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Removal of Azodye And Simultaneous Power Generation by Using Microbial Fuel Cell From Waste Water: A Review.

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ABSTRACT: A microbial fuel cell (MFC) has great potential for treating wastewater containing azodyes for decolourization, and simultaneous production of electricity with the help of microorganisms as biocatalysts. The concept of MFC has been already well established for the production of electricity; however, not much work has been published regarding dye decolourization and simultaneous electricity generation using MFC. Microbial fuel cells (MFCs) represents an emerging technology that focuses on power generation and effluent treatment. This paper reflects the study of different types of MFC, membrane, electrodes, and substrate, for removal of dye and simultaneous power generation from waste water.

Keywords: Azodye, Decolourization, Microbial Fuel Cell, Substrate, PEM, Power generation, Wastewater treatment.

I. INTRODUCTION:

A microbial fuel cell (MFC) is converts chemical energy into Electrical energy by using microorganisms. In addition, a sequential treatment system with MFCs is suggested for complete mineralization of azodye. A MFC consists of an aerobic and anaerobic chamber linked by a proton transferring device, a salt bridge or the membrane. The use of waste water in the anaerobic chamber facilitates growth of the native microorganism which donates the electrons to the anode. The circuit is completed by the aerobic chamber consisting of the cathode, where the H+ ions are transferred through the salt bridge from the anaerobic substrate. The current thus produced was measured using a digital multimeter. A physical separator between the anode and cathode is called a membrane. The main function of the membrane is to transfer protons that have developed in the anode to cathode. Substrate is an important factor that supports biological activities in the MFC. Acetate, glucose, lactate, sucrose etc. Industrial wastewaters and synthetic wastewaters are the main substrates used in MFCs. For colour removal of azo dyes, much research has so far focused on biological studies conducted a study of colour removal o f azo dye using anaerobic process. In terms of the trend of treating azo dyes using biological methods, a recent up gradation is treating azo dye using MFCs. Simultaneous power generation and color removal can be achieved in this biochemical process. Azo dyes represent the largest class of dyes used in textile industries, in different stages. **[1]**

Microbial fuel cells (MFCs) represent the most recent technology to convert degradable organics into useful electrical energy. The main components of MFCs are electrodes, membranes, and substrate. In general, electrode materials exhibit characteristics such as good conduction, good chemical stability, high strength, and so on. Moreover, significant characteristics of the electrode are good biocompatibility and efficient electron transfer between the bacterial and electrode surface. This dye containing wastewater treatment technologies aim at achieving: color removal and reduction of TDS, BOD and COD. Treatment processes include physical, chemical and biological; yet they have merits and limitations. Some conventional physico-chemical processes such as adsorption, sedimentation and advanced oxidation, have been used to treat dye containing wastewater and high grade electricity generation by using MFC.

II. MICROBIAL FUEL CELL AND AZODYE:

In microbial fuel cell MFC, These electrochemical cells are constructed using either a anode and/or a cathode. Most MFCs contain a membrane to separate the compartments of the anode (where oxidation takes place) and the cathode (where reduction takes place). The electrons produced during oxidation are transferred directly to an electrode Most MFCs use an organic electron donor that is oxidized to produce CO2, protons and electrons. The cathode reaction uses a variety of electron

acceptors that includes the reduction of oxygen as the most studied process.

