Reduction of Chemical Compounds in Petrochemical Effluents Through Electrocoagulation

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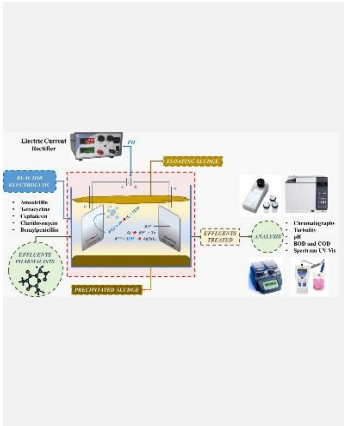

This project proposes a solution for the treatment of industrial effluents, combining the technique of electrocoagulation with adsorption in a hybrid process. Using aluminum/iron electrodes, electrocoagulation stands out in the removal of contaminants in liquid effluents from various sectors. The effectiveness of this hybrid process is optimized through careful manipulation of experimental variables, such as electric current density (ECD), distances between electrodes (DBE) and time operation (OT). The synergy of these variables, coupled with the addition of an oxidizing agent, results in a significant reduction of pollutants after treatment. In addition, the project aims to develop a neural network model to study and optimize the hybrid effluent treatment process. This model will allow a deeper understanding of the complex interactions between the process variables and will help identify the ideal conditions for maximum treatment efficiency. The implementation of this neural network model promises to take the effectiveness of the hybrid effluent treatment process to a new level. This project represents a significant step towards a more sustainable and ecologically responsible future.

Introduction

The choice of water treatment process must be based on analyzes and examinations carried out over time. Treatment techniques are constantly evolving, allowing online monitoring of the quality of treated water. New treatment methods are being studied, such as electrocoagulation with aluminum electrodes, which has been shown to be effective in the degradation of phenolic compounds and separation by decantation [1].

This study focuses on the application of electroflocculation, an emerging technique for the treatment of industrial effluents. Specifically, the effluent in question is generated in a catalytic alkylation process by a local petrochemical company, containing compounds such as phenol and nonene. Electroflocculation, carried out with aluminum electrodes, has demonstrated effectiveness in degrading these phenolic compounds.

This work aimed to study the treatment of an industrial effluent generated in a catalytic alkylation plant between phenol and nonene, supplied by a company in the petrochemical sector in the region, using electrocoagulation technology with aluminum/iron electrodes.

Material and Methods

The effluent to be treated was supplied by a petrochemical process company from the petrochemical complex in the Mauá region - SP. The study of treatment of phenolic industrial effluent by electrocoagulation (EC) used the developed electrolytic reactor of the batch type, composed of an electrical source, plastic resin electrolytic tank and a support grid for the aluminum electrodes in parallel arrangement (3 cathodes and 3 anodes).

The experiments were conducted according to the experimental plan, varying the study parameters: operating time - OT (10, 20 and 30 min), electric current density - ECD (8.47, 16.9 and 25.4 $mA.cm^{-2}$) and distance between electrodes - DBE (0.5, 1.0 and 1.5 cm). The polarity between the electrodes was kept constant during each experiment.

To evaluate the effectiveness of the treatment, various analysis methods will be employed, including Total Organic Carbon (TOC), Chemical Oxygen Demand (COD), phenolic compounds, Turbidity, Hydrogen Ion Potential (pH), Conductivity and iron ion. For comparison purposes, an artificial effluent was prepared with phenol with a concentration of approximately 200 ppm of phenol PA with a concentration of 99.99% and was treated for 4 hours.

Results and Discussion

The Table 1 presents the results obtained for the parameters studied. It is noted that under the study conditions, no parameter was found to be significant. However, it was possible to notice that the electroflocculation technique was effective in all parameters, which reduced the TOC, COD, phenol, turbidity and iron ions values, for the pH values there was a change from an acidic to a basic effluent and the conductivity remained practically constant.

Based on previous experience and research, we know that the intensity of the electric current, the distance between the electrodes and the operating time are variables that influence the process.
Furthermore, we observed that the smallest amounts of Phenol are found when using shorter distances and longer times. Likewise, for greater currents and shorter distances, we also find smaller amounts of Phenol.
These observations suggest that although the parameters were not shown to be significant in this study, they still play an important role in the process and can be optimized to improve treatment efficiency.
As reported by Abdulredha and colleagues [2], phenol removal increased significantly with prolongation of treatment time. Removal effectiveness rose from 18% to 57% as treatment time extended from 20 to 120 minutes.
Based on this observation, this study carried out a treatment using a synthetic phenolic effluent, seeking to get as close as possible to the industrial effluent tested. Another advantage is the reduction or even elimination of the use of chemical products, in addition to a considerably shorter treatment time compared to traditional methods. This is particularly relevant when considering the essential parameters for evaluating effluent reuse, such as turbidity, pH and COD.

Table 1. Values of variables and parameters obtained in the treatment of effluent using electrocoagulation.

Exp	OT	ECD	DBE	TOC***	COD***	Phenol (ppm)***	Turbidity (NTU)***	pH	Conductivity ($mScm^{-1}$)***	Iron (ppm)***
00**	**-**	**-**	**-**	331.1	827.8	172.12	426	3.21	57.7	40.01
7	**10**	**25.4**	**1.5**	310.1	769.4	152.48	2.38	7.65	56.5	0.811
10*	**20**	**16.9**	**1.0**	313.4	762.0	150.59	1.62	8.47	56.6	0.678
9*	**20**	**16.9**	**1.0**	308.0	755.8	159.25	1.68	8.38	56.6	0.700
4	**30**	**25.4**	**0.5**	301.7	754.3	141.66	1.73	8.14	56.7	0.702
3	**10**	**25.4**	**0.5**	302.3	753.0	148.28	2.06	7.98	56.8	0.719
5	**10**	**8.47**	**1.5**	301.2	760.8	147.02	43.6	5.72	56.5	1.532
6	**30**	**8.47**	**1.5**	304.3	775.3	153.21	2.51	8.39	56.5	0.731
1	**10**	**8.47**	**0.5**	307.8	787.4	144.18	43.5	5.62	56.6	1.697
2	**30**	**8.47**	**0.5**	304.8	769.9	158.05	2.55	8.31	56.9	0.696
11*	**20**	**16.9**	**1.0**	308.9	308.9	157.21	1.44	8.41	56.8	0.718
8	**30**	**25.4**	**1.5**	315.0	315.0	156.89	1.66	8.42	56.8	0.737

* Central Points of Experimental Planning Untreated sample** Average results acquired ***

Conclusions

The results presented by this study showed that the EC method reduced the phenol content in the industrial effluent used. The bench-top EC unit reduced the phenol level by approximately 40%, indicating that electrocoagulation can be an excellent alternative for treating this type of effluent. The ideal efficiency for clarification and physical appearance was found with OT between 10 - 20 minutes, with an ECD between 8.47 to 25.4 mA cm^{-2} and a DBE between 0.5 - 1.5 cm. For the removal of phenols, the ideal efficiency was found with an OT of less than 120 minutes, with an ECD of 25.4 $mA.cm^{-2}$ and a DBE of 1.5 cm. Furthermore, the electrocoagulation process reduced turbidity by up to 99%, adjusted the pH to a range of 8-9 without the need to add an acid or base, reduced the phenol content present in the effluents, showing efficient elimination of these compounds..

Acknowledgments
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