THE NATIONAL INSTITUTE OF ENGINEERING

(Autonomous Institute under VTU, Belagavi)
Mysuru – 570 008

Seminar Report on

BIO-BATTERY

Submitted in partial fulfillment of the requirement
for the award of degree of Bachelor of Engineering
in

Electrical & Electronics Engineering

Prepared by:
Priyanka K M
(4NI19EE077)
VII Semester

Under the Guidance of:

Mrs. SONAXI BHAGAWAN RAIKAR
Assistant Professor

Department of Electrical & Electronics Engineering
The National Institute of Engineering
(Autonomous Institute under VTU, Belagavi)
Mysuru – 570 008

2022-23

Assessment Sheet

Seminar title: BIO-BATTERY

Date of Presentation:12/1/23

Name of the student with USN Signature of the student

Name of the Course Instructor:

Comments of the Course Instructor:

Signature of Course Instructor

DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

THE NATIONAL INSTITUTE OF ENGINEERING
(An Autonomous Institute under VTU, Belagavi
Recognised by AICTE, New Delhi, Grant-in-Aid by Government of Karnataka,
Accredited by NAAC, New Delhi)
Manandavadi Road, Mysuru- 570 008.
Phone: 0821-2480475, 2481220, 4004900 Fax: 0821-2485802, E-mail: principal@nie.ac.in
Website: www.nie.ac.in

CERTIFICATE

Certified that this seminar report entitled ***"BIO-BATTERY"*** *is a bonafide work carried out by* ***Ms. PRIYANKA K M(4NI19EE077),*** *under the guidance of* ***Ms. SONAXI BHAGAWAN RAIKAR,*** *in partial fulfilment for the award of the degree of Bachelor of Engineering Electrical and Electronics Engineering at The National Institute of Engineering (Autonomous Institute under VTU) during the academic year 2020-2021.*

Mrs. Sonaxi Bhagawan Raikar
Assistant Professor,
Department of E &EE
The National Institute of
Engineering Mysuru

Dr. H Pradeepa
HoD, Department of E &EE
The National Institute of
Engineering Mysuru

Principal
The National Institute of
Engineering Mysuru

Name of the examiners	**Signature with date**
1.	
2.	

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to Mrs. Sonaxi Bhagawan Raikar for providing invaluable guidance, comments, and suggestions throughout the course of the seminar. I would also like to express my profound thanks to all those who have indirectly guided and helped me in the preparation of this seminar.

I also express my heartfelt gratitude to our Head of the department, Dr. Pradeepa H for providing me with all the facilities and permission to do this Seminar.

I consider myself privileged to have studied in esteemed institution, THE NATIONAL INSTITUTE OF ENGINEERING, Mysuru. Lastly, I would like to thank all the faculty and staff members of the Department of electrical and electronics Engineering, Mysuru. I would also like to thank my parents for their moral support and encouragement.

ABSTRACT

Electricity is considered as an integral utility in today's world. One of the portable and convenient sources of electrical energy is a Battery. A bio battery or a bio fuel cell is an energy storing device that is powered by organic compounds, especially glucose. It generates electricity from renewable fuels providing a sustained, on-demand portable power sources. By using enzymes to break sown organic compounds, bio-batteries directly receive energy from them. Bio-batteries are alternative energy devices based on bio-electro catalysis or natural substrates by enzymes or microorganisms. This seminar brings out an alternative solution to the conventional batteries which is not only a boon to the environment by being eco-friendly but also it is an end to worries about non-renewable and vanishing sources of energy; gives a through insight on this relatively revolutionizing and satisfying solution of energy storage through bio-batteries and provides an in-depth analysis of the same. Bio-batteries have potential adaptability to power the next generation of electronics, medical devices and hybrid vehicles, allowing for radical new designs and medical technologies. It is aimed at understanding and analyzing the properties and characteristics of Bio-Batteries and I have studied about its advantages, potential applications, and disadvantages.

