

学 位 論 文 内 容 の 要 旨

| | |
|--------|--|
| 学位論文題目 | A STUDY ON BIOELECTRICITY GENERATION IN MICROBIAL FUEL CELL BY USING ORGANIC WASTE (有機廃棄物を用いた微生物燃料電池によるバイオ発電に関する研究) |
| 氏 名 | Tun Ahmad Gazali |

Today, people around the world face some problems especially world's energy crisis problems. Moreover, we need green energy for the future generation as well as a need the safe source of energy. In another hand, in many countries in the world, the organic waste is not recycled properly. So we need a technology that can generate a bioelectricity from waste materials without destroying the crops and the design is a sustainable source of bio-electricity by using unwanted materials.

Microbial fuel cells (MFCs) are bio-electrochemical transducers that convert microbial reducing power, into electrical energy. Depletion of energy reserves, global warming and the concern of environmental pollution are inspiring the search for new environment-friendly and sustainable energy production methods all over the world. Both in developing countries and the industrialized countries people are trying to find a way how to collect energy from various renewable sources. So far, MFC technology can be used for this purpose.

This research is to design a MFC system to generate bio-electricity from different organic waste and to design an integrated hybrid system for multisource of resource recovery from the organic waste. Resource recovery and reuse of the organic waste is a much-needed task for the world. So, it will be the challenge of this research to develop a new system for resource recovery from the organic waste which will be more sustainable. For next development planning, to use the by-products of the electricity generation as bioremediation purposes.

Some laboratory and field experiments shows various achievements especially bioelectricity production which is good to consider that some variety of organic wastes contains large amounts of nutrients and various other minerals, it can have improved to be more valuable as a MFC to generates green and safe electricity moreover as an efficient, eco-friendly solution for organic waste management. This is a useful method of green and safe energy. Therefore, bioelectricity can be produced using mixed samples of organic waste and soil.

学位論文審査の結果及び最終試験の結果報告書

(博士後期課程博士用)

山口大学大学院理工学研究科

| | | | |
|---|---|----|------------------|
| 報告番号 | 理工博甲 第 738 号 | 氏名 | Tun Ahmad Gazali |
| 最終試験担当者 | 主査 Md. Azizul Moqsud 審査委員 Yukio Nakata 審査委員 Motoyuki Suzuki 審査委員 Hiroyuki Sakakibara 審査委員 Norimasa Yoshimoto | | |
| 【論文題目】 | | | |
| A study on bioelectricity generation in microbial fuel cell by using organic waste (有機廃棄物を用いた微生物燃料電池によるバイオ発電に関する研究) | | | |
| 【論文審査の結果及び最終試験の結果】 | | | |
| <p>Microbial fuel cells (MFCs) are bio-electrochemical transducers that convert microbial reducing power, into electrical energy. Depletion of energy reserves, global warming and the concern of environmental pollution are inspiring the search for new environment-friendly and sustainable energy production methods all over the world. Both in developing countries and the industrialized countries people are trying to find a way how to collect energy from various renewable sources. So far, MFC technology can be used for this purpose. In this study it was aiming to design a MFC system to generate bio-electricity from different organic waste mixing with soil. Some laboratory and field experiments shows variation of voltage generation with time. The scale up experiments showed that electricity generation increased with the increasing of size and volume of the waste. Weather factors did not affect much however, solar radiation showed effects to the plant microbial fuel cell.</p> <p>Firstly, the use of organic waste such as cow dung, chicken droppings and leaf mold in MFC research was carried out. These types of waste are causing serious environmental problems in different parts of the world. If this waste can be used as a resource recovery material in MFC then it will be very useful for the people and the environment at the same time.</p> <p>The persimmon fruit production in Japan is relatively abundant and causes a waste disposal problem. So, again if we can use the persimmon fruit waste in MFC then it will again cause an environmental benefit. The results showed that all MFCs successfully generated electricity with the maximum values of $12720 \pm 114.31 \text{ mV/m}^2$, $9830 \pm 81.79 \text{ mV/m}^2$ and $1650 \pm 65.32 \text{ mV/m}^2$ for MFCs containing persimmon waste and soils, leaf mold and rice bran respectively.</p> <p>The MFC can be applied to generate bioelectricity in the real field. So, the environmental factors those affect the power generation is very important. The effect of the electrode materials in power generation in MFC was measured during the test. Carbon fiber, carbon felt were good electrode materials for MFC. The scanning electron microscope (SEM) pictures showed that carbon felt and waste materials interacted very well and hence increase the bioelectricity generation.</p> <p>Plant microbial fuel cell (PMFC) is another application of MFC research by using living plants. The mechanisms of plant MFC involves the photosynthesis in the green leaves and produce carbohydrate in the green leaves. The extra amount of carbohydrate disposes naturally in the root zone. The geobacteria living in soil biodegrade the carbohydrate and releases electron. The MFC catches</p> | | | |

