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Review on Electrochemical Oxidation for Degradation of Dye Effluents

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ABSTRACT

Treatment of wastewater has become a real challenge in recent years. Effluents of a large variety of industries usually contain important quantities of synthetic organics. The discharge of these colored compounds in the environment causes considerable non-aesthetic pollution and serious health-risk factors. The textile industry is one of the most important export industries of India. This paper presents a general review of efficient electrochemical techniques to decolorize dyeing effluents for environmental protection. The electrochemical treatment of wastewater is considered as one of the advanced oxidation processes, potentially a powerful method of pollution control, offering high removal efficiencies the removal of colour in textile industry. Electrochemical treatment of dye industry wastewater was investigated using different electrodes. Also it has to be seen that whether this type of industrial waste influent can be reused by proper implementation of treatment on water and choosing the correct method for treatment of dye waste water.

Introduction

The textile industry comprises a diverse and fragmented group of establishments that produce or process textile-related products. Textile establishments receive and prepare fibres; transform fibres into yam, thread, or webbing; convert the yarn into fabric or related products; and dye and finish these materials at various stages of production [1]. The process of converting raw fibres into finished apparel and non-apparel textile products is complex, so most textile mills are specialized in dyeing process. This results in the discharge of dye wastewater containing toxic and refractory organic pollutants into the environment. The efficient removal method of dye wastewater is an important demand for environment protection. The classical physico-chemical treatment processes that are used for the wastewater treatment is filtration, air stripping, ion exchange, chemical precipitation, chemical oxidation, carbon adsorption, ultrafiltration, reverse osmosis, electro dialysis and gas stripping. In recent years, electrochemical oxidation method plays vital role in the treatment of organic pollutants, because of its strong oxidation performance, mild operative condition, environmental compatibility and low operative cost [2, 3]. Electrochemical oxidation method have been in existence for many years using variety of anode and cathode geometries by passing of electric current through water, has proven very effective in the removal of contaminants from water. This paper describes the research that had been made in different aspects regarding electrochemical oxidation.

Research and discussion

Rekha & Bhavya [4] studied the electrochemical oxidation for a textile dye wastewater. It is collected from a textile processing industry was investigated in their study using *Stainless Steel* as an anode. The following parameters represent the dying effluent before treatment. The waste water is highly colored.

The BOD_5 and COD parameters are high and BOD_5/ COD ratio is anywhere between 0.15-0.3. Following are characteristic after treatment maximum color removal of 77%, COD reduction of 71% and increase in BOD_5/COD ratio from 0.1 to 0.58 is achieved. Also, increased current density increased the anode oxidation and removal rate of pollutants. Hence, it can be concluded that electrochemical treatment can be used as a pretreatment technology to treat this electrolyte.

Rathinakumar [5] studied the basic and applied aspects in the electrochemical degradation in the industrial effluent. Their study deals with the treatment of dye wastewaters from the textile industries by electrochemical oxidation using *Ti*/RuO_2-IrO_2 anode and *rotating Stainless Steel* cathode in a batch reactor. The main objective of their work is to reduce the colour of the dye effluent. Before treatment the industrial effluent was purple blue and pH value is 9.0. After treatment the color was removed and pH value reduced into 6.0. Their studied can be concluded that the color removal depends on current density, initial concentration of the dye, pH, temperature and cathode rotation speed. The increase in current density increases the color removal.

Narayana and Spoorthi [6] investigated degradation of pulp and paper mill industrial dyes by indirect electrochemical method using carbon electrodes. They used commercial pulp and paper mill industrial dyes *Basic green 1*(CAS no. 633-03-04) and *Direct Green 26*(CAS no. 6388-26-7). In their study using *graphite carbon electrodes.* During the process, degradation of the chromporic groups and aromatic rings of the dyes were proved by this method. The degradation of the dyes was followed using UV-Vis spectroscopy, LCMS, COD and TOC measurements. The maximum removal efficiency of colour 97% and 95% chemical oxygen demand (COD) of 95% and 90% and Total organic compound (TOC) of 95% and 97% could be achieved for the dyes at 2.5g/l of NaCl concentration

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They concluded that increasing the initial pH will lead to corresponding decrease in the degradation efficiency of dyes. The effects of conducting salt clearly showed that introduction of Cl ion containing electrolytes enhance the degradation efficiency of dyes.

Raja and sibi [7] studied decolorization of synthetic and real polluted water by indirect electrochemical oxidation process. In their paper the decolorization and degradation of synthetic and real polluted water by electrochemical oxidation method were investigated. Synthetic polluted water consisting of Fast Blue B Salt (FBBS) was used as a model compound. Electrochemical degradation processes were performed using *Graphite* as an anode Stainless Steel (304) as a cathode. In the bulk solution, the strong oxidizing potential of the chemicals were produced when the polluted water was passed through the polluted water was passed through the electrolytic cell. The organic pollutants were oxidized to little or harmless organic molecules, carbon dioxide and water. The results indicated that the removal of chemical oxygen demand (COD) and color were 75% and 88% respectively. The removal of COD and color increased by increasing voltage and chloride concentration at low pH. They concluded the effectiveness and ease in operation, this technique can be applied for treatment of large volume and industrial scale of textile polluted water.

Babu [8] investigated use of electrochemical and biological process on dye waste water treatment. The *azo dye* used in this investigation was obtained from a textile-dyeing factory. By this process about 70% of COD removed and 80% of color was removed. The intensity of UV-Vis spectra was reduced drastically that clearly indicates Azo dye degradation with electro-oxidation followed by biological treatment.

Morsi and Al-sarawy [9] studied electrochemical degradation of some organic dyes by electrochemical oxidation on a Pb/PbO_2 electrode. Their work investigated the electrocatalytic degradation of three types of textile dyes by electrochemical oxidation on *lead oxide* anode. The influence of pH, current density, time of electrolysis, temperature, the conductive salt concentration and the initial dye concentrations were critically examined. The results of these influences are expressed in terms fo the remaining organic compounds concentrations (color removal) and Chemical Oxygen Demand (COD) removal. The electrochemical treatment of simulated wastewater containing the investigated in NaCl conductive electrolyte and under several operating conditions using of Pb/PbO_2 electrode. The results of their studies revealed the following: The optimal electrocatalytic activity was achieved in the presence of NaCl (3g/l) for Pb/PbO_2 electrode in which the degradation of the investigated dyes occurs by both direct as well as indirect oxidation. The optimal electrocatalytic activity was achieved at applied current density of 30mA/ cm^2 for Pb/PbO_2 electrode. The optimal electrocatalytic activity was achieved at pH of 3 and temperature of 30^0C for Pb/PbO_2 electrode. Both of the color and COD removal are increased with treatment time and high current efficiency was achieved.

The electro oxidation is the method where every toxic materials of the wastewater is removed [9-11]. Apart from this the type of work depends on the selection of electrode and its characterization and specific parameters and also the characterization of wastewater before and after treatment were also studied.

Conclusions

Water is the important source for all type of living being in the world. The electro-oxidation process is a method which is successfully applied for industrial wastewater treatment whereas it does not produce any hazardous materials to the environment.

The electrochemical oxidation method is the proven method for the degradation of both chemical and biological demand of the wastewater taken. This review tells about the treatment of wastewater by various methods and the effectiveness of the method was also shown. This review is an initiation of conserving and treating wastewater to develop sustainable environment.

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