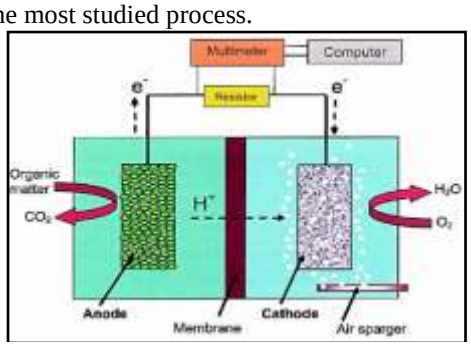

Fig 1: Structure Of MFC

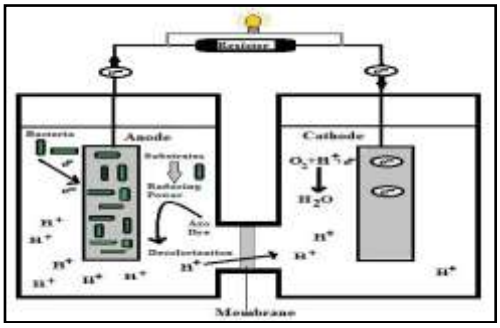

Fig 2: Two chamber MFC showing dye decolorization and power generation process.

Azo dyes are organic compounds bearing the functional group R−N=N−R′, in which R and R′ are usually aryl. They are a commercially important family of azo compounds, i.e. compounds containing the linkage C-N=N-C. Azo dyes are pervasively used to treat textiles, leather articles, and some foods. Chemically related to azo dyes are azo pigments, which are insoluble in water and other solvents.

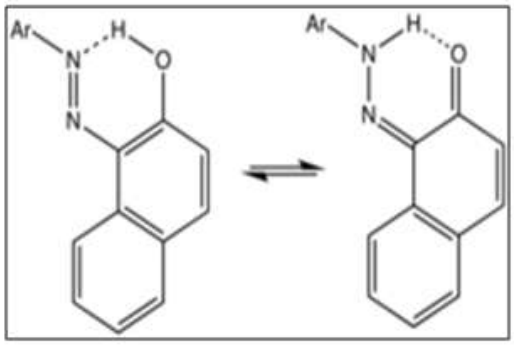

Fig 3: Structure of Azodye

Many kinds of azo dyes are known, and several classification systems exist. Some classes include disperse Dyes, metal complex dyes reactive dyes and substantive dyes. Also called direct dyes, substantive dyes are employed for cellulose-based textiles, which include cotton. The dyes bind to the textile by non-electrostatic forces. In another classification, azo dyes can be classified according to the number of azo groups The mechanism of microbial degradation of azo dyes involves the reductive cleavage of azo bonds (-N=N-) with the help of azo reductase under anaerobic conditions resulted into the formation of colorless solutions containing potentially hazardous-aromatic amines (Chang et al., 2000). **[2]** (Van der Zee and Villaverde, 2005). The azodye are organic compound that are different types yellow, orange and red. Such as methyl red, methyl yellow and methyl orange, Congo red, amaranth, acid orange & reactive blue etc. **[3]**

III. AZO DYE REMOVAL IN MICROBIAL FUEL CELLS:

Li et al., (2008) suggested that two chamber microbial fuel cell anaerobic and aerobic systems with an anode electrode material as carbon felt and cathode electrode material as a combination of carbon felt and, graphite granule. The membrane was used as a proton exchange membrane. Author introduces synthetic waste water of Congo red azo dye to an anaerobic anode chamber and treated effluent transferred to the cathode to remove aromatic amines generated from azo dye reduction. The study was conducted different concentration and optimized the electricity generation was 14.8 hours. The study was give the color removal of azodye 69.3 to 92.7% at glucose concentration of 4000 mg/L and electricity generated 387 mW/m^2at glucose concentration 1000 mg/L. **[4] [5]**

Ding et al., (2010) suggested that a study of two-chambered microbial fuel cell based on azodye removal.. During startup, the anode chamber of the MFC was inoculated with the anaerobic sludge. andanodic electrode consist of unpolished graphite electrode. And the cathode consist of polished graphite electrode and cathode chamber was filled with electrolyte and then replaced with the azodye as a methyl orange. before monitoring started. The cathodic was select the Visible light responsiveness. Rutile electrode radiated by visible light shows maximum power generation and color removal as graphite electrode 37.8%, Rutile cathode electrode 47.4%, Rutile cathode electrode irradiated by visible light 73.4%. High current density obtained in the irradiated rutile cathode electrode. **[6]**