This Seminar report explains about how to use the available resources such as waste vegetables, almonds and other vegetables such as onion, turnip, Raddish,etc.,to produce energy. We can utilize these energy sources to produce energy which is of high energy density and which is renewable and eco-friendly. Through this high energy density bio-battery we can produce applications which have long lasting battery life . These bio-batteries founds its various applications in Pacemakers, Insulin pumps, remote sensing devices and also in recent searches they have been used in textile industries ,for example, Scalable yarn based bio-batteries have also been developed. This Bio-batteries application fields are quite interesting and yet to be discovered. In order to utilize these environment friendly and renewable resources bio-battery should be used more and more in future.

CONTENTS

List of Figures

1.INTRODUCTION

1.1 Battery:

Battery is most important component in electric vehicles and also for various energy storage applications. The battery is a device which converts chemical energy into electrical energy by electrochemical redox reactions. An electric vehicle battery is a rechargeable battery used to power the electric motors of a battery electric vehicle or hybrid electric vehicle.

1.2 Bio-Battery:

A bio-battery is an energy storing device that is powered by organic compounds. Bio-Battery generates electricity from renewable fuels (glucose, sucrose, fructose, etc) providing a sustained, on-demand portable power source. As we know battery is a device that directly converts chemical energy to electrical energy. Bio batteries are energy-conversion devices based on bio-electrocatalysis leveraging on enzymes or micro-organism. A bio-battery is a device where substrate material that may be either organic or inorganic, is converted to electrical form of energy. This conversion takes place with the help of different biological or biochemical agents, such as micro-organisms or enzymes. In the last decade the major fundamental problems of coupling between the biochemical and electrochemical processes, mostly related to the efficient interfacial charge transport using mediated or direct electron transfer between enzymes/ microbial cells and electrodes, were solved and the biofuel cells became feasible. Practical application of biofuel cells is still awaiting for solutions of most of these engineering problems require biochemical, microbiological or, in general, biotechnological approaches . One of the important potential applications of the biofuel cells is powering implantable biomedical devices. Miniaturized biofuel cells might be implanted in a human body to use naturally existing biochemical substances as fuel (e.g., glucose in a blood stream).Adaptive behavior of the implantable biofuel cell being self-regulated and producing electrical power on-demand would be an immense advantage for these bioelectronics devices. Such devices could be based on modified electrodes with switchable/ tunable activity.

1.3 LITERATURE SURVEY

Sl.No	Title of Paper	Author name and year of Publication	Summary
[1]	Construction of rechargeable bio-battery cells from electroactive antioxidants extracted from wasted vegetables.	Hussain, Z., G. Rukh, A. Zada, M. Y. Naz, K. M. Khan, S. Shukrullah, and S. A. Sulaiman(2021)	✓ The juices of common and low-cost vegetables were successfully used for the preparation of bio-batteries. ✓ The results were based on an open circuit voltage of the batteries. ✓ It was observed that the voltage and shelf-life of bio-batteries can be improved by cooking and optimizing pH of the juice. ✓ The onion-radish battery produced the highest power among all combinations.
[2]	A scalable yarn-based biobattery for biochemical energy harvesting in smart textiles.	Gao, Yang, Jong Hyun Cho, Jihyun Ryu, and Seokheun Choi(2020)	In summary, authors have created a flexible and readily scalable yarn-based biobattery that harvests electricity from microbes. The single cells generated maximum power and current densities of 22.12 W m-3 and 315.45 A m-3, respectively. The intrinsic structural flexibility and strength of yarn also make the biobattery suitable for smart textile integration**.**
[3]	Characterization of bio-battery from tropical almond paste	Togibasa, O., E. Haryati, K. Dahlan, Y. Ansanay, T. Siregar, and M. N. Liling. (2019)	✓ A prototype of bio-battery device from tropical almond paste was been developed ✓ The characterization of the device yielded an average open cell voltage of 0.98 ± 0.09 V and power of 0.25 mW. ✓ The daily power curve trend indicated that a presence of glucose may be responsible

