The aim of the present investigation was to treat the pulp and paper mill, agro-waste and dairy wastewater by using Microbial fuel cell (MFC). Waste water served as an effective substrate for power generation by using microbial fuel cell as they are rich in organic content. In MFC, bacteria’s were grown under anaerobic conditions. It had been observed that MFC gives a maximum of 957 mV after 10 days of operation when used with dairy waste water, while the cell using agro-waste functioned disappointingly to give a maximum of 601 mV as compare to other wastes. In case of paper mill waste a maximum of 758 mV was observed.

**Keywords**: Microbial Fuel Cell, Pulp and Paper Mill, Bacteria, Substrate Utilization, Power Generation

**Introduction**

Pulp and paper industry, dairy industries and waste water from agriculture are considered as most polluted industry due to its toxic effect on environment. The problems associated with effluents are pH, colour, and high levels of Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), suspended solids (SS), etc. MFC can replace the conventional waste water treatment plants and the electricity produced from it can be used for running the waste water plants as well as for supply to households. Its potential also lies in desalination, hydrogen production, biosensors also for energy production. In present investigation, microbial fuel cells was been designed by using Agro-waste, pulp and paper mill and Dairy waste. Comparative efficiency of MFC’s was monitored and effect of parameters on microbial fuel cell efficiency had been be optimized.

**Material and methods**

**Collection of waste samples**

Three industrial waste samples namely Dairy waste, Paper waste, Agro-waste from Noida, GB Nagar and kept into the refrigerator for further research purpose.

**Microbial fuel cell using agro-waste water**

Agro-waste water was added to the container to make up the volume. Sugar solution ((1 g/L or 0.1%) was added slowly after interval of two hours. Sugar solution was used as it acts as the source of food for bacterial growth. Dilute sugar solution was used because concentrated solution may damage the bacterial cell wall due to osmotic pressure. Aluminum plates (140 cm²) with pores of diameter 0.1 cm (approx) were used as anode. Graphite rods extracted from pencil batteries were also tied with the aluminum plate as it helped bacteria to grow on it. This was then connected with copper wires and immersed in the agro waste water. Now the anodic chamber was sealed with epoxy. Cathode compartment was filled with salt solution (200gNaCl/1.5 L water). Salt was added to make the catholyte conductive. Aluminum plate (70 cm²) with same pore size was immersed which act as cathode. The cathode and anode compartment were connected with salt bridge. A constant load resistor of 10 K ohm was connected through the circuit. Potential drop was measured across the resistor after particular interval of time using multimeter.

**Microbial fuel using pulp and paper mill waste water and dairy waste water**

The pulp and paper mill waste water sample was collected from Suchi paper mill, Ghaziabad and dairy waste was collected from Ghazipur Dairy Delhi. This grade of water sample contains bacteria of mixed strains. The type of anode and cathode used are same as previous experiment but instead of adding agro-waste to anodic chamber, pulp and paper mill waste water and dairy waste water were used. Hence the cell
voltage attained a constant value after 16 hours of the experiment after which sugar solution was added to supplement the bacterial growth. Readings were taken at different time intervals.

Analytical methods
pH of the effluent sample was measured by a pH meter (model PR 8404) using glass electrode. TDS was also calculated. BOD values were monitored by conventional method samples after 5 days of incubation in MFCs proving the fact that MFCs can be good BOD sensor. COD by reflux method, was measured according to Swamy et al.3

Electrical parameters and measurements
Digital multimeter (T-33) was used to measure the voltage, which was generated during the experiments. After 2 hours, readings were recorded for a maximum of 60 hours.

Results and Discussions
Physical analysis of Waste water samples were carried by analyzing various parameters viz. pH, TS, TSS, TDS, BOD, COD etc. Further the effluent was treated by constructing microbial fuel cell. In all the three set-ups glucose acts as the source of food for the bacterial growth. Anaerobic bacteria were situated in anaerobic chamber which on decomposition of glucose liberated carbon dioxide, protons and electrons. These protons were transferred to the cathode compartment through salt bridge. Electrons were transferred to the cathode through external circuit connected to a load.

$$C_6H_{12}O_6 + 6H_2O \rightarrow 6CO_2 + 24H^+ + 24e^- \quad \ldots (1)$$

Addition of sugar solution in the anolyte of waste water after 16 hours resulted in rapid increase in the cell potential. Salt addition in the catholyte of all the three samples result in increase in the cell potential due to increase in conductivity of the catholyte. Minor change in pH of waste was observed during operation of MFCs with waste. There is slight reduction in pH of Agro and Dairy waste water while there is increase in pH of pulp and paper mill waste Table 1. There is great reduction in TSS after treatment, the appearance and color also changed during treatment. TDS values are observed to be increased it may be due to increase in number of microorganism during treatment. BOD values are monitored by conventional method proving the fact that MFCs can be good BOD sensor. All the MFCs were efficient in COD removal. 65%, 75% 99.9 % COD removal was observed after 5, 10, 20 days respectively of operation of MFCs with Dairy waste as substrate, 45%, 68%, 99% COD removal was observed after 5, 10, 20 days respectively of operation of MFCs with Agro waste as substrate, 40% 62%, 75% COD removal was observed after 5, 10, 15 days respectively of operation of MFCs with pulp and paper mill waste as substrate Figure 1. Maximum 75% COD removal and maximum electricity generation of 758 mv Figure 2 with pulp and paper mill waste were observed during operation of MFCs as compared to other waste recirculation. In previous studies3,4,5, local area waste samples were applied for
isolating electrogenic bacteria and the most occurring strains are traced out for COD removal as well as electricity generation efficiencies of isolates. Earlier investigations are successfully progressing toward goal of achieving good electricity generation using mediator less MFCs which confirms the fact that the bacteria did not require soluble mediators \(^6,7,8,9\) but can donate electrons directly by adhesion to the electrode surface and perform the work with a proton exchange membrane and however, the results are 55% COD removal while 75% COD removal operating the MFCs without a proton exchange membrane.\(^7\)

**Conclusion**

During the current research three industrial wastes samples from NCR were analyzed for electricity generation and COD removal efficiency. Maximum COD removal (99.9%) was achieved after 10 days by utilizing Dairy waste as substrate for MFCs constructed during current research. So it can be concluded that the electrogens isolated from MFCs reactors are successful mean for waste water treatment along with generation of electricity. Future research can be suggested for improving the efficiency of microbial fuel cell in context to industrial effluent.

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**References**