source. If fossil fuels run out, we will lose our largest source of electrical energy. Therefore, we need a way to reduce dependence on fossil fuels by making good use of renewable energy as a source of electrical energy. One of them is Green Technology Electricity with the utilization of sewage water to convert chemical energy into electrical energy. This study aims to determine the potential of sewage water assisted by Cu/Mg electrodes as a source of street lighting, manufacturing, and testing methods, and the effect of optimizing sewage water on electrical performance as street lighting. Lack of lighting in residential areas is also a supporting factor in this research. The stages used are preparation, incubation, construction assembly, research, and strength testing. Based on research, the sewage water from Perum Pesona Permata Gading can be used as street lighting with the highest potential difference and current strength being 4.4 V and 0.55 A for each 50 mL of the sewage water.



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Highlights

- Green technology applied to sewage water converts chemical energy into electricity.
- Potential of sewage water assisted by Cu/Mg electrodes as a source of street lighting.
- The stages are preparation, incubation, construction, research, and strength testing.
- The highest ΔV and I were 4.4 V and 0.55 A for each 50 mL of sewage water.

[1]State University of Malang, Chemistry, Malang, Indonesia. [2]SMA Negeri 3 Sidoarjo, Sidoarjo, Indonesia. [3]Universitas Airlangga, Pharmacy, Surabaya, Indonesia. [4]Universitas Brawijaya, Computer Science, Malang, Indonesia. [5]Indonesia Defense University, Medical, Bogor, Indonesia.
+Corresponding author: Deni Ainur Rokhim, **Phone:** +6283857257301, **Email address:** deniainurrokhim@gmail.com

1. Introduction

The need for electrical energy in this globalization and modernization era is critical (Hutabarat *et al.*, 2022). Energy is produced by burning non-renewable natural resources. Thus, the amount of natural resource reserves globally is becoming thinner and has an impact on the environment. This is shown by the energy production process that produces gas emissions such as carbon dioxide, methane, and others. The gas then envelops the earth, preventing the sun's heat from evaporating at night. In other words, the energy crisis makes the earth warmer, thus triggering global warming. In addition to having an impact on the environmental sector, the use of non-renewable natural resources has an impact on the economic sector. The higher the energy use, the cost of energy production also increases. Meanwhile, the available natural resources are very limited, so it is very possible that prices will increase many times and can trigger damage to economic stability. One of the logical solutions in dealing with the current energy crisis is to use renewable alternative energy. Therefore, technological innovation and sustainable alternative energy research are urgently needed.

In this era, human beings all around the world are in dire need of renewable alternative energy that will be the new electrical energy source. This is because the availability of electrical energy is not capable of meeting the increasing demand for electricity in Indonesia, there is a division of electrical energy in rotation is the impact of limited electrical energy distributed by PLN (Sintiya and Nurmasyitah, 2019). Alternative energy is an energy source that comes from nature and can be regenerated freely. Electrical energy is a vital need for people worldwide, and Electrical energy is the most economical resource that can be used for our daily needs, jobs, and various activities (Wahid *et al.*, 2014). Almost every aspect of human life cannot be separated from electrical energy (Hamamni *et al.*, 2020). The use of electrical energy is based on cheap supply energy and can be easily used compared to other energy (Priyarsono *et al.*, 2010). Electrical energy generally depends on the availability of natural resources such as fossil-based, solar, wind, and others (Hikmawan and Suprayitno, 2018).

In Indonesia, there are a lot of alternative energy sources that have the potential to be solar power plants, water, and a lot more. Utilization of this natural resource must be developed so that it can become one of the solutions that can be offered to overcome the country's problems, especially in the energy sector. One alternative energy that can be used is sewage water. Sewage water can easily be found across the nation. Sewage is a channel to distribute wastewater and rainwater to be taken to a destination so that it does not bring environmental and health problems. This wastewater can come from households, industrial industries, or other public places that contain materials that can endanger human life and living that can interfere with environmental sustainability (Chandra and Jaya, 2021). Imagine if all the streetlights in the environment are using wastewater as a power for the streetlights. This can result in more available natural resources to store and a lot of wastewaters to be used for something useful. "Public Street Lighting" (PSL) is a lamp used for street lighting at night, making it easier for drivers to see the road in the middle of the night to improve traffic safety.

