

Degradation route for amaranth dye by sonoelectrochemical process using BDD anode

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Introduction

Amaranth dye is an organic compound largely used in food and beverage industries. It can be found as potential pollutant in aquatic environments and it has been classified as endocrine disruptor (ED) [1,2]. This study describes the amaranth degradation upon ultrasonic action associated to an electrochemical system using BDD anode, defined as sonoelectrochemical process. The effects of concentration decay, pH influence, energetic and current efficiencies, as well as discoloration rate were evaluated. After 5 h electrolysis, in the best current density condition (35 mA cm^{-2}), the analyses of intermediates were performed using HPLC-MS to identify aromatic and aliphatic reaction products.

Experimental

The degradation of amaranth dye (100 mg L^{-1} in $0.05 \text{ mol L}^{-1} \text{ K}_2\text{SO}_4$ aqueous solution, pH 12) was investigated using electrochemical systems consist in a one-compartment pyrex cell (400 mL) with temperature control at $25 \pm 1 \text{ }^\circ\text{C}$. A BDD electrode with geometric area 9.68 cm^2 was used as anode and a platinum wire with the same area as cathode and the reference electrode was an Ag/AgCl. To the electrochemical system was coupled an ultrasound device operating at 20 kHz and 523 W of electrical power. Different electrolysis of 90 minutes was performed using current densities in the range of 10 to 50 mA cm^{-2} .

Results and discussion

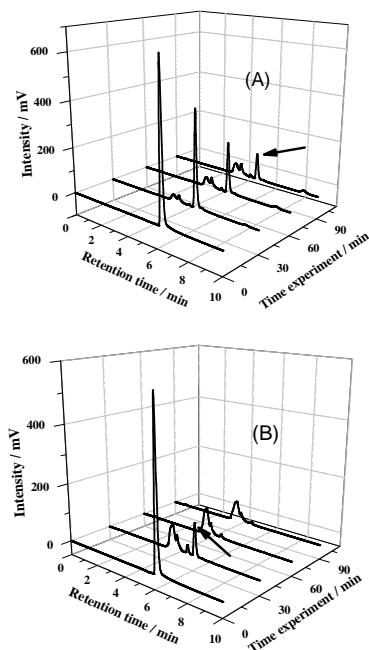


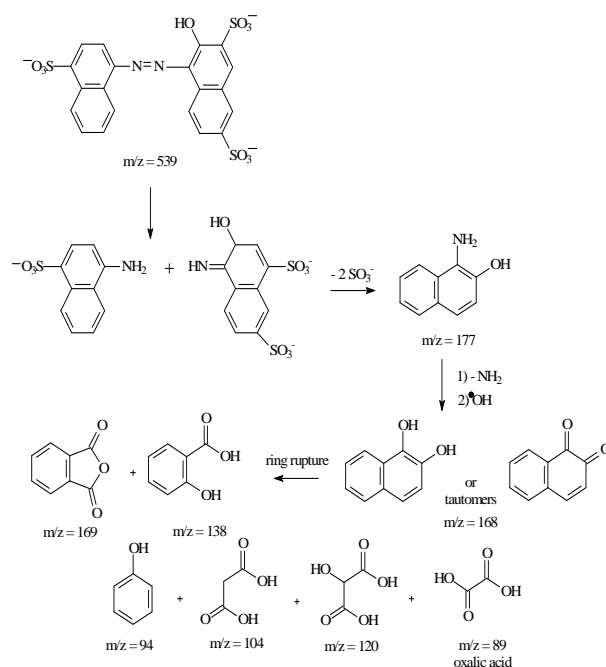
Fig. 1. Concentration decay as time function for the (A) electrochemical and (B) sonoelectrochemical processes using HPLC technique for 35 mA cm^{-2} .

Fig. 1 (A and B) shows the analysis for amaranth concentration decay with electrolysis time. It can be observed the appearance of the peaks corresponding to the degradation products formed.

Table I. Parameters for the electrochemical (EC) and sonoelectrochemical (SEC) galvanostatic oxidation at 35 mA cm^{-2} of the amaranth (100 mg L^{-1}) in $0.05 \text{ mol L}^{-1} \text{ K}_2\text{SO}_4$ solution using BDD anode

	TOC _{rem} / mg L^{-1}	CE / %	EC / kWh m^{-3}
EC	84.6	23.7	7.6
SEC	90.0	25.2	7.22

Table I shows some parameters associated to the amaranth oxidation electro and sonoelectrochemical process. According to HPLC analysis (Fig. 1), after 90 minutes, the amaranth is completely removed. The by-products formed during the treatments were identified by HPLC-MS and the Scheme 1 suggested the possible degradation route for the amaranth dye during the sonoelectrochemical process, can be observed the rupture of azoic bond and formation of two primary amines.



Scheme 1. Sonoelectrochemical degradation pathways of amaranth dye.

Conclusions

The best results for amaranth degradation were obtained by using the sonoelectrochemical process that showed a synergic effect. Studies have shown that the electrochemical and sonoelectrochemical oxidation of amaranth in BDD electrode were both effective for the total removal of this compound after 90 minutes. The by-products were determinate and they can also be removed by the processes applied.

References

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- [2] Y. G. Adewuyi, *Ind. Eng. Chem. Res.* 40, (2001), 4681.

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