Percentage reduction of Chloride, Nitrate by Double chamber microbial fuel cell (MFC)

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ABSTRACT:

The extraction of Textile dyes from the wastewater in industry becomes an environmental worldwide issue. The need for new and alternate source of energy is increasing day by day. In the upcoming days the alternate source of energy will be applied everywhere. Microbial fuel cell (MFC) technology is a new type of renewable and sustainable technology for electricity generation. The set-up of Double chamber produced the maximum voltage; the maximum current and power produced were of 2.69V, 3.38mV and 0.502W/m^2 respectively.

Keyword: *Microbial fuel cell, Textile wastewater, Double chamber.*

INTRODUCTION

Energy is the prime mover of economic growth of a country. Future economic growth significantly depends on the extensive availability of energy sources. The textile industrial wastewater is largely yielded by the textile industry all day long to night, although a good number of chemical of variable textile processing such as bleaching, scouring, dyeing, finishing and so forth, most obviously dyeing and finishing are the processes in which a variety of chemical used. Microbial fuel cells have attached global interest in source of energy supplying electricity generated from organic and inorganic matter in wastewater. Microorganism in microbial fuel cell metabolizes fuels or substrates and shuttle transfers electrons to the surface of the electrode.

OBJECTIVES OF THE STUDY

The study was conducted to assess the treatment efficiency of Textile mill wastewater using microbial fuel cell, with the following objectives.

1. To study the characteristics of Textile mill wastewater
2. To fabricate Double chambered microbial fuel cell (MFC).
3. To study the treatment efficiency with respect Chloride, Nitrite.
4. To study the rate of current generation, voltage and power
5. To study the effect of wastewater concentration on treatment efficiency.

MATERIALS

- Two Non-Reactive plastic box of Ten liters capacity
- Agar agar Bacto (for bacteriology)
- Potassium chloride
- Carbon rods of 4mm diameter & 47mm length extracted from Eveready battery cells.
- Copper wire
- PVC pipe of 3.2 cm diameter and length of 22cm.
- Sealants: M-seal
- Digital Multimeter (DT-830D)

METHODOLOGY

a) OPERATING CONDITIONS

The whole study was conducted under ambient environmental conditions. The microorganisms present in Textile wastewater acted as the substrate for MFC. The Textile wastewater samples were kept in refrigerator at 4^0C before use. The wastewater is used as substrates for all MFC tests without any modifications such as pH adjustments or addition of nutrients etc. The study was conducted by feeding Textile wastewater separately to MFC with different wastewater strengths.

b)MFC Operation

The anode chambers of MFC were ¾ filled with Textile wastewater with different wastewater strengths in sequential order and 3mL of sewage is added as seed material. In the cathode chamber of MFC, 1M Potassium chloride (KCL) solution was added as catholyte. The internal wiring of anode and cathode were connected to a multimeter to complete the circuit. The entire setup was left for 4 days for stabilization and the multimeter initial reading was noted down. The wastewater parameters were analyzed weekly and the current & voltage readings were noted and were monitored every 24 hrs interval.

Experimental set-up:

- **Selection of anode and cathode material**: Non-reactive, non-conductive and non-biodegradable plastic boxes are selected as anode and cathode chambers.{3}.
- **The Agar salt bridge** is constructed using common salt, agar and water. 650mL of water is boiled in a beaker, 65gm of agar & 75gm of Sodium chloride are added to the boiling water, the mixture is further boiled for 3-5 minutes.{4}.

- **Assembling of Electrodes**: This arrangement of carbon allowed to increase the surface area and to come in contact with substrate. The length and diameter of carbon rods is 47mm and 4mm respectively.{3}.
- **Assembling of Double Chambered Microbial Fuel Cell**: For MFC, one end of the PVC pipe containing agar salt has been fitted into the anode chamber and the other end of the PVC pipe is fitted into the cathode chamber schematic diagram of double chamber is as shown in Fig.1.{2}.

