SUSTAINABLE ENERGY RECOVERY FROM SEWAGE VIA MICROBIAL FUEL CELLS

OMEIAT NATIONAL SCIENCE FAIR – 2025

DISPLAY SHEET

SUBMITTED BY

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NSF-SCH-2025-19

ABSTRACT:

- The project aims to design a small-scale MFC system using locally available materials and sewage samples, to test its efficiency in producing measurable voltage and current.

- The expected outcome is to showcase how waste, often considered a pollutant, can be transformed into a valuable resource for energy production, making it a promising solution for future energy and environmental challenges.

HYPOTHESIS:

If bacteria in sewage break down organic matter inside a microbial fuel cell, then they will release electrons that can generate measurable voltage to power small devices (like an LED).

SELECTION OF PROBLEM AND BACKGROUND INMFORMATION:

- To conduct the electricity from savage by the process of microbial fuel cell.

  Using that electricity to purify the polluted air to clean air from many industries.
- The aim is prevent from pollution and global warming and harmful microbes in savage to

affect the diseases and create the beautiful nature surroundings.

Research Question:

- **Can microbial fuel cells generate usable electricity from sewage or wastewater while simultaneously reducing waste?**

PROCEDURE:

A dual-chamber microbial fuel cell was constructed using two plastic containers separated by a proton exchange membrane. The anode chamber contained sewage under anaerobic conditions, while the cathode chamber contained aerated water acting as the electron acceptor.

1. **Prepare salt bridge:** Fill a small tube with agar + salt solution (acts as proton conductor). Let it set.
2. **Set up chambers:**
    - **Anode chamber (sealed no oxygen):** Fill with wastewater/sewage. Insert graphite electrode connected to wire. Bacteria in sewage will break down organic matter.
    - **Cathode chamber (aerobic, oxygen present):** Fill with saltwater. Insert graphite electrode connected to wire. Oxygen acts as electron acceptor.

Setup Design:

- Anode Chamber: 500 mL of raw sewage sample.
- Cathode Chamber: 500 mL of tap water mixed with potassium ferricyanide.