One of the causes of traffic accidents is the lack of lighting in the area. Based on police data, an average of 3 people die every hour from traffic accidents in Indonesia (Sugiyanto *et al.*, 2017). The data also says that several causes caused many accidents, 61% of accidents were caused by human factors related to the ability and character of the driver, 9% were due to vehicle factors, and 30% were caused by infrastructure and environmental factors (Zulkarnaen *et al.*, 2018). Dark lighting conditions lead to lousy eye-sighting and bad road sense. When doubled with the condition of a sleepy driver, it will be even more dangerous. This condition is threatening for motorists and pedestrians. Furthermore, a dark location can also provoke someone to commit a crime.

The reason why the writer chooses to do this research is that the writer wants to examine how the increasing demand for electrical energy in Indonesia is currently not balanced with the availability of electrical energy supply or the electrical energy crisis is something that cannot be avoided. The control blackouts in Jawa-Bali and planned control blackouts in certain places in Sumatra are sign that the electrical supply within the interconnection routine is able to fulfill the expanding power needs of individuals and industry. The circumstance compounds with the expanding toll of fuel which rises to the moon indeed the larger part of control plants exterior Java which are utilizing diesel as fuel experienced swelling operational costs (Agung, 2013).

After examining these conditions, at least two things have to be considered and assessed. To begin with, how distant is the viability and productivity of the interconnection framework for supplying electrical vitality that includes numerous powerplants accessible to date? It is presently the time to explore an elective, more reasonable electrical vitality supply framework. Both dependences on fuel oil ought to continuously be diminished by utilizing elective vitality based on nearby potential from each locale in Indonesia. Since of this reason, an expansion to the utilization of preliminary vitality sources whose saves are bigger such as gas and coal, too calculated application of naturally inviting renewable vitality, such as geothermal, sun powered vitality, wind, and water (Agung, 2013).

This research was conducted based on the green technology electricity method. Green Technology Electricity is a development of the electrical energy concept that starts from the theories of designing or developing an operating system that integrates modern technology and electrical energy with environmental science, to reduce the negative impacts of human activities. Also, with the help of Cu/Mg electrodes, which will have an impact on the electricity to be used and the lights on public street lighting. The writer wants to use Perum Pesona Permata Gading's sewage water because there are dozens of paths in the area as well as the lack of public street lighting in the area. This is done by testing the strength of the current and voltage, which is intended to analyze the effectiveness of ditch water on the three paths contained in the ditch namely the main line, entrance and exit as a source of electrical energy. The voltage and electric current generated in this study can be explained by adopting the working principle of a voltaic cell. If two different electrodes are placed in an electrolyte solution, they will produce electrical energy from a chemical reaction that takes place spontaneously (Atina, 2015).

2. Experimental

2.1. Tools and Materials

The tools and materials used in this experiment are: AVO Meter commonly called a multimeter which serves to measure more than one electric quantity, 9 pieces of 50 mL beaker as a place to react ingredients, Crocodile clip cable as a connecting circuit, Miniatur LED lights as a measure of the ability of the power to turn on the lights, Cu plate and Mg band 5 cm x 1 cm x 0.1 cm as conductor, Sandpaper which serves to smooth the surface of the Cu plate and Mg band 5 cm x 1 cm x 0.1 cm, Sewage water from 3 different paths as a source of electrical energy.

2.2. Step-step

First, pour the sewage water into the beaker with the provision of sewage water on each line using 3 beakers. Sand the Cu plate and Mg band until you can see the difference in color from the original color. After that, insert the Cu plate and Mg tape that has been sanded into each beaker that has been filled with sewage water. Attach the alligator clip cable to the Cu plate and Mg band. Then, connect it with an AVO Meter or Multimeter analogue and see how much voltage and electrical wear is contained in each sewage line. Repeat the experiment up to 5 times every 30 min with an estimated standard deviation not exceeding the mean.

