**Improvements in the treatment of the polluted streams containing non-polar organochlorine pesticides**

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**Highlights**

* The efficiency in the degradation of oxyfluorfen increases with concentration strategies.
* The most efficient process is the combination of electrocoagulation and electroFenton.
* The solid produced in electrocoagulation can be efficiently treated as a solid phase.

**1. Introduction**

The removal of chlorinated organic compounds from wastewater has become a matter of high interest lately due to their high toxicity, persistency and bioaccumulation.

In order to minimize the mass transfer limitations related to the treatment of low-concentrated streams the development of concentration strategies may be the solution. They can be integrated to the main treatment process or coupled as a pre-treatment step. When choosing a treatment technique, the nature of the pollutant must be considered. According to their physical and chemical proprieties, the organochlorine pesticides can be classified as polar or nonpolar, ionic or nonionic. For the ionic polar pollutants such as 2,4-Dichlorophenoxyacetic acid, electrodialysis combined with electro-oxidation offers a good solution to treat high volumes of wastewater, as demonstrated in our previous work [[1](#_ENREF_1)].

For the nonpolar nonionic pesticides, the concentration by electrocoagulation was successfully developed in a previous work [[2](#_ENREF_2)] leading to various treatment options that can be further applied. By applying the electrocoagulation as a pre-concentration step, it can be achieved the transfer of the pollutant from the liquid phase into a smaller volume of solid phase. The solid phase can now be dissolved and treated as a liquid waste or, treated as it is, like a solid or pulp.

This work aims to demonstrate that by concentrating the wastewater applying a cheap and noninvasive concentration technique followed by an aggressive degradation step it is possible to increase the removal efficiency and to reduce the energy consumption. Moreover, different alternatives for the treatment of the concentrated stream are presented and compared.

**2. Methods**

In this work, 2 types of electrochemical cells and 3 technologies were used. The first cell, a homemade cell equipped with a Fe anode and a BDD cathode it was used for electrectrocoagulation, EC (j = 50 Am-2). The second cell, a commercial Adamant Cell equipped with BDD electrodes, was used for electrooxidation (EO) and electroFenton, EF (j= 254.67, j= 177.33 and j= 63.6 A/m2 respectively). In order to dissolve the concentrated phase it was added H2SO4.

When the concentrated phase is treated as solid, it must be applied another disturbing agent, ultrasound irradiation in this particular case, (75 khZ and 1MhZ) in order to alter the structure to release the pollutant for its further electrochemical removal step.

The concentration of Oxyfuorfen was measured by means of High Performance Liquid Chromatography (HPLC) equipped with an analytical column Phenomenex Gemini 5 μm C18.

**3. Results and discussion**

By applying EO to a non-concentrated wastewater, it was possible to achieve a removal of Oxyfluorfen from 100 to 79 mg/l in three hours at j= 254.67 A m-2. When electrocoagulation is previously applied and the concentrated phase is treated as a liquid stream (acidified with H2SO4), it is possible to achieve a removal of Oxyfluorfen from 1250 to 776 mg/l with EO, giving a specific power consumption almost 10 times lower than that required when treating the raw diluted solution. When applying EF, the concentration can be reduced from 1340 to 69.3 mg/l F in only three hours at the same current density, thus resulting in the best performance when the concentrated solution is treated as a liquid.

The treatment of the concentrated phase as a solid phase (as it is obtained in the EC process) is still in development but the preliminary results obtained so far show that by applying ultrasonic irradiation to the mixture it is possible to release an important amount of the pollutant that is trapped into the flocs, being the best performance obtained when the lowest ultrasound frequency is applied.

**4. Conclusions**

This work demonstrates that by previously concentrating a wastewater containing non-polar organochlorine pesticides, it can be significantly increased the removal efficiency, being the combination of EC with EF the process with the better performance.

Moreover, the treatment of the concentrate as a solid phase seems to bring promising results opening a new path for the treatment of this type of contaminants.

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**References**

[1] J. Llanos, A. Raschitor, P. Cañizares, M.A. Rodrigo, Exploring the applicability of a combined electrodialysis/electro-oxidation cell for the degradation of 2,4-dichlorophenoxyacetic acid, Electrochimica Acta, 269 (2018) 415-421.

[2] M. Muñoz, J. Llanos, A. Raschitor, P. Cañizares, M.A. Rodrigo, Electrocoagulation as the Key for an Efficient Concentration and Removal of Oxyfluorfen from Liquid Wastes, Industrial and Engineering Chemistry Research, 56 (2017) 3091-3097.