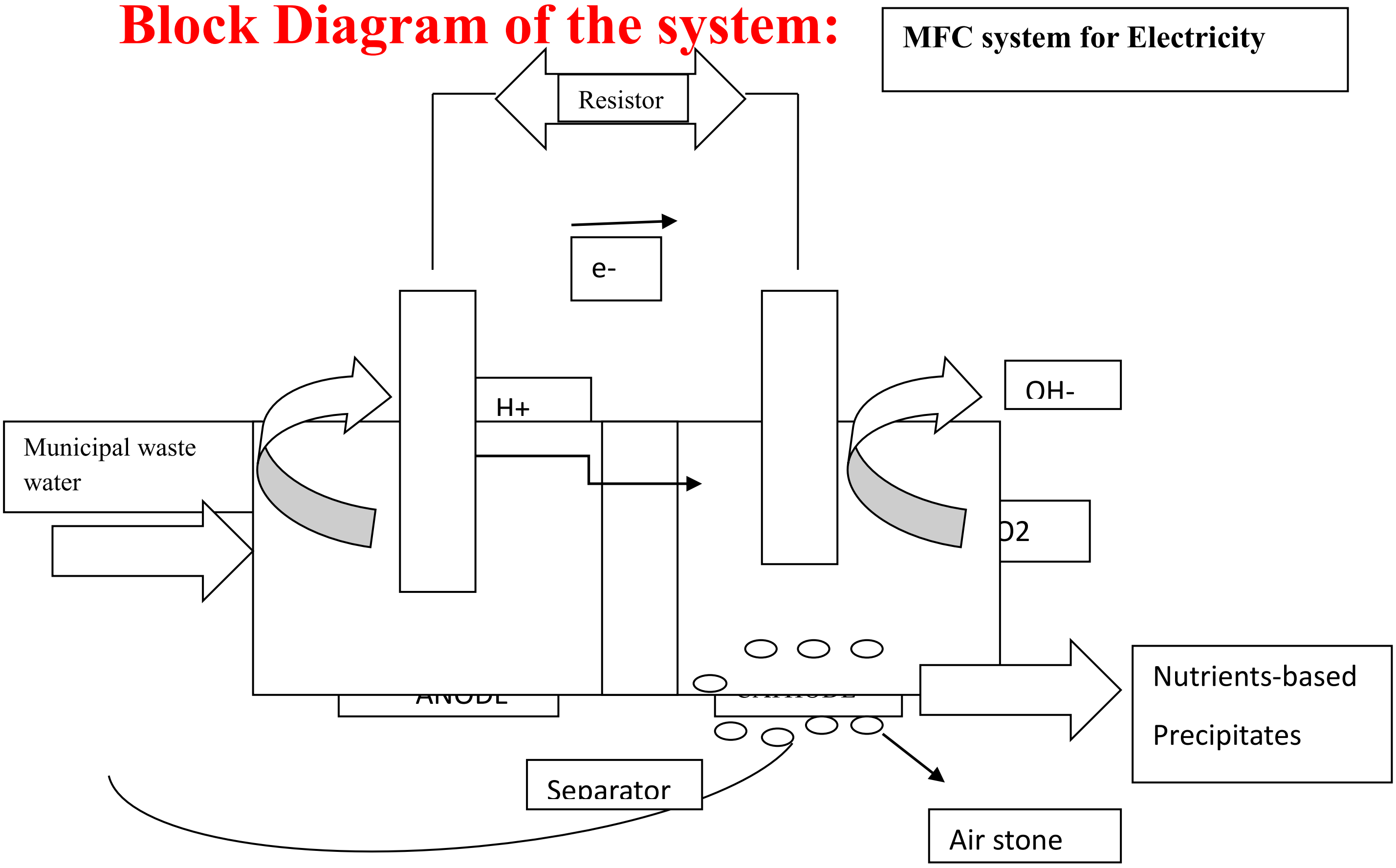
3. **Setup of MFC**:
   - Prepare two chambers: one with sewage (anode chamber) and one with clean water + oxygen (cathode chamber).
   - Insert electrodes into each chamber and connect them with a salt bridge.
   - Connect electrodes with wires to an external circuit.

- Electrodes: Graphite rods (6 cm × 1 cm) connected via copper wire. Membrane: Proton exchange membrane (Nafion 117 or salt bridge of KCl and agar).