3. Results and discussion

An electrode is a conductor that can give an electric current from one media to another. Electrodes are generally made from metal—namely copper, silver, tin, and zinc. But there are also electrodes made from Non-metal electrical conductor materials, a kind of graphite. Electrodes can be used in welding, batteries, medicines, as well as manufacturing for processes involving electrolysis (Tanjung, 2021).

In the case of unidirectional electric current, electrodes came hand in hand and were named as anode and cathode. In a battery, or other DC, anode is interpreted as when the electrons emerge from the electrochemical cell, oxidation occurs. On the opposite, a cathode is interpreted as when electrodes at an electron pass through electrochemistry thus resulting in electrodes when electrons pass through an electrochemical cell resulting in reduction. Each electrode can make an anode or cathode depending on the potential differences given to the electrochemical cell. Bipolar electrodes are electrodes that act as anode of an electrochemical cell and cathode for other electrochemical cells (Sumanzaya *et al.*, 2019).

As a result of electrons flowing from the negative electrodes to the positive electrodes, it impacted the electric current in the voltaic cells. This thing was caused by the differences between the potential ratio and the two electrodes. For example, measuring the potential difference between two electrodes using the potentiometer when the electric charge is flowing until it runs out. As a result, this causes potential differences when the electric current reaches zero, named potential cell. The Potential differences are obsessed with various electrode materials and concentrations as well as electrolyte temperatures. For example, if Daniel cells were measured with a voltage potentiometer at 25°C of temperature when the concentration of Zn^{2+} and Cu^{2+} ions is the same the voltage is 1.10 volt. If the electrodes of Cu^{2+} inside Daniell cells were exchanged with Ag/Ag^{+} electrodes, and the cell potential will be 1.56 volt.

This research method will utilize one pair of Cu/Mg electrodes to measure the current and voltage of 3 path's sewage water, the 3 path's are at inlet, outlet, and main way. Utilizing a series of devices such as LED lights and multimeters to measure the current strength and electrical potential differences. The result of this research is that Cu-Mg electrodes can produce a large current value and electric voltage so that the lights using the Cu-Mg electrode become brighter.

The data obtained in this research conducted 5 repetitions in measurement every 30 minutes with an estimated standard deviation not exceeding the mean. If the standard deviation is greater than the mean, it means the data is more diverse. If the standard deviation is smaller than the mean, it means that the data is less diverse. The standard deviation of the electric voltage is 0.00–0.20 and the standard deviation of the current strength is 0.08–0.16. This is in line with expectations, namely, it does not exceed the mean, which means the data is less diverse, so the data is stable. The voltage and current values vary because of different sewage water paths, there may be differences in each sewage water's content. The voltage and current generated at every 5 cm x 1 cm x 0.1 cm Cu/Mg electrode in sewage water can be explained by the working principle of a galvanic cell. Two different electrodes inserted into the electrolyte will produce electrical energy because of chemical reactions, namely the reduction-oxidation reaction. On the anode, namely the Mg band, the oxidation process occurs, meanwhile, on the cathode, the Cu plate occurs a reduction reaction (**Eq. 1**).

$$
\begin{array}{l}
Mg_{(S)} \rightarrow Mg^{2+}_{(aq)} + 2\,e^{-} \\
Cu^{2+}_{(aq)} + 2\,e^{-} \rightarrow Cu_{(S)} \\
\hline
Mg_{(S)} + Cu^{2+}_{(aq)} \rightarrow Cu_{(S)} + Mg^{2+}_{(aq)}
\end{array}
\quad (1)
$$

The electron moves from the anode to the cathode; this reaction keeps repeating until it produces electrical energy. **Table 1** shows the result of sewage water at the inlet with a Cu plate and Mg band.

Table 1. The experiment of sewage water at the inlet with Cu plate and Mg band.