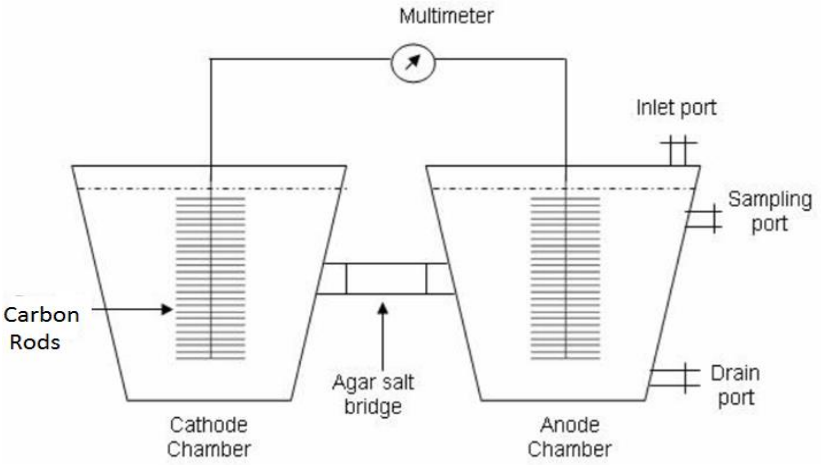

Fig.1. Schematic diagram of Double chambered MFC.

RESULTS AND DISCUSSIONS:

Treatment efficiency of Textile wastewater and electricity generation for various feed concentration is as shown in Table.1:

Time in days	Chlorides (mg/L)		Nitrate(mg/L)		Current in (mA)&Voltage in (volts)	
	Influent	Percent Reduction	Influent Effluent	Percent Reduction	current	Voltage
1-10	453	41.28	232.3	21.52	0.78	0.56
11-18	573	46.24	349.54	26.72	0.95	0.69
19-26	805	52.54	552.1	32.54	1.04	0.84
27-34	914	56.01	866.3	38.6	1.35	1.05
35-42	1092	61.17	969.2	43.21	2.02	1.56
43-50	2002	66.43	1072.45	49.65	2.87	2.57
51-58	**2102**	**67.03**	**1729.64**	**53.52**	**3.38**	**2.69**
59-66	2120.8	65.90	2082.43	49.89	2.76	2.43

Table.1 Treatment efficiency of Textile wastewater and electricity generation for various feed concentrations

Chloride removal efficiency:

The highest Chlorides removal efficiency is 67.03% on 58th day. After 58th day onwards the Chlorides removal efficiency decreased as the feed concentration. The Chlorides removal efficiency improved with the increase in feed concentration up to 453mg/L to 2102mg/L. Slowly the Chlorides reduction started to decline converted to chlorine ion. Chlorides removal efficiency is as shown in Fig.2.

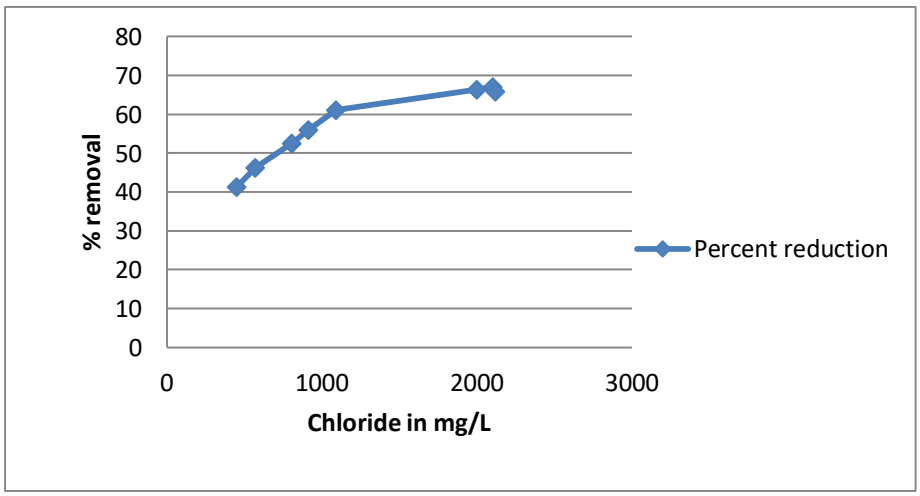

Fig .2. Chloride Percentage Reduction.

Nitrite Removal Efficiency:

During the operation considerable reduction in Nitrate concentration of Textile wastewater is observed. The highest Nitrate removal efficiency is 52.04% on 58th day. After 58th day onwards the Nitrate removal efficiency decreased as the feed concentration. The Nitrite removal efficiency improved with the increase in feed concentration up to 232.3mg/L to 1729.63mg/L. Nitrate removal efficiency is as shown in Fig.3.