			for the current production. Series and parallel combinations should be developed in the future to achieve higher circuit voltage and power values.
[4]	Review paper on bio-batteries : Powering the next generation of energy.	Sapkota, Ranjan & Sarhaddi, Swarn. (2018).	✓ The author has proved bio-battery as a eco-friendly , non-explosive, non-toxic and more efficient source of energy. ✓ And the author has also discussed regarding the future scope of this biobattery.
[5]	Electrical Analysis of Combination of Orange Peel and Tamarind for Bio-battery Application as an Alternative Energy	Aghisna Nuthfah Anshar, Aldi Maulana, Siti Nurazizah, Zalfa Nurjihan, Sri Anggraeni , Asep Bayu Dani , Nandiyanto(2021)	✓ The purpose of this study is to know the influence of good electricity on variations of the combination of orange peel and tamarind. ✓ The method used in this study is by experimenting with a mixture of sweet orange peel and tamarind made into pasta and put in a used battery. ✓ The results showed that biobatteries with a variation of 25% orange to tamarind had the highest voltage and the most powerful electric current
[6]	The Effect of Comparison of Soybeans and Coconut Water on Bio-Battery Electrical Power for Education	V. Valensia ,Fitriani Halimatus Sadiyyah ,Miussa Rio Hibatulloh , Dwi Putra Setiadi , Asep Bayu Dani Nandiyanto ,Sri Anggraeni , Tedi Kurniawan(2021)	The novelty of this study is: ✓ Use of soybean biomass with coconut water as an electrolyte paste , Testing of bio-battery resistance to wall clocks. ✓ Comparison of the composition of the two materials. In this study, an electrolyte paste made from soybeans (SBs) and coconut water (CWs) with different ratios. ✓ The experimental results show that the composition of coconut water increases the value of the electric voltage on the bio-battery.

1.4 Need For Bio-Batteries:

- ✓ Better energy density: Battery energy density is crucial because the higher the energy density, the longer the battery can emit a charge in relation to its size.