Fu et al., (2010) suggested that combination of two chambered microbial fuel cell MFCs. Anode electrode consist of as granular graphite and cathode electrode was used consist

of spectrographic pure graphite. The separator between the anode and the cathode as membrane was used as a proton exchange membrane (PEM). Author emphasize of two different Fenton system. Conventional and electrochemical. Color removal in conventional Fenton system shows better results in comparison with electrochemical Fenton system, whereas power density is more in electrochemical Fenton system in comparison with conventional. This study was shown that power production was higher in the electrochemical Fenton system 28.3 W/m3than the conventional Fenton system 11.1 W/m Amaranth dye percentage removal efficiency was higher for the conventional Fenton system 82.59 % then the electrochemical Fenton system 76.43% removal efficiency was obtained. **[7]**

Sun et al., (2011a) suggested two chambered microbial fuel cell MFCs. And emphasized anaerobic bio cathode. Anode electrode material consist of porous carbon paper (without waterproofing) and cathode electrode consist of a porous carbon paper (without waterproofing). The separator between the anode and the cathode as membrane was proton exchange membrane (PEM) in this two-chambered MFC. Aerobic cathode and anaerobic anode MFC was used azodye as a active brilliant red X-3B. The maximum power density obtained was 50.74 mW/m2and 81.56% of the color was removed from the source of substrate. **[8]**

Bakshian et al., (2011) shows that graphite bars is used as a electrode in two chambered MFC. Which consist of proton exchange membrane as a separator. Molasses is used as the energy source in the anaerobic anode and in cathode commercial laccase with phosphate buffer along with reactive blue 221 were added. Monitoring of COD reduction and color removal were carried out. As per observation after addition of molasses maximum voltage will be of 305 mV was observed. It was stable for 30 hours. 87% of color removal rate was observed in cathode chamber and 84% COD removal was observed in anode chamber. **[9]**

Kalathil et al., (2011) suggested that in two chambered microbial fuel cell (MFC).Granular activated carbon was packed in cylindrical stainless steel mesh in one chamber and graphite rod was inserted in second chamber these combination is used as an electrode and glass wool is used as a membrane. During the experimentation the real dye wastewater was used on both the anode and cathode for the duration of 48 hours. After the experimentation it was observed that the power density was 1.7 W/m3. In anode color removal was 73% and in cathode it was 77%. **[10]**

Liu et al., (2009) suggested that used carbon felt as an electrode and cation exchange membrane as a separator for two chambered MFC. In the anode chamber glucose was added and cathode chamber azodyes was added. The various azodye were used such as orange I, acid orange 7 and methyl orange. The MFC was generated power density in the form of voltage was 250 to 15 mV was achieved about 2.7 hours. And beyond that period a sharp voltage was achieved. **[11]**

Liu et al., (2011) suggested that anode electrode material used as activated carbon fiber with electrochemical active bacteria and cathode electrode material used as carbon paper and the proton exchange membrane as a separator in a two chambered MFC. The phosphate buffer solution containing methyl orange was filled in the cathode and in anode filled with the autoclave medium and methyl orange. In this system high grade of color removal efficiency was achieved in the cathode chamber upto 99%.Maximum power density was 1.4 mW/m^2 . **[12]**

Sun et al.,(2009) suggested that using single chamber air cathode and the anode material was used as a porous carbon paper projected surface area of 6x6 cm2 and cathode material as air cathode consist of a catalyst layer (containing 0.5 mg/cm2 of Pt) on water facing side and a polytetrafluroethylene (PTFE) diffusion layer on air-proofing side. The membrane was used as a microfiltration membrane (MFM).The azodye were used as active brilliant red X-3B and the glucose, acetate, sucrose, wastewater with an initial concentration of 500 mg/L COD were used as the substrate. The color removal performance depend upon anaerobic autoclave sludge. The testing is depend upon different dye concentration such as 300 mg/L and 600 mg/L the color removal efficiency achieved at anaerobic as 80.1% but the maximum color removal efficiency is achieved in glucose and minimum at acetate. It means that, 100% color removal efficiency obtained as compare to other concentration. **[13]**

