PERFORMANCE EVALUATION OF GREEN SYNTHESIZED NANOCOMPOSITE ENHANCED ELECTRODES IN MICROBIAL FUEL CELL FOR GENERATING EFFICIENT ELECTRICITY

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Keywords:

Microbial Fuel Cell (MFC), Salt Bridge, Microbial Activity, Ion exchange, Waste water treatment.

Introduction:

In an era marked by growing environmental concerns and increasing demand for sustainable energy sources, microbial fuel cell (MFC) have emerged as a promising innovation at the intersection of biotechnology and renewable energy. These ingenious devices harness the power of microorganisms to convert organic matter directly into electricity, offering a tantalizing solution to our dual challenge of waste management and clean energy production. Microbial fuel cell (MFC) is a type of bio electrochemical fuel cell system that generates electric current by diverting electrons produced from the microbial oxidation of reduced compounds on the anode to oxidized compounds such as oxygen on the cathode through an external circuit.

MFCs require sustained electron release in the anode and electron consumption in the cathode. The attainable metabolic energy gain for bacteria is directly related to the difference between the anode potential and the substrate redox potential extensive studies have confirmed new insights into MFC, which show that a wide array of carbon sources including wastes can be employed using a variety of microbes. Consequently, microbial transformation of wastes using novel bioremediation strategies such as MFC for energy generation is considered as an efficient and environmentally benign approach. Microorganisms' metabolic processes can be used by devices called microbial fuel cells (MFCs) to generate electricity. They are essential for bioremediation, renewable energy, and wastewater treatment. In the process of consuming organic matter, MFCs produce electricity. They can speed up the removal of pollutants from contaminated environments, are suited for independent 2 or remote areas, and are environmentally beneficial. MFCs provide an adaptable and sustainable answer to a range of problems. Microbial fuel cells (MFCs) are a cutting-edge technique for treating water that can be used to both treat wastewater and produce energy. Utilizing the metabolic processes of microorganisms, they clean water and generate electricity as a byproduct, showcasing a significant advance in sustainable technology. Because MFCs use less energy, they have a smaller environmental impact and lower operating expenses. They are a potential substitute for traditional techniques since they can function in a variety of environments.

Objectives:

Main Objectives:

- To determine the performance evaluation of nanocomposite enhanced electrodes in microbial fuel cell for generating efficient electricity

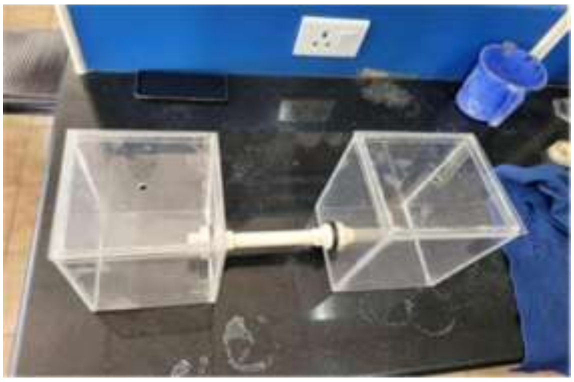
Specific Objectives:

- To collect and characterize the physical and chemical properties of domestic sewage collected in DSATM campus.
- To find out the efficiency of the various contaminants in the water by using MFCs like percentage removal of COD, BOD, PH and TDS.
- To treating the domestic sewage and generation of electricity.
- To know the efficiency and lifespan of anode and cathode used and along with the electricity generation.
- Characterization of the sludge.

Methodology:

Materials:

MFC reactor is a two-chamber microbial fuel cell (MFC) was constructed using acrylic fiberglass with dimensions of 15 cm × 15 cm × 20 cm, providing a total volume of 4500 ml. The anode and cathode chambers were separated by a salt bridge, facilitating ion exchange while preventing direct mixing of the chamber contents.



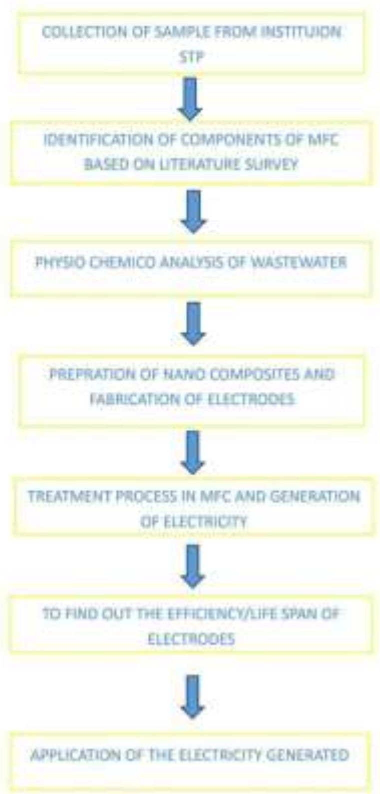
Fabrication of Electrodes is a Coating of ZnO2/Nf immobilized on the electrode- Before electrode modification, the mirror like surface of the electrode was obtained by using various size of emery sheets.