these electrons and generate electricity. In this research 4 different types of water plants were used. It was found that the 4 of the water plants were generated the bioelectricity. The effect of solar radiation, temperature, humidity, precipitation was checked. It was found that in plant MFC the solar radiation has significant effect to voltage generation which was not found in MFC with organic waste. It was observed that when the solar radiation was higher, the voltage generation was also higher. The other environmental factors did not have significant effects on voltage generation. It was interesting finding that the marine plants with marine soil showed better performance in terms of bioelectricity generation. The electrical conductivity of saline soil had effect to the electron transfer and consequently generates more electricity.

During the public defense, there are many questions and comments came from the audience. Some of the questions and comments are related to soil used in the current research. Such as whether the soil has been pre-treated or not and Mr. Tun answered that he used soil in his research to increase the amount of waste volume in MFC. As the 2nd generation biofuel was not successful due to the lack of amount of waste so it will be good try to increase the amount of waste by using soil. Another reason for mixing the soil is that it will increase the amount of microorganisms in MFC. Another question was related to the microorganisms used in the MFC research. It was answered that the anaerobic bacteria are more effective for bioelectricity generation in MFC. Specially, the geobacteria such as *Shewanella* are widely found in the soil and waste to work as some electro-genesis bacteria in MFC to generate bioelectricity. It was asked that why did he use persimmon fruit waste in his research. Due to the abundant production of persimmon fruit waste in Japan and other east Asian countries, the waste from the persimmon fruit can be recycled and get energy which is green and safe. The candidate responded to all question appropriately with his expert knowledge. By considering this the committee has decided that Mr. Tun has passed the examination.

The originality of this research was to generate bioelectricity through different organic waste. Specially persimmon fruit waste mixing with soil was first time to use as bioelectricity generation system. The relation between the power generation and size of the MFC was another good finding for the practical application of MFC in real world. To find out the relation between weather factors and power generation is another good originality of this research that will help to use MFC in practical field. To find out the best electrode materials in MFC by using organic waste is another novelty of this research.

The importance of this research is very much for the utility point of view. The two major things are related to get bioelectricity from organic waste and to recycle the organic waste. The reliability of this research is important as a practical point of view. This research can solve the two major problems which are very much serious problem in developing countries. The current research focused on to solve energy problems and to resource recovery from organic waste. It completes the major objective of the research. The completeness of this research is that it can be used for practical use as it covered all the related factors of this research.

By considering the above things the committee has decided that Mr. Tun Ahmad Gazali is eligible to get the Ph.D.

【主な関連論文】

1. M. Azizul Moqsud , Tun Ahmad Gazali, Kiyoshi Omine , and Yukio Nakata . Green electricity by water plants in organic soil and marine sediment through microbial fuel cell. *Energy source: Part A : Recovery, Utilization, and Environmental Effects*. Vol. 39 (2): 160-165, 2017.
2. Tun Ahmad Gazali, M. Azizul Moqsud. The effectiveness of animal dungs and leafmold for bioelectricity generation using microbial fuel cell with soils. *Journal of Sustainable Bioenergy Systems*. Vol. 7 (4): 165-181, 2017.