Sun et al., (2011b) used air cathode single chamber with non-wet proof carbon papers as the anode electrode and the cathode electrode material was prepared by coating 0.5 mg/cm2of Pt on a wet proofing carbon paper. The membrane was used as a separator as a microfiltration membrane. The Congo red was used as a azodye were used in bioanode. Congo red shows their results the power

generated up to 900 mg/L at the different concentrations. **[14]**

Hou et al., (2011b) suggested that different separators used in single air cathode chambered microbial fuel cell. The anode electrode consist of Non-wet-proofed porous carbon paper and a coating of 0.5 mg/cm^2 of Pt on wet-proofed porous carbon papers was used in the cathode electrode. Experiment was performed for assessment of color removal and power generation using the following different membranes such as microfiltration membrane (MFM), proton exchange membrane(PEM), and ultra filtration membranes (UFM), wit molecular cutoff weight 1 K (UFM-1K), 5K, 10K was used for high power density of 324 mW/m^2. The microbial fuel cell MFC with UFM-10K achieve high and fastest decolarization efficiency rate of the dye for Congo red. **[15]**

Zhang and Zhu et al., (2011) study was conducted in single-chambered air cathode MFC using 25 g of granular graphite with a graphite rod as the anode electrode and cathode electrode as a carbon paper and (containing 0.5 mg/cm2Pt). was used as a separator. The acid orange 7 was used as a azodye. The research was conducted using two- or single-chambered MFCs. The maximum power density obtained was 5.0 W/m^3 for single-chamber MFCs using glucose with acid orange 7. About complete color removal efficiency as (97%) was achieved after 168 hours. **[16]**

Maksudur R. Khan & Mohammad Shaiful Alam Amin et al., (2013) using two chambered microbial fuel cell MFC. The anode electrode and cathode electrode was used as a plain graphite electrode. The dye was used for decolorization is Yellow Cibacron-2G (Clariant, India) these dye local used in textile industry and the glucose is used as a substrate. The membrane was used as proton exchange membrane (PEM) Nafion was fixed between two chambered anode and cathode chamber. The textile dye continuously two chambered microbial fuel cell was conduct COD removal and decolorizaton and potentially act as a wastewater treatment unit. Three cells having the dye concentrations of 300, 600 and 900 mg/L along with 300 mg/L of glucose and azo dye concentration must be necessary to achieve high electricity production and efficient wastewater treatment. At optimum glucose and dye concentrations (300 mg/L for both) this system can simultaneously generate electricity of about 0.03 A/m2 and remove 57% of COD from the wastewater.**[17]**

Shaikh et al., (2016) using two chambered microbial fuel cell MFC. The anode and cathode electrode as a graphite electrode and the two chambered MFC is connected to Nafion 117 membrane as used as a proton exchange membrane. The azo dye methyl red decolorization in a two chambered microbial fuel cell (MFC), that is aerobic and anaerobic anode and cathode chambers. The dye decolorization at optimal condition 98% methyl red (300ppm) decolorization, 9.9 mg/l/h maximum decolorization rate and 856 mW/m^2 maximum power densities were achieved. **[18]**

IV. CONCLUSION:

According to literature survey for MFC we can conclude that decolorization of azo dye achieved with very good results. Power density needs to be improved in MFC. In future there is a good scope for biocathod technique and nanocoated electrods which helps to increase the surface area, power density and decolorization of dye. But in the single set-up of two stage microbial fuel cell (MFC) is not sufficient to achieve maximum decolorization of azodye and power density, to achieve this we need to add number of set-up in series with a different electrodes and membrane due to this we can achieved decolorization of dye and maximum power density. The electrode which is made from platinum (Pt) gives maximum power density but cost of material is very high so, we need to replace with a carbon electrode the various cells is connected in series to achieve a decolorization of azodye with simultaneous power density.

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