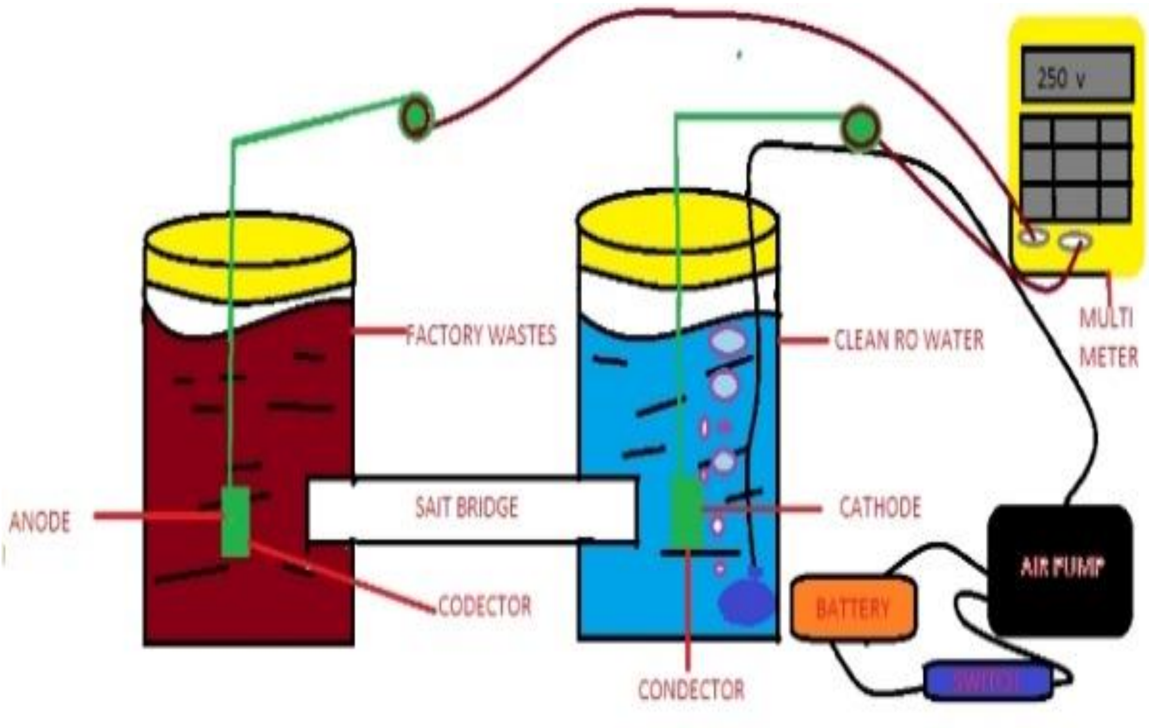
Microorganisms in MFCs

- Geobacter sulfurreducens → direct electron transfer.
- Shewanella oneidensis → versatile metabolism.
- Mixed consortia in sewage → robustness and adaptability.

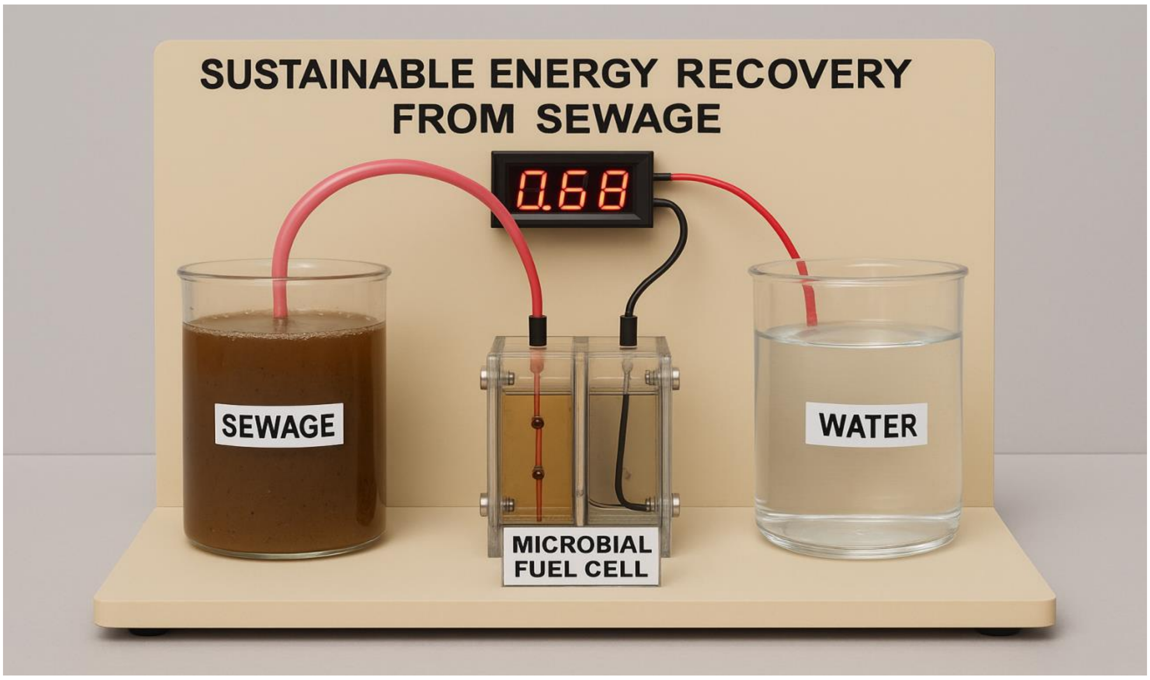
Block Diagram of the system:



Circuit connection of MFC:

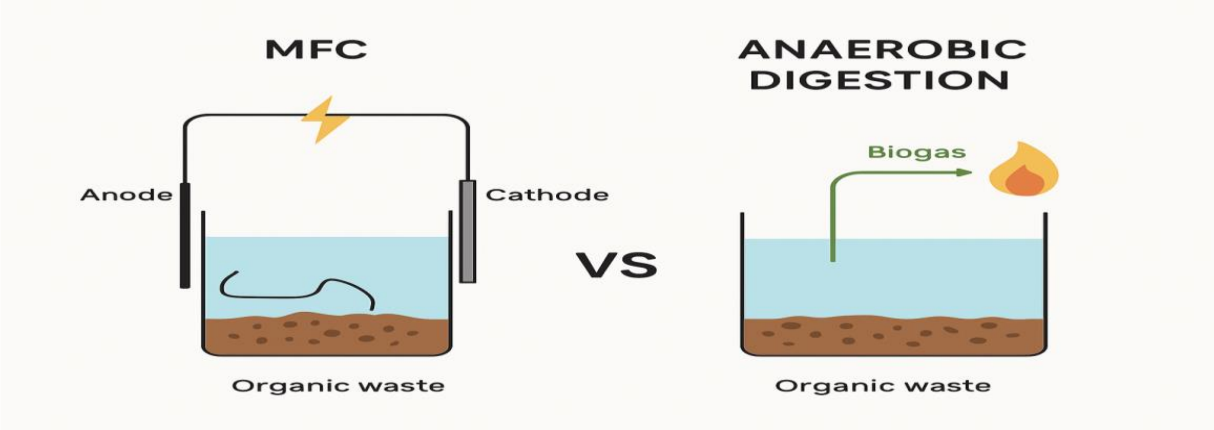


Working Model:

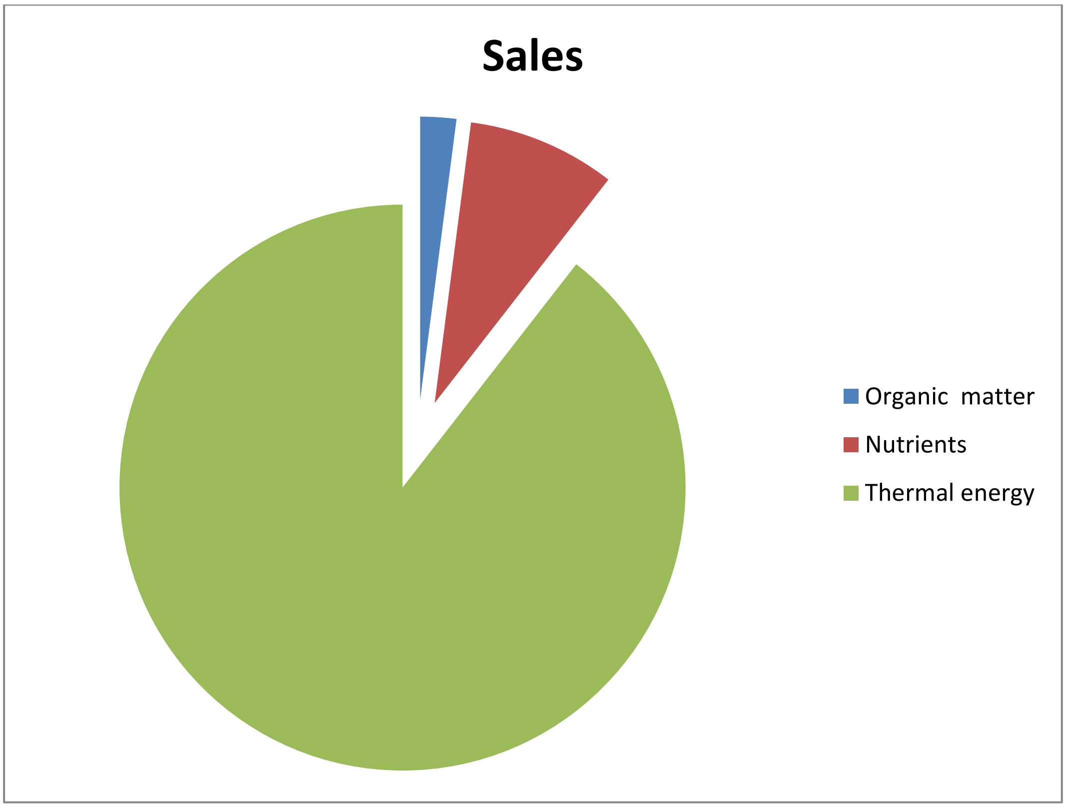


Comparative Performance:

MFC vs. anaerobic digestion: faster electricity recovery.