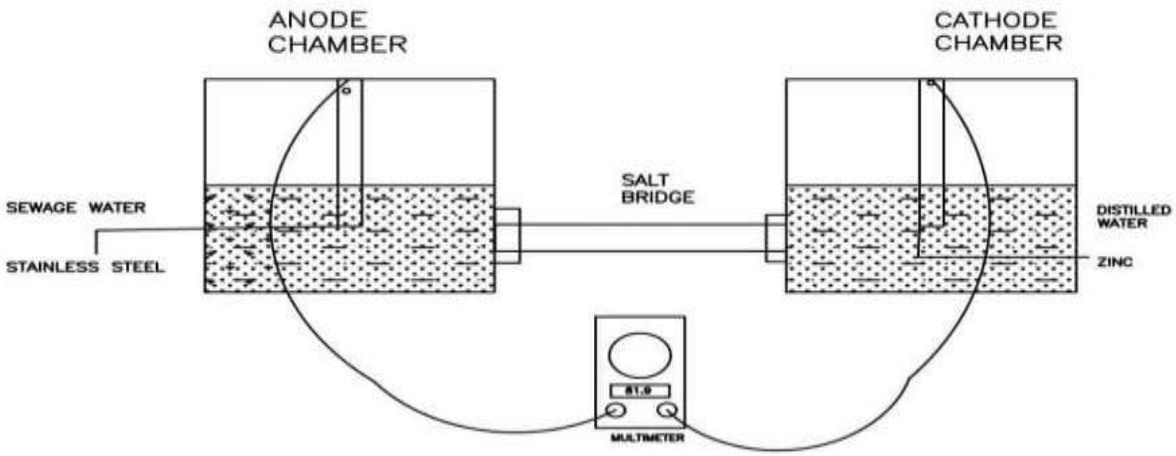
The salt bridge is a key element in a microbial fuel cell (MFC), serving to keep the anode and cathode electrodes separate while maintaining distinct anaerobic and aerobic conditions in the respective chambers.

Copper was utilized as outside circuit that interfaces the cathode and anode. On both electrode sides, the copper wires were attached along with electric tape.

The miscellaneous materials utilized in the present study include Glue gun, Para film, and variety of glassware, PH meter, digital multi-meter, spectrometer, chemical reagents, digital balance, thermometer, crucibles, oven, and desiccator.

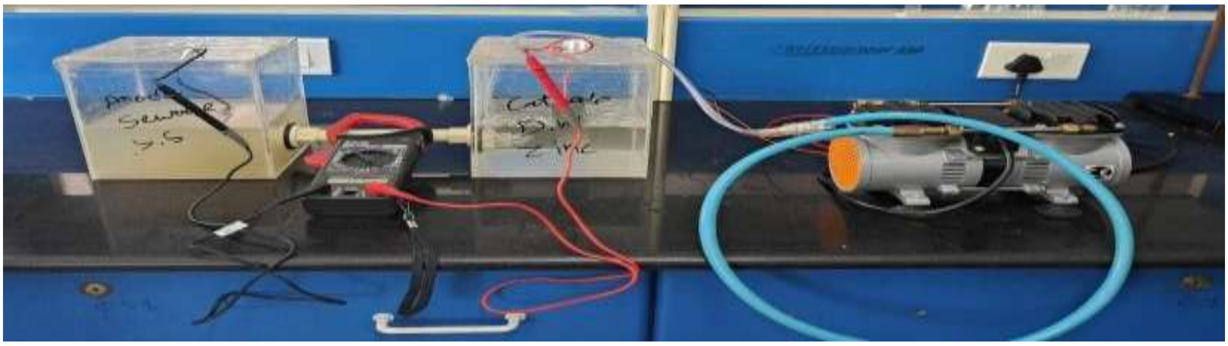
Process:





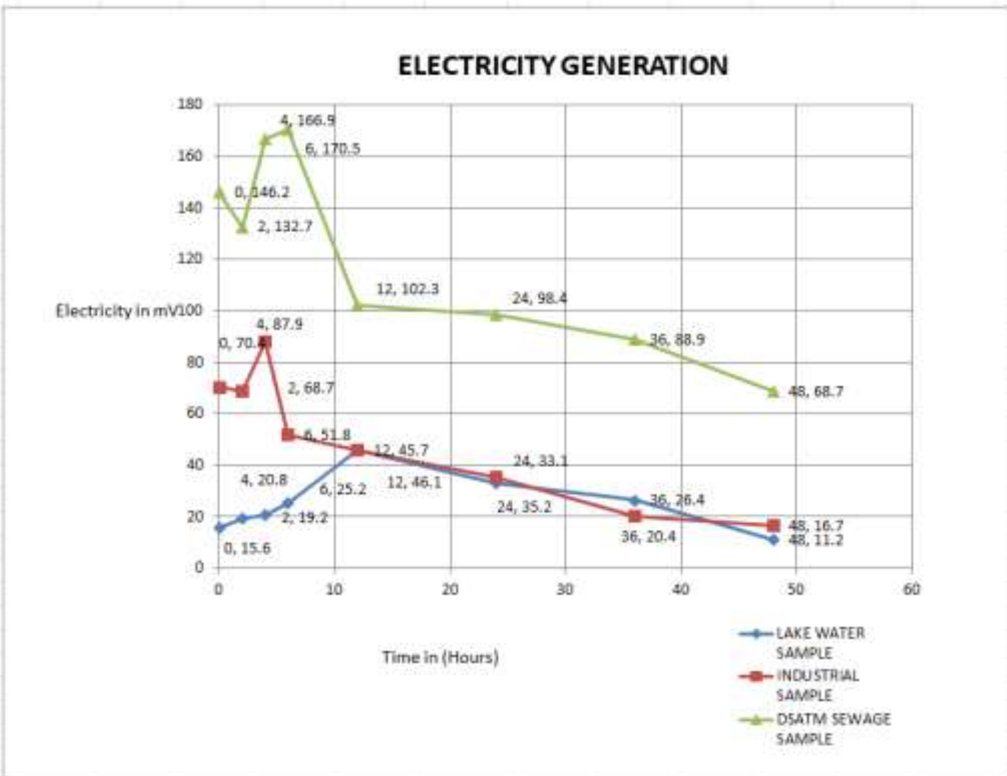
Typical Prototype

Physico-Chemical Analysis of Sewage water Sample through Fabricated Prototype



Fabricated Prototype Model

Results & Conclusions:



Comparative Analysis

Initial Voltage Production:

1. **Institutional Sewage Wastewater**: The initial voltage was the highest at 146.2 mV.
2. **Industrial Wastewater**: The initial voltage was moderate at 70.4 mV.
3. **Lake Water**: The initial voltage was the lowest at 15.6 mV.

Peak Voltage Production:

1. **Institutional Sewage Wastewater:** The peak voltage was reached at 4 hours with 170.5 mV.
2. **Industrial Wastewater :** The peak voltage was reached at 4 hours with 87.9 mV.
3. **Lake Water**: The peak voltage was reached at 12 hours with 45.7 m

Voltage Decline:

1. **Institutional Sewage Wastewater**: The voltage declined steadily after 4 hours, dropping to 68.7mV by 48 hours.
2. **Industrial Wastewater:** The voltage showed a significant decline after 4 hours, reaching 16.7mV by 48 hours.
3. **Lake Water:** The voltage also showed a significant decline after 12 hours, reaching 11.2 mV by 48 hours.

Overall Voltage Trends:

1. **Institutional Sewage Wastewater:** Exhibited the highest overall voltage production, indicating high organic content and microbial activity.
2. **Industrial Wastewater:** Showed moderate voltage production with a sharp decline, indicating lesser organic content compared to sewage wastewater.
3. **Lake Water:** Exhibited the lowest voltage production, suggesting the lowest organic content and microbial activity among the three water sources.

Project Outcome:

- Efficiency of anode and cathode is obtained-thus their life span estimated.
- Based on characterization of sludge its utility and place of application could be determined.
- Feasibility of electricity generation from waste water is quantified.

- Soruce of waste water that provides maximum electricity generation can be identified

Scope For Future Work:

- Improve MFC design by exploring advanced electrode materials, optimized chamber configurations, and cost-effective membranes.
- Enhance microbial efficiency through diverse consortia, genetic engineering, and bioaugmentation with electroactive bacteria.
- Optimize wastewater treatment by using pre-treatment methods, co-substrate addition, and continuous feeding strategies.
- Focus on large-scale implementation, economic feasibility, and integration with renewable energy for sustainable power generation.