  a] Energy density of Li-ion batteries: 225Wh/Kg

  b] Energy density of Bio-Batteries: 596 Ah/Kg

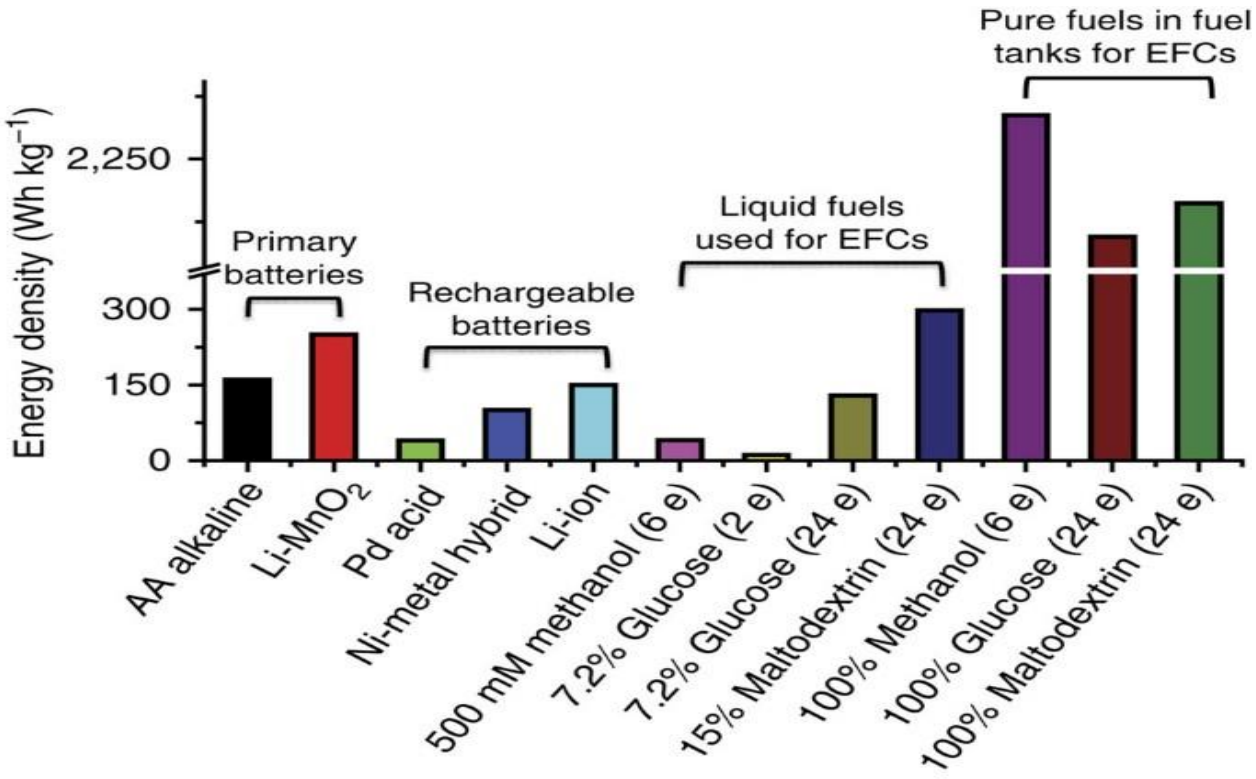

Fig 1. Comparison of energy density for different type of batteries

- ✓ Instant recharge: with the help of bio-battery we can recharge the device within a fraction of minutes.

  a] The time for charging in normal battery is 2.2 hours for 24 V strength charger.

  b] The time for charging in biobattery is 10mins for 24 V strength charger!.

- ✓ It may lead to an alternative solution of oil and other energy sources.

- ✓ Bio-batteries don’t require external power supply due to the constant supply of glucose or sugar.
- ✓ Eco-friendly: These Bio-Batteries are environmental friendly as it will not lead to explosions like chemical batteries.
- ✓ It will not contribute to increase in CO2.
- ✓ Renewable biocatalyst and Continuous Source of Energy: It converts Oxygen to Carbon dioxide and that in turn will gets converted to Oxygen again thus it will lead to Continuous exchange of energy.
- ✓ Room temperature operation: Bio-batteries can be operated at room temperature
- ✓ Readily available fuel: It can be made using readily available fuel.
- ✓ Biobatteries are very secure to use due to no leakage and explosions like chemical batteries.

2.WORKING OF BIO-BATTERIES

Bio-batteries directly receive energy from glucose. These batteries then store energy for later use. The concept is same as how plants and animals obtain energy. Bio-battery use biocatalyst, either biomolecules like enzymes or even whole living organism. Bio-batteries operated by organic compounds mostly by glucose.

The working of the Bio battery is shown in Fig 2. This system uses the flow of electrons as well as protons for generating electricity. The proton movement can be occurred due to the moving force which is known as current. The electrons flow can be from anode to cathode whereas current flow can be from cathode to anode.

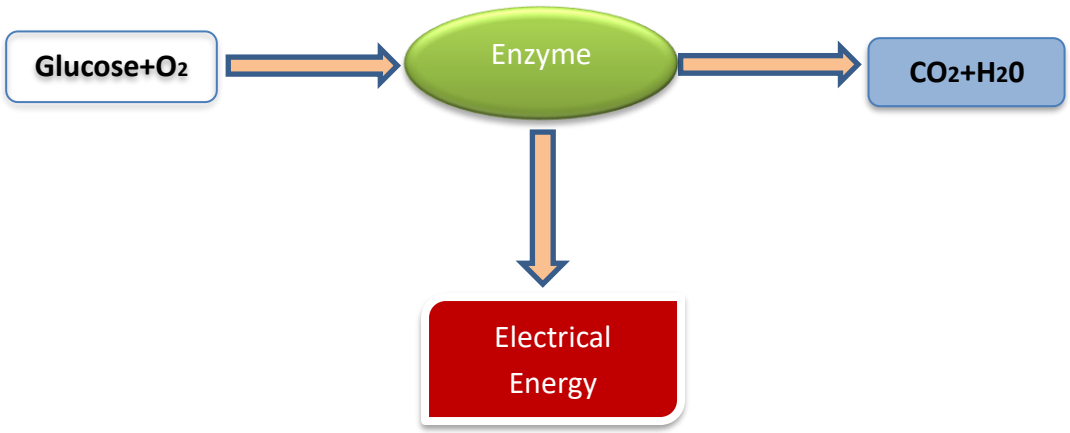

Fig 2. Bio-Battery Working

Glucose in the presence of Oxygen with the help of enzymes converts it into the Carbon dioxide and water molecule and also it releases Electrical Energy. This working mechanism of Bio-Battery is shown in Fig 1.The Byproducts Carbon dioxide and water molecule are ecofriendly. This Carbon dioxide can be reutilized or recycled with the help of plants and this enzyme on this reaction produces electrical energy.

