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GREEN APPROACH FOR THE TREATMENT OF TEXTILE WASTEWATER USING MICROBIAL FUEL CELL AND BIOELECTRICITY PRODUCTION

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ABSTRACT

Microbial fuel cell (MFC) is a green and promising alternative for saving the depleting non-renewable resources. In the present research, MFC technology is utilized to bring about detoxification of textile wastewater with simultaneous production of electricity. Textile wastewater has a high pH value, high concentrations of dyes, organic pollutants, suspended solids, chlorides, nitrates, heavy metals (high BOD and COD values). The high organic load in the wastewater makes it function as the useful substrate for microorganisms in MFC. Experimental results showed that MFC using textile wastewater gave excellent electrical output of 546 mV after 60 h of operation It has been found under the operating conditions of the experiments, there was 90–95% reduction in colour, TDS, BOD and COD of the textile wastewater.

Keywords: Textile wastewater, Microorganisms, Bioelectricity, Detoxification, Colour

INTRODUCTION

Textile industry is one of the most water polluting industry. Textile wastewater is one of the most harmful wastewaters for environment when it is released directly into water streams without appropriate treatment. The untreated or insufficiently treated textile wastewater finally on reaching water bodies severely disturbs aquatic ecology. The nondegradable characteristic of dyes. The most eminent ecological effect is water utilization and wastewater release (100-195 kg of COD/ton of completed item along with a variedrange of natural or synthetic dyes, inorganic solids, colour and high BOD, COD values. Traditionally, physical, chemical and biological methods have been utilized for the treatment of brown colouredTextile Wastewater (TWW). However, these methods are neither cost-effective nor eco-friendly as they pose certain problemssuch as significant cost of adsorbent material, production of highly concentrated sludge, formation of toxic by-products, fouling issues, etc (Ghaly *et al.,* 2014; Crini *et al.,* 2019).

Microbial fuel cell (MFC) is abio-electrochemical system that employsmicrobial transformation of wastesto generate bioelectricity. MFCs are gaining attention, due to their green approach in the production of electricity and simultaneous treatment of organic wastes/wastewater (Singh *et al*, 2017). It

is an innovative bioremediation technique which is highly efficient and environmentally friendly. MFC comprises of two parts: aerobic cathode (positively charged) and anaerobic anode (negatively charged). The anaerobic bacteria present in anode consume organic waste to release carbon dioxide, protons and electrons (Srivastava *et al.,* 2021)

The present study highlights the use of double chambered-MFC using TWW for its detoxification. The optimization of various process parameters was carried out to improve the power generation of the MFC.

MATERIALS AND METHODS

Textile Mill Wastewater Based MFC

The TWW sample was collected from Jagdamba Textile Mill, Delhi, India. Mixed bacterial and fungal strains were present in the collected sample. Experimental set up for MFC was designed and textile wastewater was added to anode. After 20 h of the experiment, constant value of cell voltage has been achieved. Then sugar solution was added to accelerate the bacterial growth. Observations of electrical output were recorded at different time intervals.

Analytical methods and Measurements

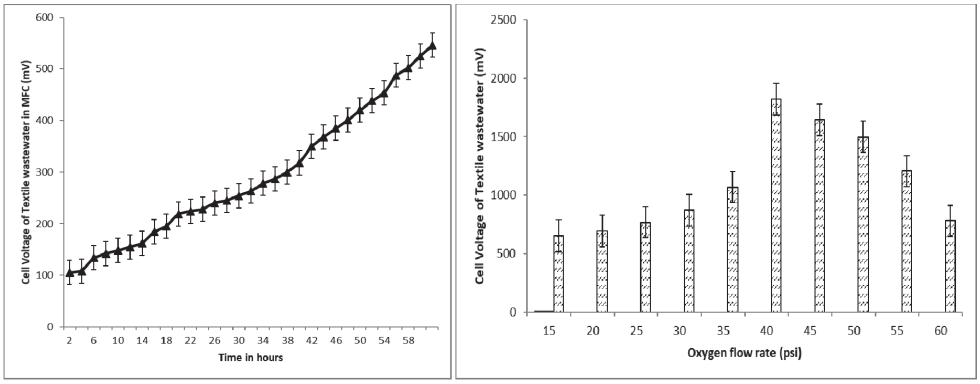
The current voltage generated during the experiments was measured using Digital multimeter (T-33). The readings were taken after every 2h interval and were recorded for a maximum of 60h.pH of the TWW sample was measured using pH meter (Systronics 335) coupled with combined glass electrode. TDS measurement was done with the help of Digital TDS meter (Tanco EE- 020).BOD calculation of the samples was carried out by using Wrinkler's method after 5 days of incubation at 27°C. COD was calculated by reflux and titrimetric method. Other parameters were also determined using analytical methods (Srivastava *et al*., 2021).