Time	Voltage (V)	Strong Current (A)
First 30 min	3.80	0.29
Second 30 min	3.80	0.35
Third 30 min	3.80	0.50
Fourth 30 min	3.80	0.35
Fifth 30 min	3.80	0.30

Based on **Table 1**, the voltage of the experiment tends to be constant at 3.80 V. Meanwhile, the highest current occurred at the third 30 min which was 0.50 A. The second highest current occurs at the second 30 min and the fourth 30 min, which is 0.35 A. The third highest current occurs at the fifth 30 minutes, which is 0.30 A. The lowest current occurs at the first 30 minutes, i.e., 0.29 A. In conclusion, the average current of sewage water electricity in the entrance path is 0.36 A. The formula for calculating power is P = V x I so the inlet power is 1.37 watts by multiplying the average voltage by the average current strength.

Table 2 presents results obtained from a second path's sewage water.

Table 2. The experiment of sewage water at the outlet with Cu plate and Mg band.

Time	Voltage (V)	Strong Current (A)
First 30 min	4.00	0.45
Second 30 min	4.40	0.55
Third 30 min	4.40	0.75
Fourth 30 min	4.40	0.55
Fifth 30 min	4.00	0.45

Based on **Table 2**, the voltage of the experiments tends to be constant at 4.00 V and 4.40 V, the average from the first to fifth 30 min is 4.24 V. Meanwhile, the highest current occurred at the third 30 min which was 0.75 A. The second highest current occurs at the second 30 min and the fourth 30 min that was 0.55 A. The lowest current occurs at the first 30 min and the fifth 30 min, which is 0.45 A. In conclusion, the average current of sewage water electricity in the entrance path is 0.55 A. The formula for calculating power is P = V x I so the outlet power is 2.33 watts by multiplying the average voltage by the average current strength.

Table 3 presents results obtained from a third path's sewage water.

Table 3. The experiment of sewage water at the main way with Cu plate and Mg band.

Time	Voltage (V)	Strong Current (A)
First 30 min	4.00	0.20
Second 30 min	4.00	0.45
Third 30 min	4.00	0.55
Fourth 30 min	4.00	0.45
Fifth 30 min	4.00	0.20

Based on Table 3, the voltage of the experiments tends to be constant at 4.00 V. While the highest current occurs at the third 30 min which was 0.55 A. The second highest current occurs at the second 30 min and the fourth 30 min, which was 0.45 A. And the lowest current occurs at the first 30 min and the fifth 30 min, which is 0.20 A. In conclusion, the average current of sewage water electricity in the entrance path is 0.37 A. The formula for calculating power is P = V x I so the outlet power is 1.48 watts by multiplying the average voltage by the average current strength.

Figures 1 and 2 show the graphic of the electrical voltage for the three parts.

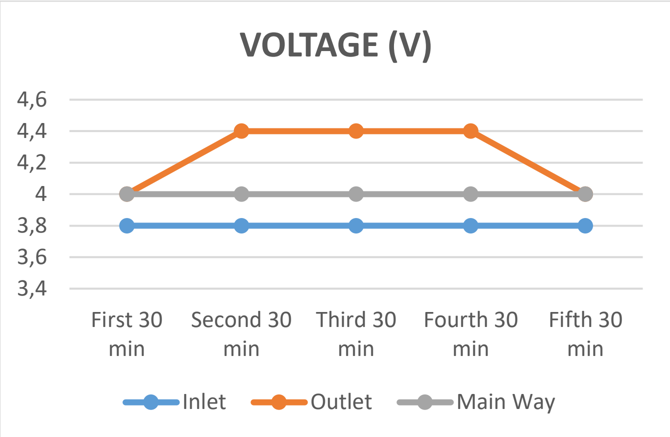

Figure 1. Electrical voltage on the three paths.

