Electrochemical Peroxidation Applied to Real Wastewater Treatment of the Confectionery Industry.

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In the present study, the electrochemical peroxidation process was applied to the effluent of a company where confectionery products are produced, the process consisted of adding hydrogen peroxide to a 200 mL Bach cell, it was determined that with a current density of 20 mA/cm^2 and a concentration of 13 mmol/L of H_2O_2 in the cell, the chemical oxigen demand (COD) decreased by 61.09 % (initial pH=3), when the initial pH was 4.98 (without modifying the original value) the decrease was 62.51 %, However, when the initial pH is 3, COD decreases rapidly at the onset. The experiments lasted 1 hour. In the treatments carried out, cyclic voltammograms and UV-Vis spectra were obtained.

Introduction

The wastewater with the highest levels of contamination are those that come from industries, the effluents from the confectionery industry, can contain substances such as: sugars, honey, starch, molasses, fats. and additives such as: antioxidants, colorants and acidulants, the organic matter of these substances generate negative effects on the soil, plants and aquatic life.

Wastewater containing substances related to the confectionery industry has been treated by applying different processes, for example, Electro-Fenton [1], chemical coagulation and electrocoagulation [2], other methods have included ozonation, or use of filtration membranes [3].

The electrochemical peroxidation process (ECP) consists of the direct addition of hydrogen peroxide to a wastewater sample and thus degrade the organic compounds present. In ECP, iron ions function as a catalyst to decompose the peroxide to hydroxyl radicals, so This process is a variant of the Fenton process in which •OH radicals are generated (Eq. 1), which have greater oxidizing power and can increase the decomposition or mineralization of organic matter.

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + \bullet OH \quad (1)$$

The ECP has been applied in various areas, in [4] was applied peroxidation to wastewater from the biodiesel industry, optimizing the response variables with a Box-Behnken design, they found that fats and oils decreased 97.5% when the optimal conditions were; COD/H_2O_2 ratio of 0.4, applied current of 1 A and 32.8 minutes of reaction time. On the other hand, [5] applied electrochemical peroxidation to treat leachate from domestic waste landfills, with pH factors = 4 and 200 ppm H_2O_2, achieving a 52% reduction in COD.

In the present study, the electrochemical peroxidation method is applied to the treatment of wastewater samples from the confectionery industry. It is studied how the applied current density, the concentration of hydrogen peroxide and the modification of the pH can influence the results, in In both processes, COD is evaluated as the main parameter indicating the reduction of contaminants.

Material and Methods

The power source used was Keatronic 30/10 brand, the electrodes consisted of commercial iron sheets with 10 cm^2 of surface area each and a separation between them of 1 cm, the COD was determined by digestion of the sample with dichromate in an acidic medium, distilled water was used to prepare H_2O_2 solutions, and to adjust the pH, 0.5 M H_2SO_4 and 1 M NaOH, voltammograms were obtained in an AUTOLAB potentiostat, and the UV-vis spectra were performed in a Perkin Elmer Lambda 365, the system was agitated at a speed of 200 rpm. In the first stage, the effect of current density and H_2O_2 concentration was evaluated and then work was done with variation of the initial pH.

Results and Discussion

The characterization of the wastewater presented the following values: pH = 4.98, EC = 1.95 mS/cm, Turbidity = 633.33 FAU, Fats and Oils = 328.75 mg/L, COD= 4523.466 mg O_2/L, settleable solids: 5 mL/L. Two current densities 10 and 20 mA/cm^2 and two H_2O_2 concentrations in the cell were evaluated (6.5 and 13 mmol/L). As can be seen in Figure 1, the degradation of organic matter increases when there

is a higher concentration. of H_2O_2, due to the greater generation of •OH radicals especially in the first 15 minutes, similar results have been found in the literature [6]. When experiments were carried out to treat water oil mill residual [7] determined that the optimal molar ratio of H_2O_2/Fe^{2+} was 15:1 to minimize the formation of sludge at the end of the process.

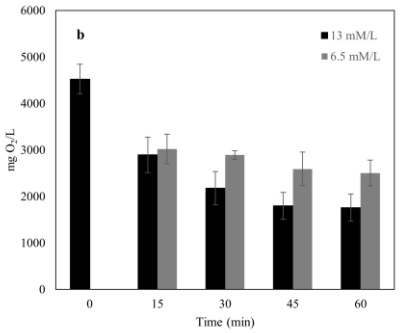

Figure 1. Reduction in chemical oxygen demand (COD), for different H_2O_2 concentrations at the end of the treatment, applying 20 mA/cm^2.

The UV-Vis spectrum graphs of this experiment showed a decrease in absorbance from 200 to 700 nm (Figure 2.), which indicates that with ECP a decrease in the organic matter present is generated, in wastewater there is a peak from 240 to 275 nm and in the treated water there is still a peak near 350 nm but on a smaller scale which indicates both a decrease in the amount of organic matter present and the modification of its composition.

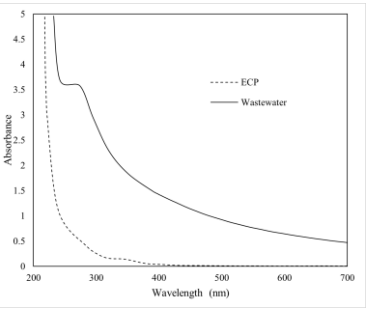

Figure 2. UV-Vis spectra of wastewater compared to ECP treatment (20 mA/cm^2 and 13 mmol/L H_2O_2).

The modification of the initial pH showed changes in the system, for example, when the initial pH tends to increase, the decrease in COD is less, this may be due to the fact that at high pH the organic matter separates in the form of flocs, forming precipitates with iron oxides [8], in this way the iron is no longer available to interact with H_2O_2 and form hydroxyl radicals.

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Conclusions

The treatment of waste water from the confectionery industry was carried out with electrochemical peroxidation, applying a current density of 20 mA/cm^2, a decrease in the organic matter present is generated and with a concentration of 13 mmol/L of H_2O_2 the process is improved, in this case it is better to apply the process with a pH between 3 and 4 since in this range the decrease in organic matter is faster.

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