2.1 Construction of Bio-Battery:

This working can also be explained with the help of this diagram as Shown in Fig.3,

The bio-battery construction can be done by using four components such as anode, cathode, electrolyte, and separator.

All these four components are coated on each other so they stack up jointly. Similar to other batteries, in these batteries, the anode is negatively charged as well as the cathode is charged positively. The main difference between the anode & cathode permits the flow of electrons inside and away from them. In bio- battery construction, the anode terminal is placed at the top of the battery whereas the cathode terminal is placed at the bottom of the battery. In between these two terminals electrolyte is placed which includes a separator.

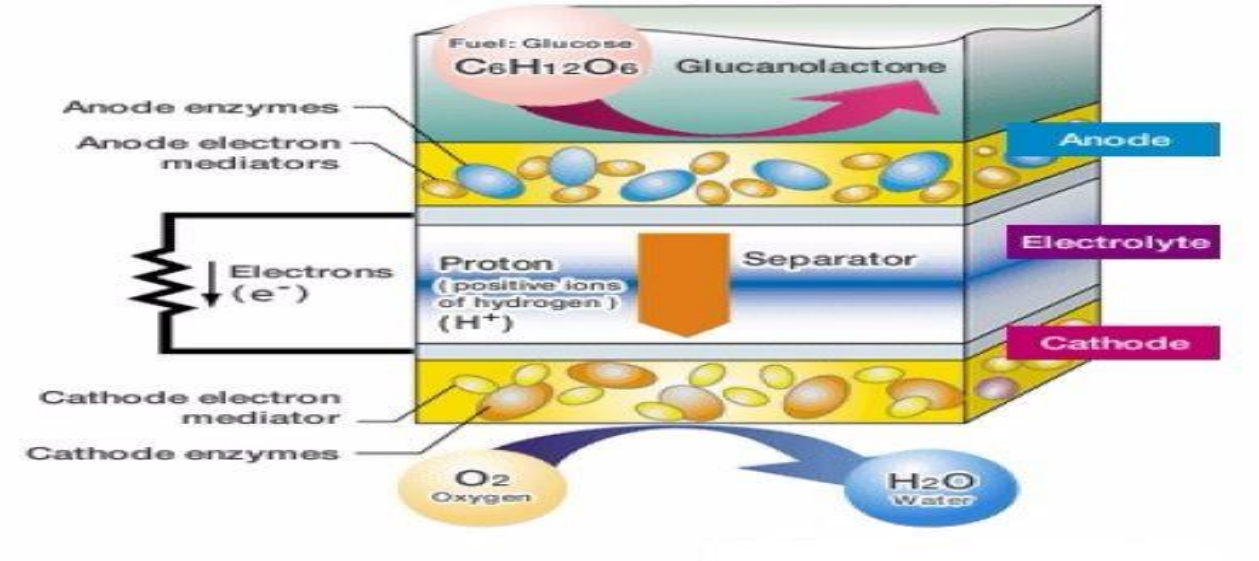

Fig 3. Bio-Battery Construction

Here, separator plays a key role by separating the anode and the cathode terminals from one another which can be lead to avoid the short circuit otherwise the entire battery will damage. In this system, the electricity will be generated by the flow of electrons as well as protons. Because the main energy source of Bio-battery is glucose so it requires plenty of glucose for generating the electricityIn the bio-battery, the breakdown of glucose can be done on the same rule while it is broken down into small pieces in the body of humans.

The bio-battery working operation is discussed below:

- In the Fig2., glucose is used at the anode side whereas enzyme is used at the cathode side
- Glucose gets broken down into electrons and protons
- The flow of protons can be travel to cathode side via a separator and the flow electrons can be travel to cathode side via a mediator.
- Enzymes are utilized at cathode side which generates water by both protons as well as electrons traveled from the anode side. Here, the reaction of Oxygen reduction is being used here.
- Above reactions will generate electrons as well as protons in the system. Finally, electric energy will be generated.

