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PEFE (Plant Eco-Friendly Energizer)

Theyshika a/p S.Tamil Maran [1], Sevitaa a/p Ramesh[2], Lyviasree Selvam[3], and Nur Shahira binti Abdul Halim[4]

[1,2] SMK Aminuddin Baki, Malaysia

shikamaran@gmail.com, sevitaaramesh@gmail.com, lyviasree@gmail.com, norishahira@gmail.com

***Abstract*— PEFE also known as Plant Eco-Friendly Energizer is an innovation that combines both a bryophyte microbial fuel cell and an electricity generating system from salt. This is a bio-electrochemical system that mimics our natural surroundings to generate electricity naturally.**

Keywords—Plant, Eco-friendly energizer, Electricity, bryophyte microbial fuel cell

I. INTRODUCTION

PEFE also known as Plant Eco-Friendly Energizer is an innovation that combines a bryophyte microbial fuel cell and an electricity generating system from salt. The problem we face today is the rising temperature of our planet. Evidence show that the extreme climate change is connected to the rising in carbon dioxide and greenhouse gases in our atmosphere which in most cases are caused by human activities. Over the last century the burning of fossil fuels like coal and oil has increased the concentration of atmospheric carbon dioxide (CO_2).

A big portion of electricity around the world uses fossil fuels and nuclear energy. These resources are unrenewable and will run out or not be replenished. We need to develop many new sources of clean, low carbon energy that is cheap and practical. That includes low carbon energy to fight global warming, clean air to stop pollution, cheap and practical energy to replace fossil fuels. We need many options for low carbon energy. Global energy demand is quickly increasing due to global growth in population, economics, wealth, industries, transport, and trade. It is possible that renewable energy will not meet the demand that is needed.

Many scientists and researches around the world are trying to solve this by using biofuel as an alternative to generate energy(electricity). PEFE is a biofuel that harnesses solar energy that can replace fossil fuels to generate electricity. The difference between PEFE and other biofuels is that it combines both a bryophyte microbial fuel cell and an electricity generating system from salt to achieve a more efficient system.

II. MATERIALS

A. Microbial Fuel Cell

In this study, the model moss species *Polytrichum strictum* was used to develop a non-vascular bryophyte microbial fuel cell. This fuel cell consists of a few layers to form a bio-electrochemical system to mimic the natural system found in our surroundings to generate electricity. The first layer is the aluminum foil(cathode) and is followed by zeolite powder(dielectric). Next, a carbon felt(anode) was placed. Then, the moist soil and moss was placed on the topmost layer. Additional materials that were used are copper tape, wire, LED lights and a voltmeter to complete the circuit.

B. Electricity Generating System from Salt

For this system, the materials used are table salt, NaCl, iron nails, A.C power supply, crocodile clips and a light bulb. We found that any soluble salt is good enough to be used in this system. It is essential that the salt used is concentrated in the solution and excess salt is required until the salt can no longer dissolve in water.

III. METHODS

In order to create the microbial fuel cell, a box was made for storing all the components. Small holes were made at the bottom. The height of the box had to be at least 2cm. Next, aluminum foil(cathode) was placed on the bottom of the box as the first layer. The aluminum foil was creeped up the wall of the box using tape so that it would not touch the anode in the future. A wire was taped on the aluminum foil using copper tape to make sure the top side would be conductive. For the second layer, zeolite powder was placed on top of the aluminum foil. 500 grams were used to cover up the 25cm×16cm box. The height if the zeolite volume was about 1cm. For the third layer, a carbon felt(anode) was placed on top of the zeolite powder and ensured that it does not come in contact with the aluminum foil. A wire was placed on top of the carbon felt. Moist soil was gathered and placed on the carbon felt about 0.5cm. Lastly, moss was placed gently on the moisturized soil with some pressure. Both wires from the cathode and the anode are the kept aside to be connected to the salt system.

