TREATMENT OF WASTEWATER AND GENERATION OF ELECTRICITY USING CONSTRUCTED WETLAND - MICROBIAL FUEL CELLS

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Abstract - *The production of pollutants in wastewater has been increasing day by day, necessitating the reclamation of wastewater for reuse. While the traditional constructed wetland method has been used to naturally remove pollutants from water, it is no longer efficient on its own. Microbial fuel cells (MFCs) have garnered global attention as an emerging environmental treatment technology. Previous studies have demonstrated that constructed wetland-microbial fuel cells (CWL-MFCs) are an eco-friendly and sustainable technology capable of simultaneously removing contaminants and generating electricity. The advantages of CW-MFCs include high treatment efficiency, electricity generation, and the reduction of persistent pollutants.*

Key Words: **wastewater treatment, generation of electricity, constructed wetland-microbial fuel cells, pollutant removal**

1. INTRODUCTION

In the current scenario, wastewater disposal has become a serious issue due to the increased concentration of pollutants and wastewater generation. This increase is attributed to factors such as the rise in the standard of living, climate change, excessive population growth, and more. Connecting the entire population to a sewerage system and treating wastewater in a centralized Sewage Treatment Plant (STP) is challenging. This is because building a new STP in a city or town requires a substantial capital investment and a large land area. The discharge of wastewater from various sources, including industries, residences, agriculture, and commercial activities, poses a threat to nature and contributes to waterborne diseases. The lack of proper wastewater treatment and rapid urbanization are exacerbating the situation.

1.1 Constructed Wetland

Constructed wetland (CW) technology utilizes natural processes to efficiently remove contaminants, offering an environmentally safe and cost-effective alternative to traditional energy-intensive treatment methods. It has been successfully used to treat various types of wastewaters, including municipal, urban, industrial, and agricultural, storm water run-off, mining effluents, leachates, and septic tank effluent.

Constructed wetlands are a low-cost option for treating different types of wastewaters such as domestic, industrial, and agricultural run-off, including dairy and livestock wastewater. They are easy to maintain and operate and can transform many persistent pollutants found in conventional wastewater into harmless by-products. While constructed wetlands have proven to be effective for both conventional and nonconventional pollutants, they do have some limitations, such as substrate clogging, low pollutant removal efficiency, and inability to address specific pollutants. Therefore, it is important to combine this technique with another suitable method to overcome these limitations and simultaneously increase its efficiency.

1.2 Microbial Fuel Cell System

MFC, or Microbial Fuel Cell, represents a cutting-edge technology consisting of a cathode, an anode, and a proton exchange membrane; combine microbial and electrochemical processes to form an intrinsic electrochemical system that transforms chemical energy into electrical energy. These components work together to provide electrical energy using microorganisms as biocatalysts and organic materials as substrates. This revolutionary technology offers a more energy-efficient alternative to traditional wastewater treatment plants, as it harnesses the organic matter in wastewater to generate electricity, thus offsetting the energy needs of the treatment plants.

1.3 Constructed Wetland Coupled With Microbial Fuel Cell

Constructed wetland-microbial fuel cells (CWMFCs) are a brilliant combination of built wetlands and bio-electrochemical innovation. CWMFCs can decontaminate wastewater and create power through physical substrate aggregation, chemical responses (different redox responses happen inside the substrate), and organic intuitive (microbial change). Inside the CWMFC, electricity-producing microorganisms produce electrons beneath anaerobic conditions in the anode. The electrons stream through outside circuits to the cathode, where redox responses take put. CWMFCs have been connected in the treatment of follow contaminants in waterway water, wastewater containing colors, and residential wastewater.

2. Material and Method Implemented

2.1 Materials

A glass container with external dimensions of 60cm in length, 30cm in width, and 30cm in height was utilized for the construction of the wetland-microbial fuel cell system. An outlet with a diameter of 2.5cm was installed at the bottom of one side of the width to release treated water (effluent).

The structure features a 6 cm thick top and bottom layer made of gravel with a size of 10-20 mm, while the middle layer is 12 cm thick and composed of normal sandstone gravel with a size of 4mm-5mm.

We employed two graphite electrodes with a diameter of 5cm and a length of 30cm. The first electrode is positioned 5 cm from the bottom, and the second electrode is situated 19 cm from the bottom. These electrodes were connected using 1 mm diameter copper wire to form an electric circuit.