2.2 Types of Bio-Batteries:

Biobatteries are classified into several types like Enzymatic Bio-Battery, Microbial Bio-Battery, body fluid based bio-batteries, cellulose-based bio-batteries, etc. But Enzymatic Bio-Battery, Microbial Bio-Battery are the commonly used batteries.

1. Enzymatic Bio-Battery.
2. Microbial Bio-Battery.
3. Liquid body substance based Bio-Battery.
4. Cellulose based Bio-Battery.

1.Enzymatic Bio-Battery: In this type of battery, biochemical agents (Enzymes) are utilized for a breakdown of a substrate.

2.Microbial Bio-Battery: In this type of battery, Microorganisms such as Escherichia coli, electric bacteria, are utilized for a breakdown of a substrate.

3. Liquid body substance based Bio-Battery: In this type of battery, Liquid based substances are utilized for a breakdown of a substrate.

4. Cellulose based Bio-Battery: In this type of battery, Cellulose is utilized for a breakdown of a substrate.

2.3 Applications of Bio-Batteries.

Bio-batteries are used in medical implants like pacemakers, insulin pumps, etc. It can be used as a charger for electronic devices like cell phones, tabs, power banks, etc. Bio-batteries are used in the defense field in the remote sensing devices, spying devices, as well as surveillance. This is as shown by Fig 4.

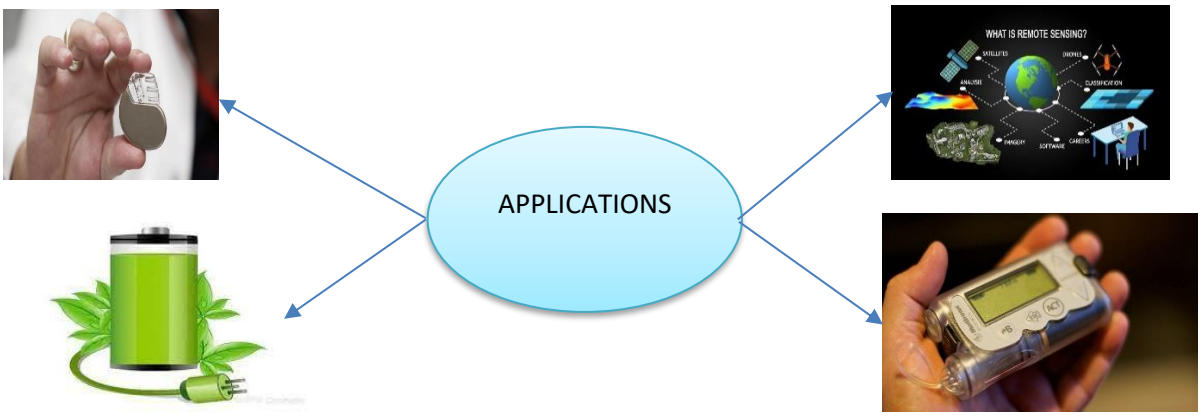

Fig 4. Applications of Bio-Batteries

2.4 Current applications of Bio-Battery

- In Orissa and Chhattisgarh, states of India water vapor fuelled brine-silk cocoon protein bio-battery for a self-lighting kettle and water-vapor panels have been developed.
- A scalable yarn-based biobattery for biochemical energy harvesting in smart textiles have been developed.
- Current researches are going on to use coffee ground for potential development of electronic devices.
- A Biobattery Capsule for Ingestible Electronics in the Small Intestine are being used for Diagnostic and Therapeutic applications.

2.5 Challenges Faced By Bio-Battery

- They are less likely to retain most of their energy compare to conventional batteries e.g. lithium based.
- They are not suitable for long term usage and storage.