Energy in waste water (kwh/m^3)



Simple System-Requirements Table (Microbial Fuel Cell from Sewage):

Subsystem	**Requirement / Target**	**Typical Options**	**Notes**
Input (Fuel)	Domestic sewage or simulated wastewater (glucose/starch/food slurry)	1–5% (w/v) organic slurry for lab demo	Remove large solids; pre-settle if needed
Microbes	Electro active bacteria from sewage/sludge	Anaerobic inoculum from septic tank, sludge, or pond sediment	Pre-acclimate 2–5 days without oxygen

Anode Chamber	Airtight, **anaerobic**	250–1000 mL plastic/glass jar with screw lid + sealant	Include feed/vent ports with one-way valves
Cathode Chamber	**Aerobic** with oxygen access	Separate 250–1000 mL vessel, or air-cathode design	If two-chamber: ensure steady airflow
Separator	Ion pathway between chambers	Salt bridge (agar + 3–10% NaCl/KCl) **or** PEM (e.g., Nafion)	Salt bridge is cheap; PEM gives higher performance
Anode Electrod	High surface area,	Carbon felt/cloth,	≥25–50 cm^2

e	biocompatible	graphite plate/rod, SS mesh (backup)	exposed area for school builds
Cathode Electrode	Good ORR (oxygen reduction)	Carbon cloth/felt; activated-carbon/PTFE air-cathode; Pt-coated (best, costly)	Add PTFE layer to reduce flooding (optional)
External Circuit	Close circuit & measure	Copper wires, crocodile clips, **load resistor** (100–1000 Ω), switch	Use a breadboard for easy swaps

Figure 1. Voltage vs. Time graph :