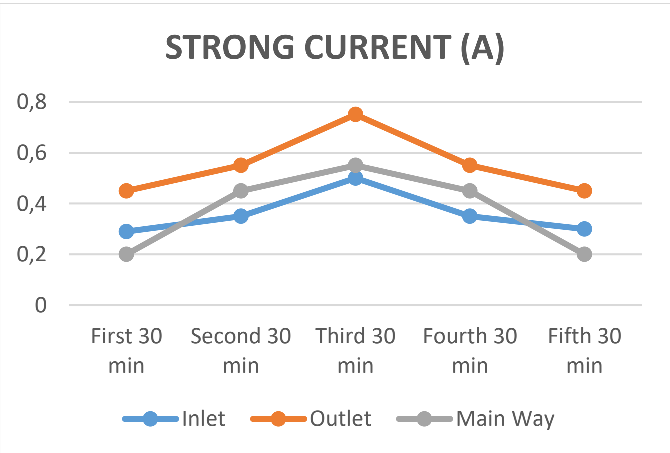

Figure 2. The strong electric current in the three paths.

From the tables and figures, it is evident that every wastewater channel in Perum Pesona Permata Gading has the potential to be a lighting power plant, considering that in Indonesia the average public street lighting lamp has a power of 30 to 60 Watts. Meanwhile, in the research above, for every 5 mL of wastewater, 1.36, 2.33 and 1.48 Watts of power were obtained from the inlet, outlet, and main lines respectively. If the sewer water volume and Cu/Mg area increases the power of the wastewater will also increase and can meet the minimum standards for public street lighting in Indonesia. With the entrance and main path of Perum Pesona Permata Gading is less effective to be the source of electricity in Public Street Lighting. Meanwhile, based on the table above, the exit path of Perum Pesona Permata Gading has high, constant voltage and current strength. So, we can conclude that the sewage water in this path is very effective in water optimization to be used as a source of electrical energy with Cu/Mg electrodes inserted into the wastewater which will later help the ions in the water interact and turn into electrical energy. This is also supported by the conductivity found in wastewater of 10,000. Conductivity is related to the amount of electron flow that is excited due to the content in the wastewater. The exit route of Perum Pesona Permata Gading leads to a river that contains many kinds of household waste so the content in the wastewater is not pure H_2O which causes the voltage and strength of the water flow to be higher and more constant.

Based on the research above, the optimization of sewage water is certainly very influential for electrical performance as an energy source for Public Street Lighting lamps as well as in people's lives. Because the use of this sewage water produces a high, constant voltage and strong electric current so that the lamp can light up brightly. The use of this sewage water as energy source is also included in the use of renewable alternative energy where this energy can be continuously used and will not run out so that it can guarantee the fulfillment of increasing human needs. Furthermore, the increasing demand for electrical energy in Indonesia is currently not balanced with the availability of electrical energy supply. This can also help the government in supplying electrical energy by utilizing wastewater so that it can be more useful, and the use of alternative energy can help the government to store natural resources that are currently in limited availability. This experiment requires further research to realize it in the field with more complex internal and external factors such as the need for greater funds and materials as well as the need for support from residents and local government for the realization of this power plant.

4. Conclusions

Based on the research's data, the experiment proves that the light is better lit on the water exit path of the Perum Pesona Permata Gading sewage than on the other two paths. With the difference of potential of 4.4 V and the current strength of 0.55 A for every 50 mL sewage water of the Perum Pesona Permata Gading. After all that, we can conclude that all 3 paths of Perum Pesona Permata Gading can be used as a source of electricity with the assistance of Cu/Mg electrodes, being able to produce voltage and high current electricity, thus has the potential to be used in Public Street Lighting with brightly lit lights.

Authors' contributions

Conceptualization: Rokhim, D. A.; **Data curation**: Smith, D. N.; **Formal Analysis**: Koto, A. Z. P.; Smith, D. N.; **Funding acquisition**: Rokhim, D. A.; **Investigation**: Smith, D. N.; **Methodology**: Mukhtar, A. R.; **Project administration**: Koto, A. Z. P.; **Resources**: Koto, A. Z. P.; **Software**: Mukhtar, A. R.; **Supervision**: Rokhim, D. A.; **Validation**: Rokhim, D. A.;

Visualization: Mukhtar, A. R.; **Writing – original draft**: Smith, D. N.; **Writing – review & editing**: Rokhim, D. A.

Data availability statement

All data sets were generated or analyzed in the current study.

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