RESULTS AND DISCUSSION

Physicochemical parameters *viz*., pH, TSS, TDS, BOD, COD, *etc* of TWWwere measured and the readings are reported in Table 1. To check the performance of MFC, cell potential was continuously monitored and the observations were noted after every 2 hr. Significant increase in the cell potential (of about 25 mV) was noticed on re-adding sugar solution after 16 h in the anodic chamber containing wastewater. Addition of salt in the cathodic chamber

Table1. Physico chemical analysis of Textile wastewater before and after treatment

Parameters	Wastewater Before treatment	Spent wash After treatment
Colour	Brown	Transparent
Odour	Unpleasant	No odour
Total Dissolved Solid	8,200 (±7.30)	10,271
Total Suspended solid	3800± (5.35)	297
pH	9.1	7.8
COD	11.205 (±346.26)	245
BOD	7842 (±10.51)	150



(a) (b)

Fig. 1. (a) Plot of cell voltage *versus* time for Textile wastewater during MFC operation (b) Effect of Change in oxygen flow rate on voltage generation

of every sample improved the cell potential due to enhance in conductivity of the cathode. The maximum voltage of 546 mV was attained in Textile wastewater based MFC. Fig. 1 showed the plot between cell voltage versus time. The result clearly shows that TWW is suitable for power generation due to presence of variety of numerous microorganisms which can oxidize the pollutants present in the wastewater. This observation can be ascribed to the presence of mixed strains of bacteria and fungi in TWW, which could be inactive in the beginning but accelerated the growth under the experimental setup. The complimentary property of mixed strain of microorganisms in TWW was their ability of detoxifying the simple as well as complex components of TWW which increases the current output as the time passed.

Factors Affecting Power Generation

Effect of Oxygen Flow Rate on Power Generation

During the working of MFC, effect of oxygen flow rate on voltage generation was studied at various oxygen flow rates (15 to 60 psi). With the increase in oxygen flow rate, voltage production ranged between 652 -1820 mV (Fig. 1b). These results validate that voltage production was improved as the oxygen flow rate was raised and attained the maximum of around 1820 mV at oxygen flow rate of 40 psi, after which it started decreasing on increasing oxygen flow rate (Verma *et al.,* 2014).

Effect of pH on voltage generation

pH is one of the important factors affecting the action of microorganisms. Most microorganisms show highest growth and development within a pH range of 6.5-8.5. As indicated in Fig. 2a, highest voltage was observed at pH 8.0. The results highlighted that activity of microorganisms was lowestbelow pH ≤ 6 which could be due to the neutralization of proteins or active sites at low pH.

Pollution load reduction

During the treatment of TWW using MFC, pH decreased from 9.1 to 7.8. There was ahuge reduction in TSS. Color of the wastewater become almost transparent after treatment. TDS readings displayed the increase due to increase in number of microorganisms during treatment. COD, BOD and TSS of TWW were reduced by 97.7% 98.1% 92.2% respectively after treatment (Table 1, Fig 2b). The electricity production wasquite good with the wastewater since it has the mixed strains of bacteria and fungi which have a capacity of decomposing simple and complex components of the waste (Sghaier *et al.,* 2019).

CONCLUSION

Based on the experimental results of the present study, it can be concluded that The similar methodology was also capable to diminish the pollutants (in terms of BOD, COD, TSS and colour). The different process parameters such as pH and oxygen flow rate played a significant part in enhancing the cell potential.

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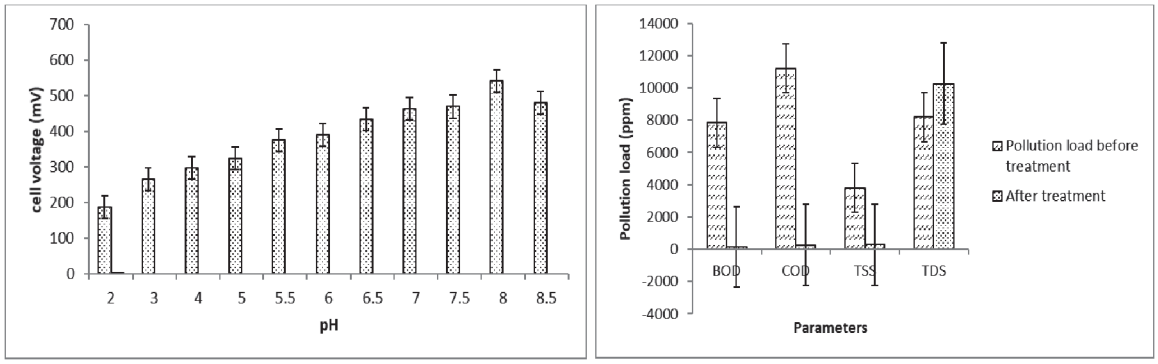

(a) (b)

Fig. 2. (a) Effect of changes in pH on voltage generation (b) Reduction in Pollution Load of Textile wastewater upon treatment in MFC

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