Type of plant used for constructed wetland:
Canna indica which is also called as Indian shot, can be used to recycle domestic wastewater by using the roots of it and soil bacteria for domestic re-usage such as for gardening, and flushing of toils.

Fig 1. Graphite Rods

Fig 2 . Layer One

Fig 3 . Layer Two

Fig 4 . Layer Three

Fig 5 . Multimeter

Fig 6 . Constructed Wetland – Microbial Fuel Cells

2.2 Operation Implementation

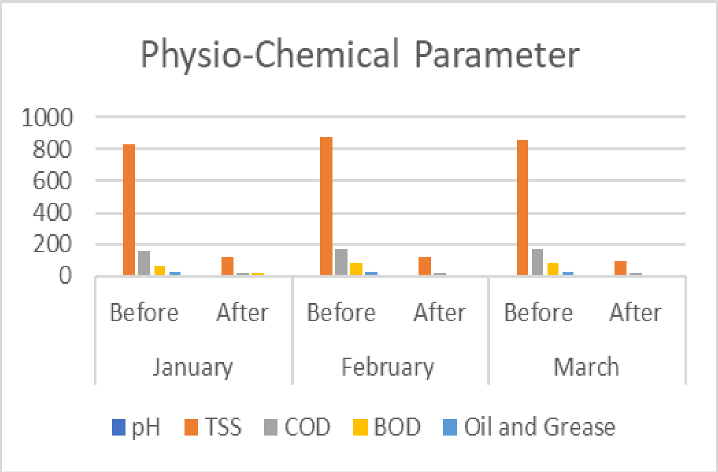
During Trial 1, a substantial experiment was carried out. A total of 15 liters of pre-sediment wastewater was introduced into the tank simultaneously with the valve sealed. The wastewater was left to settle for 1 hour.
The findings were extraordinary: 0.9V of electricity was produced for every 15 liters of water.

During Trial 2, a substantial experiment was carried out. A total of 15 liters of pre-sediment wastewater was introduced into the tank simultaneously with the valve sealed. The wastewater was left to settle for 1 hour. The findings were extraordinary: 1.08V of electricity was produced for every 15 liters of water.

During Trial 3, a substantial experiment was carried out. A total of 15 liters of pre-sediment wastewater was introduced into the tank simultaneously with the valve sealed. The wastewater was left to settle for 1 hour. The findings were extraordinary: 0.87 V of electricity was produced for every 15 liters of water.

2.3 Result and Analysis

	January		February		March	
	Before	After	Before	After	Before	After
pH	6.65	7.03	6.28	7.41	6.06	7.22
TSS	836	125.4	881.4	117.04	856.91	91.96
COD	159.74	20.66	172.13	18.93	165	19.8
BOD	66	13.2	79.54	11.93	78.39	10.97
Oil and Grease	22	4.4	24.4	4.11	23.9	3.93



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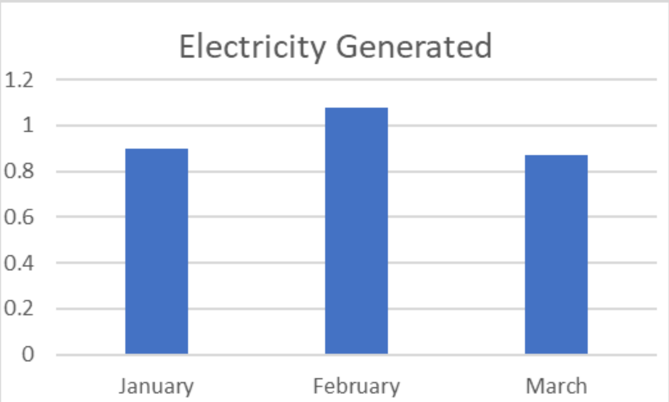
Month	Electricity Generated (V)
January	0.9
February	1.08
March	0.87



3. CONCLUSIONS

It has been observed that electricity can be successfully generated while treating wastewater. The CW-MFC technology is an innovative approach to enhancing wastewater treatment efficiency with simultaneous electricity generation.

To enhance electricity generation, we recommend the addition of graphite gravels and an increase in the number of electrodes. With these measures, we can significantly boost the production of electricity.

By implementing this method, we can effectively reclaim and reuse treated wastewater for various purposes such as cleaning, gardening, and more. This approach not only helps to conserve water but also contributes towards a greener and healthier environment.

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