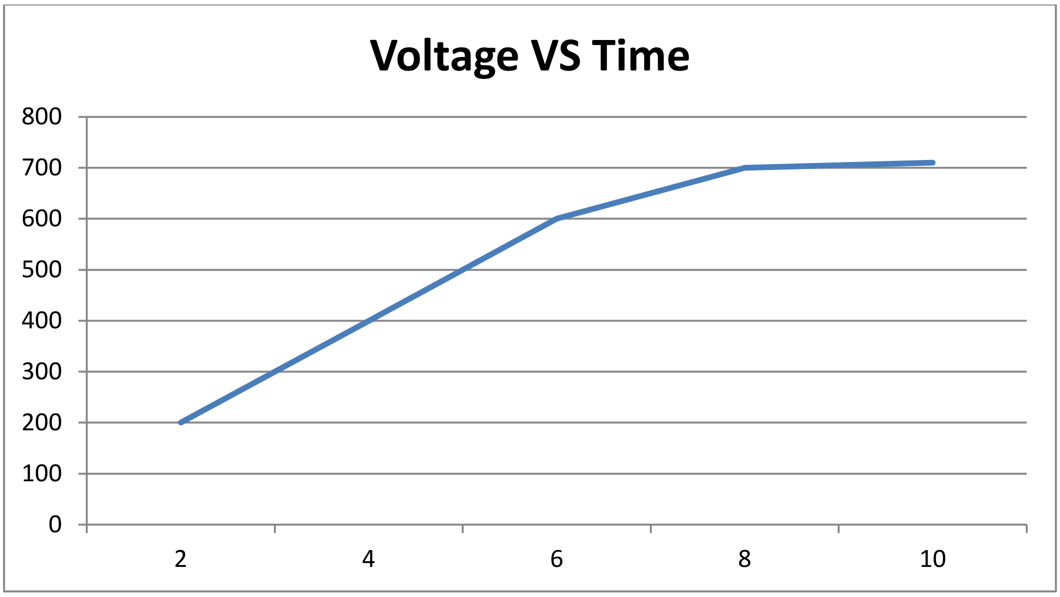
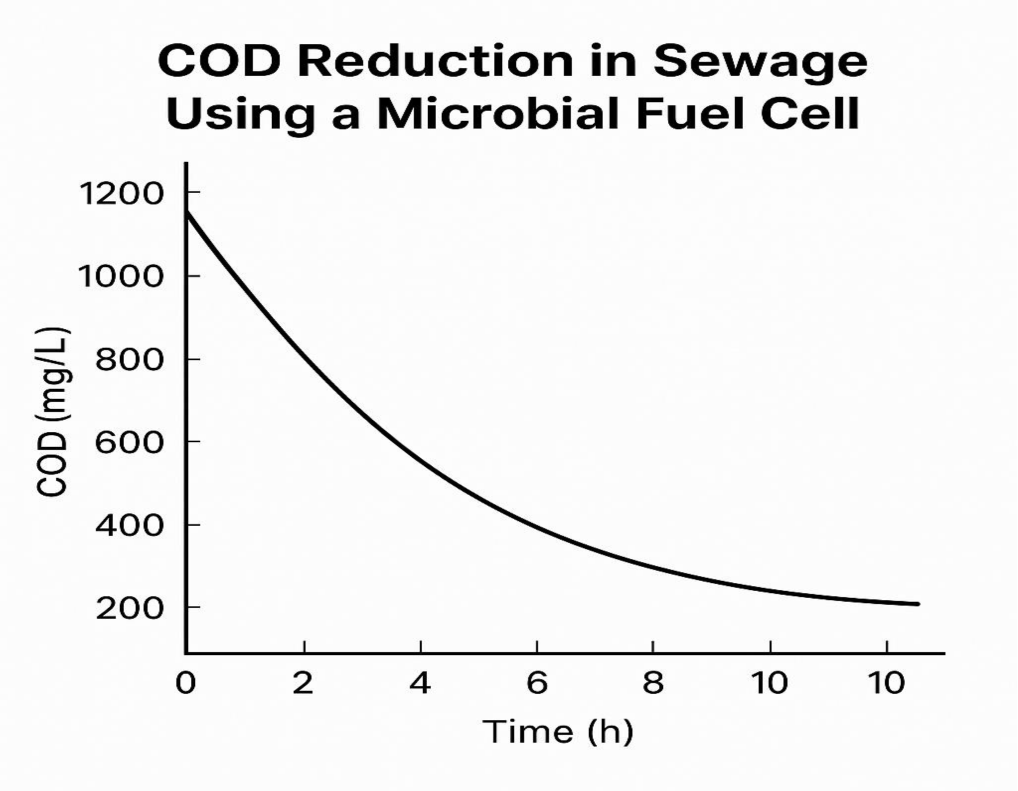


Figure 2.

COD Reduction vs. Time graph



Bar chart:

Application of MFC (Usage areas)