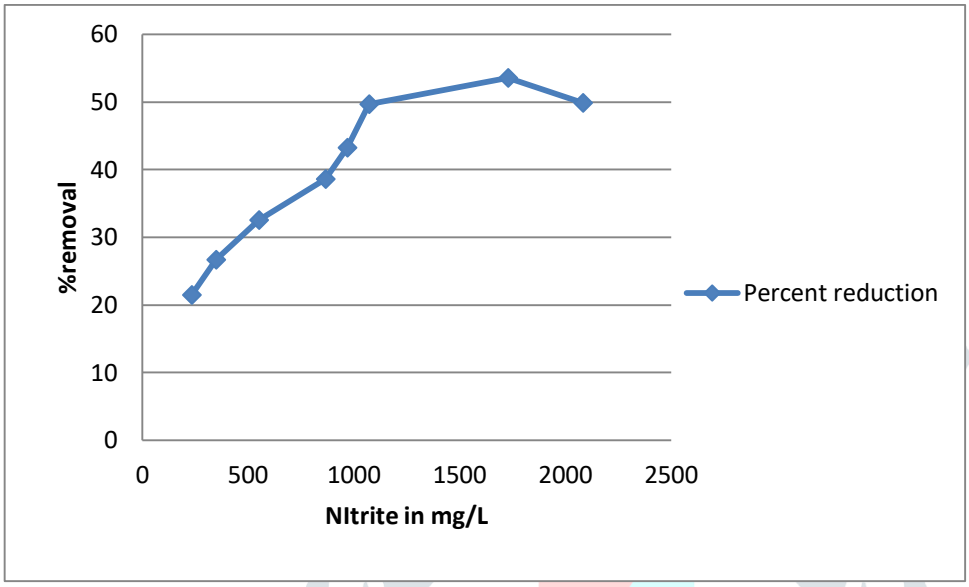

Fig .3. Nitrite Percentage Reduction.

Current and voltage Generation:

The voltage value obtained is 2.69 V The power produced for 1m² area is 0.502 watt. Current and Voltage Generation is as shown in Fig .4.

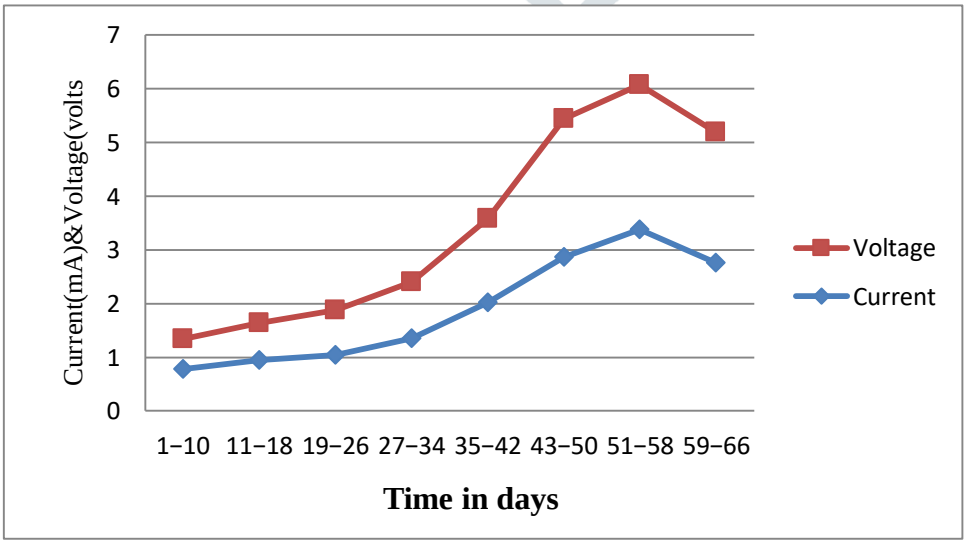

Fig..4. Variations of Current and Voltage.

CONCLUSIONS

On analyzing the results based on the laboratory experiments conducted, the following conclusions are drawn.

- Textile wastewater showed 67.03%Chloride and 54.04%Nitrite removal with different feed concentrations.
- The current, voltage and power generation in the reactor is 3.10 mA, 2.69V and 0.502W/m² respectively.

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