Photo-Fenton degradation of the hydrochlorothiazide in aqueous medium

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INTRODUCTION

The occurrence of human pharmaceuticals and endocrine disrupting compounds in wastewaters and in surface waters has been reported.[1]

The lack of water treatment processes and effluent combined with adequate diversity of these contaminants, which have been found in domestic sewage and industrial development, creates the need for new treatment processes that ensure a good removal efficiency of these emerging pollutants.

The aim of the study was to optimize and evaluate the efficiencies of photo-Fenton (Fe^{2+}) and (FeOx) processes in the degradation of hydrochlorothiazide using a recirculation flow-through photoreactor and blacklight irradiation. The concentrations of H_2O_2 (x_1) and Fe^{+2}/FeOx (x_2) were independent variables in a central composite design (CCD) experiment, and the remaining concentration of hydrochlorothiazide (HPLC-UV) and the percentage removal of total organic carbon (TOC) were monitored responses. The central point concentrations for CCD, represented by the coded values 0, were established as 0.3 mM for Fe^{+2}/FeOx and 0.61 mM for hydrogen peroxide.

RESULTS AND DISCUSSION

The quadratic models are shown in Equations 1 and 2, in which the standard deviations of the coefficients are presented in parenthesis.

$$[HZT] = \underset{(0.131)}{0.181}x_1 - \underset{(0.131)}{1.55}x_2 + \underset{(0.107)}{1.35}x_2^2 - \underset{(0.1849)}{0.237}x_1x_2$$

$$(R^2 = 0.799) \tag{1}$$

$$TOC = \underset{(3.908)}{20.45} + \underset{(2.397)}{7.65}x_1 - \underset{(2.397)}{3.605}x_2 - \underset{(2.849)}{5.366}x_1^2 - \underset{(2.849)}{6.616}x_2^2$$

$$(R^2 = 0.951) \tag{2}$$

When ferrous sulfate was the font of ferrous, the degradation of HZT was fast and after 30 minutes no more HZT was found in the majority of the 9 experiments, therefore the percentage of TOC removal was used as response. However, when the FeOx was used the remaining concentration of HZT was used as response, because the oxalate increases the organic carbon of the solution and in 30 minutes the percentages of TOC removal is not significant. The response surfaces, constructed on the basis of the adjusted models, representing the remaining concentration of HZT (y_1) and the percentage of TOC removed (y_2), respectively.

According to response surfaces the best iron concentration for both Fe^{+2} and FeOx is close to 0.4 mM. But for the FeOx, within the experimental area, the concentration of H_2O_2 was not significant and the best response was obtained with the least concentration (0.18 mM), while to Fe^{+2} this was significant and the best response was obtained with 0.82 mM.

The results shows that the Fe^{+2} was more efficient for removing HZT. After the optimization, when Fe^{2+} was used, no more HZT was found after two minutes of the reaction, and the percentage of TOC removing was 30%. However, when FeOx was used, only after ten minutes the HZT was not found, and the percentage of TOC removing was 12%.

Ferrioxalate complex used as a source of iron has shown to be more efficient in most studies in the literature, [2,3] except in degradation of chorophenols which involves a specific mechanism with the formation of intermadiates that catalyze the Fenton reaction. The presence of ferrioxalate probably interferes with the formation of these intermediates and slows the reaction. [4] Probably the same happens to HZT. Studies to identify the reaction intermediates are being developed to assess this possibility.

CONCLUSION

The most efficient degradation of the hydrochlorothiazide for both (Fe^{+2} and FeOx) iron concentration is close to 0.4 mM, but Fe^{+2} seems to be more effective.

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