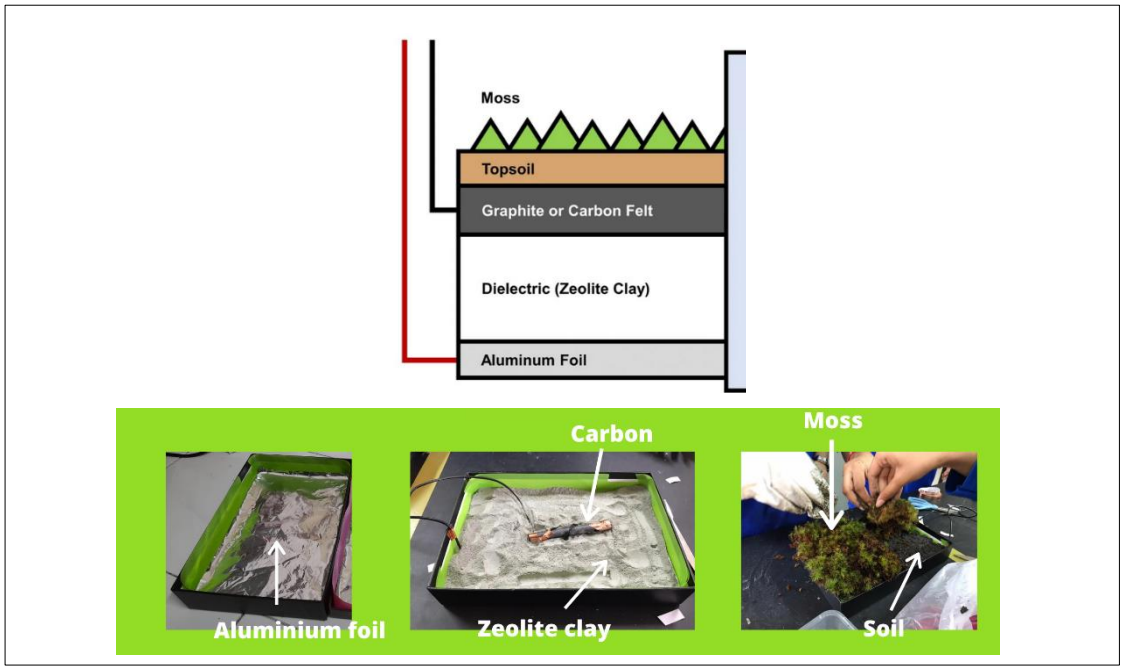

Fig. 1. Plant Eco-Friendly Energizer Setup

As for the electricity generating from salt system, a transparent plastic container was used. The container was filled with ¾ distilled water. Copper tape was used to coil the wire and the iron nail together and placed on one end of the container. This was repeated with another iron nail and it was placed at the opposite end of the container. One wire was connected to the A.C supply and the other wire was connected to the microbial fuel cell.

The other wire form microbial fuel cell is connected to a light bulb and the light bulb is connected to the A.C supply to complete the circuit. In simple words, the microbial fuel cell and the electricity generating from salt system were combined to complete the circuit. Fig. 1 shows the full setup for this project.

A. Process of generating electricity from microbial fuel cell

In this microbial fuel cell, a bryophyte was used. Bryophytes are poikilohydric plants with a greater tolerance to dehydration than vascular plants. Bryophytes have a unique physiology enabling them to accumulate water and nutrients, and survive in a wide range of temperatures and habitats. They have root hair-like rhizoids that bind the surface on which they grow, stabilizing the soil and preventing loss of nutrients by erosion.

In the microbial fuel cell, the moss carries out photosynthesis. In the photosynthesis reaction, electrons are released. This can be proven in the following processes:

Photosynthesis occurs in 2 stages which are the light-dependent reaction (happens in thylakoids) and light-independent reaction (happens in stroma). In light-dependent reaction, the photosynthetic pigment on the surface of thylakoid absorbs light energy. The light energy excites the electrons in chlorophyll pigment to a higher level. The excited electron from chlorophyll goes through a series of electron carriers until it reaches and is accepted by NADP+. Next, photolysis of water happens and H_2O molecule is broken down in the presence of light energy and chlorophyll to form hydroxide ion (OH^-) and hydrogen ion (H^+). The OH^- ion loses electron to form O_2 and H_2O.

$$4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$$

The electron released in this reaction is one of the many reactions in photosynthesis that releases electrons. These electrons can be used to generate electricity. The electrons will move to the carbon felt (anode) and flow thro

B. Process of generating electricity from electricity generating salt system

Water is a polar solvent containing partial negative charge at the oxygen atom and partial positive charge at the hydrogen atom. When salt is added into the water, the positive ion, Na^+ will be attracted to the oxygen atom of water which is negatively-charged while the negative ion, Cl^- will be attracted to hydrogen atom of water which is positively-charged. Attraction force between atom of water molecules with the ions of ionic compound are strong enough to overcome electrostatic attraction force between ions themselves. Thus, it breaks down the lattice structure of the solid compound. As a result, the ions can move freely in water. This enables the salt to conduct electricity and eventually lights up the bulb.

C. Combination of both systems

The microbial fuel cell and the electricity generating from salt system are combined though a complete circuit to form a more efficient energy producing system.

IV. RESULTS AND FINDINGS

A. Microbial fuel cell

Before combining the microbial fuel cell with the salt system, it is found that the microbial fuel cell alone produces 0.6V and is able to light up 2 LED lights. A mentol was managed to be brightly lit.

B. Electricity generating from salt system

Before combining the salt system with the microbial fuel cell, it is found that the salt system alone was able to brightly light up a mentol of 2 volts. The more the salt is added into water, the brighter the bulb lights up. Bare in mind that the electricity can't be generated without the supply of Alternating Current.

C. Combination of both systems

With both the microbial fuel cell and the salt system combined, the brightness of the mentol was higher. This proves that with both systems, a sufficient amount of electricity can be produced.

V. CONCLUSIONS

PEFE which is a combination of microbial fuel cell and electricity generating salt system is a developed technology that can help solve many pressing environmental issues such as climate change by replacing fossil fuels with biofuels instead. In a larger scale, PEFE can aid the country's economy and provide a more sustainable environment. The goal of PEFE is to stop the usage of fossil fuels as they release greenhouse gases and replace it with a more environmentally friendly system. PEFE can generate electricity naturally and can make a huge impact if it is used in a larger scale. This technology can be further improved into a smaller device which can then be used to generate electricity on-the-go without ever harming the environment.

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