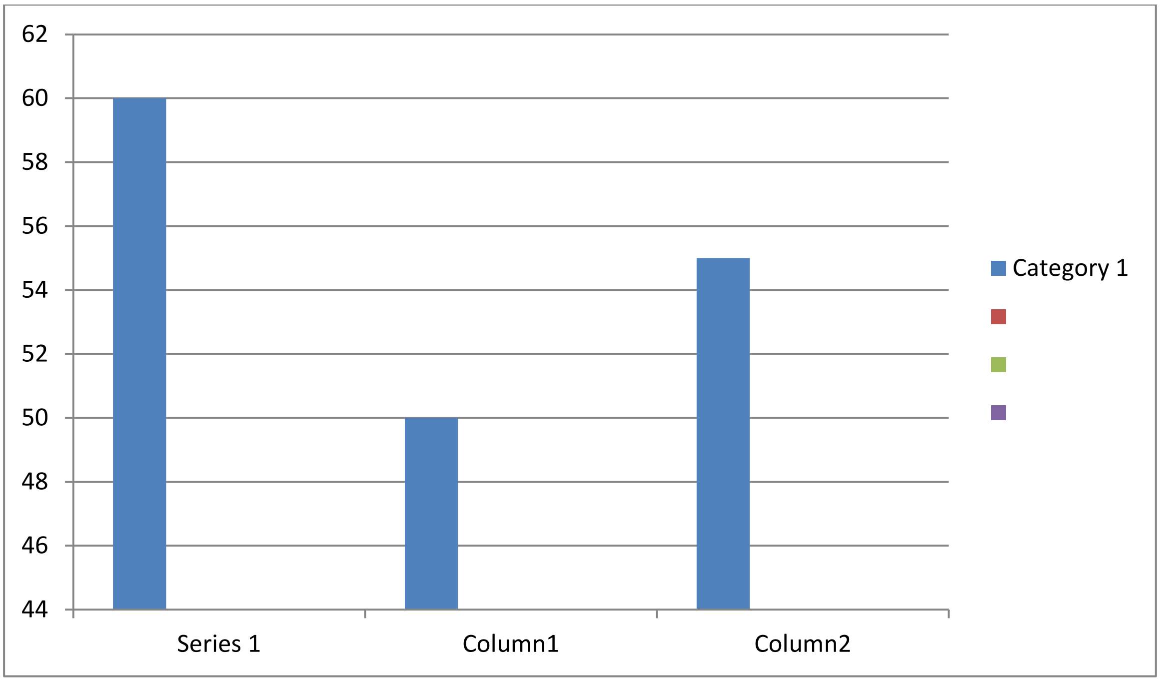
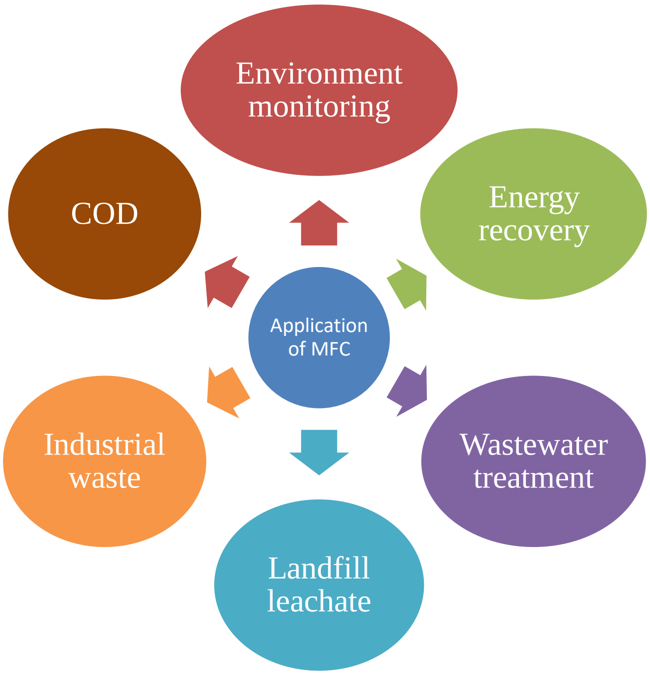


TABLE:

Day	Voltage (mV)	COD Reduction (%)
1	120	5
2	210	15
3	310	25
4	410	38

5	520	47
6	610	56
7	670	63
8	700	72
9	710	78
10	720	82

Application of MFC:



The constraint functions are:

- **Low Power Output.**
- **Cost of Materials**
- **Maintenance & Stability**
- **Environmental Constraints**
- **Energy Recovery Efficiency.**

RESULTS:

- The microbial fuel cell generated a maximum voltage of approximately 720 mV by the 10th day.
- The COD analysis revealed an 82% reduction in organic content, indicating effective wastewater treatment.

- The power output stabilized after Day 8, suggesting the system reached **steady-state microbial activity**.
- The voltage increased gradually over time as microbial biofilms developed on the anode surface, enhancing electron transfer.

CONCLUSION:

- MFCs offer a promising solution for sustainable sewage treatment
- Energy recovery is feasible but needs optimization
- Future research: improving efficiency, scaling up.