2.6 Difference between Conventional and Bio-Batteries

Conventional Battery	**Bio-Battery**
1.Energy density is less (70 Ah/kg)	1.**Energy density is more (596 Ah/kg)**
2.Not Eco-friendly.	**2.Eco-friendly.**
3. It requires more time to recharge.	**3. Can be recharged instantly.**
4. It contribute to increase in CO2	**4. It doesn't contribute to increase in CO2**
5. Non-Renewable source of energy.	**5.Renewable source of energy.**
6. There are chances of explosion in high temperature regions.	**6. This can be operated in any weather conditions.**

3.CONCLUSION

The Bio batteries are high performing, stable, and reproducible enzymatic fuel cell technology developed over last decade. While many exciting announcements have been made in the field of bio-batteries, it may be some time before we see them replacing nickel-cadmium, lithium-ion or the several other types of traditional batteries. This report explains the bio batteries as a eco-friendly source of energy, non-explosive battery, non-toxic source of energy and more efficient source of energy, Even so, the small, flexible, long-lasting and environmentally friendly battery shows the great possibilities. The bio-batteries are environmentally friendly as they do not use harmful chemicals or metals. With that in mind, scientists seem to be exploring every possible option in bio-battery and fuel-cell technology.

This report has explained the working principle of Bio-Battery and also regarding the types of Biobattery and various other applications of Bio-Battery and how to use the waste vegetables, vegetables, almond etc., to create a efficient bio-batteries by Literature Survey.

3.1 FUTURE SCOPE

Fully-integrated Bio-Battery charging prototypes are already developed. While many technological challenges may still remain, Bio Batteries have great potential as a next generation energy storing device. Since there is glucose in human blood, some research facilities are also looking towards the medical benefits of bio-batteries and their possible functions in human bodies. Although this has yet to be further tested, research continues on the subject surrounding both the material/device and medical usage of bio-batteries. Bio-batteries have a very bright future ahead of them as test productions and research have been increasing over recent years. They serve as a new form of energy that is proving to be environmentally friendly, as well as successful, in producing and reserving energy. Fully integrated demonstrations are to be executed in close collaboration with customer, for relevant applications.

The future of a bio battery is a very bright as a lot of research is being conducted on it. They are a new source of energy that is being considered environmentally friendly. In addition to being environmentally friendly they are also a good reliable news source of energy. Sony is one of the corporation that is constantly working on the bio batteries the corporation is extending many million dollars on the research of this type of battery. The company has also been able to make a bio battery that gives an output power of 50 MW. This power is enough to run one MP3 player. However, Sony is conducting more research on this type of battery and one day these batteries will definitely lead the market.

3.2 REFERENCES

[1] Hussain, Z., G. Rukh, A. Zada, M. Y. Naz, K. M. Khan, S. Shukrullah, and S. A. Sulaiman. , "Construction of rechargeable bio-battery cells from electroactive antioxidants extracted from wasted vegetables.," *Cleaner Engineering and Technology,* vol. 5, no. 100342, 2021.

[2] Gao, Yang, Jong Hyun Cho, Jihyun Ryu, and Seokheun Choi. , "A scalable yarn-based biobattery for biochemical energy harvesting in smart textiles.," *Nano Energy,* vol. 74, no. 104897, 2020.

[3] Togibasa, O., E. Haryati, K. Dahlan, Y. Ansanay, T. Siregar, and M. N. Liling. , "Characterization of bio-battery from tropical almond paste," *Journal of Physics: Conference Series,* vol. 1204, 2019.

[4] Sapkota, Ranjan & Sarhaddi, Swarn. , "REVIEW PAPER ON BIO BATTERIES: POWERING THE NEXT GENERATION OF ENERGY," *International Journal of Higher Education and Research,* vol. 8, pp. 132-140, 2018.

[5] Aghisna Nuthfah Anshar, Aldi Maulana, Siti Nurazizah, Zalfa Nurjihan, Sri Anggraeni , Asep Bayu Dani , Nandiyanto, "Electrical Analysis of Combination of Orange Peel and Tamarind for Bio-battery Application as an Alternative Energy," *Indonesian Journal of Multidisciplinary Research,* pp. 125-128, 2021.

[6] V. Valensia ,Fitriani Halimatus Sadiyyah ,Miussa Rio Hibatulloh , Dwi Putra Setiadi , Asep Bayu Dani Nandiyanto ,Sri Anggraeni , Tedi Kurniawan, "The Effect of Comparison of Soybeans and Coconut Water on Bio-Battery Electrical Power for Education," *Indonesian Journal of Multidisciplinary Research,* pp. 49-54, 2021.