Degradation of Pantoprazole in aqueous solution using ozone and ozonation enhacement by hydrogen peroxide and nanoparticles Fe/Cu as catalysts

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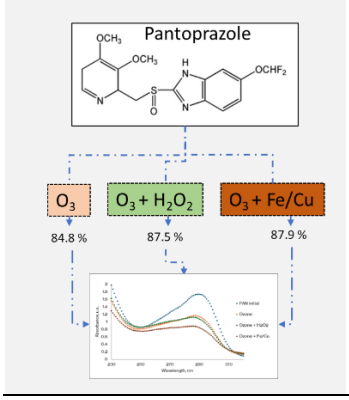


In this study, ozone treatment with H_2O_2 and Fe/Cu nanoparticles synthesized were used as catalyst for the degradation of Pantoprazole (PAN) in aqueous solution. Under condition of pH 9.6, 200 µL of H_2O_2, 1g of Fe/Cu nanoparticles and 50 mgL^{-1} of concentration of PAN, in 90 minutes of treatment the degradation porcentage was 84.8 % , 87.5 % and 87.9 % in O_3, O_3 + H_2O_2 and O_3 + Fe/Cu teratment respectively. The catalyst was prepared by green reduction using eucalyptus extracts and pumice blocks as a support; it was characterized by SEM, FTIR spectroscopy and UV-Vis spectrophotometry.

Introduction

Emerging pollutant (EPs) are a class of chemical pollutants and are defined as synthetic or naturally ocurring chemicals that are not commonly monitored in the environmental and poses potential risks to human health and the environment's ecological balance [1, 2].

This contaminants have emerged in recent years due to the high consumption of products sucah as: medications, personal-care items, cosmetics, insecticides, agricultural practices, electricity generation, among others.

Advanced oxidation process (AOPs) have been successfully used to remove these kind of compounds from drinking water with effective results. The ozone-based AOPs to treat wastewater is used due to its high oxidizing power (1.08V), ozone can oxidize most organic contaminants, it can be in two ways, directly attacking electron-rich sites or by indirectly producing hydroxyl radicals (OH•). On the other hand, the combination with others oxidizing agents or catalysts helps to improve the degradation of ozone-resistent organic micropollutantas and prevents the formation of toxic by-products [3].

Pantoprazole (PAN) is one of the most commonly consumed drugs worlwide, and the consumed PAN is excreted as inactive or active metabolites in urine and faces, be present in domestic wastewaters (up to 0.18 µg L^{-1}) [4].

The main goal of this study is to investigate the degadation of pantoprazole in aqueose solution with ozone system using hydrogen peroxide and nanoparticules (NPS) of Fe/Cu as catalyst.

Material and Methods

The pharmaceutical PAN of 40 mg, was synthesized by Intas Pharmaceuticals Ltd, hydrogen peroxide (30 %) was purchased from Merk, $CuSO_4 \cdot 5H_2O$ purity 99.1% and $FeSO4 \cdot 7H_2O$ were acquired from Fermont. Fe/Cu nanopaticles prepared by green reduction, using eucalyptus extract as a reducing agent, supported on pumice stone blocks,

Solution of 50 mgL^{-1} of PAN was used on each experiments, desionized water was used in all the experiments.

The ozone treatment in batch mode was carried out in a glass bubbling reactor with a capacity of 1. 2 L, with a entry of the gas, entry of the solution of PAN (1 L), one exit where residual ozone is transported to the ozone destroyer (Pacific Ozone Heated Catalytic Ozone destruct) and one exit were samples were taken at different times during 90 minutes in order to determine UV-Vis. The ozone used was produced in an electric corona discharge ozone generator (Pacific Ozone Technology, Mod), the concentration of ozone was 6.5 mgL^{-1}, determinated by the colorimetric technique of indigo blue [5]. To improve ozonation was used 200 µL of hydrogen peroxide and 1g of Fe/Cu nanopaticles.

PAN was spectrophotometrically monitored in a UV-Vis spectrophotometer Perkin Elmer precisely Lambda 365 UV-Vis spectrometer, betwen 200 and 350 nm.

Results and Discussion

The degradation of PAN in each treatment was determined with the absorption spectra of the samples at different times, the porcentage of

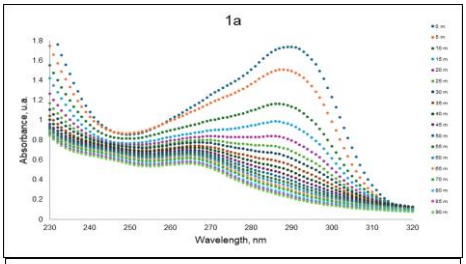
degradation was calculated in the maximum intensity band at λ_{max} of 290 nm of PAN, following ecuation 1 [6].

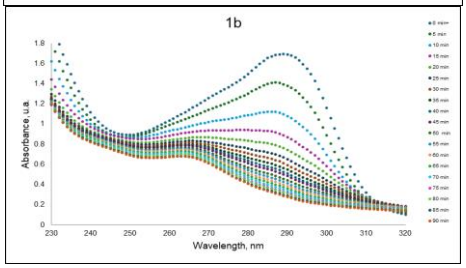
$$\% \, Degdaration = \left(\frac{A_0 - A_t}{A_0}\right) * 100 \qquad (1)$$

Where A_0 and A_t are initial absorbance and absorbance after treatment at different time intervals, respectively. Reports results are the avarege of two tests.

Figure 1, show the absorption spectra obtained during the tree diferent experiments during the treatment time (90 minutes), ozone (Figure 1a), ozone with H_2O_2 (figure 1b), and ozone with Fe/Cu nanopaticles (figure 1c), it can be seen how the intensity of the main band (λ_{max} = 290 nm) of each experiment decrease after 5 minutes of treatment.

In figure 2 can be observed the degradation of PAN after 90 minutes of treatment resulting in a 84.8 % with ozone, 87.5 % in ozone with H_2O_2, and 87.9 % in ozone with Fe/Cu NPS.





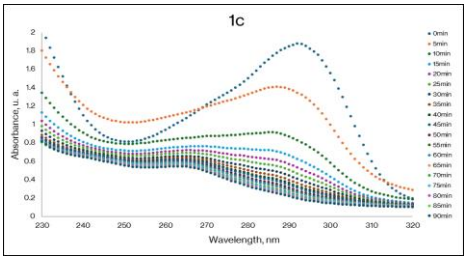


Figure 1. UV-Vis spectra of PAN (50 mgL^{-1}) in, 1a) Ozone treatment, 1b) Ozone with H_2O_2, and 1c) Ozone with Fe/Cu nanoparticles.

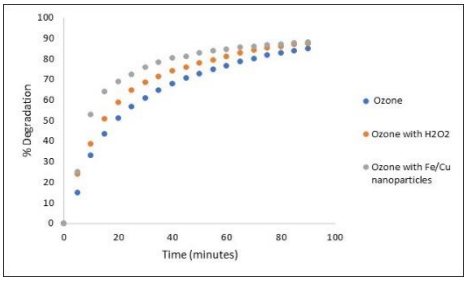


Figure 2. % of degradation of PAN at λ_{max} (290 nm)

As can be seen in figure 2, the porcentage of degradation increases with the aplication of catalysts such as hydrogen peroxide and Fe/Cu NPS especially in the first ten minutes of reaction.

This results are consistent with the research conducted by Della Rocca, et al (2021), which evaluated the use of Ag_2MnO_4 as catalyst in a peroxidation and photo-peroxidation teatment to degrade pantoprazole from aqueous suspension, they found that the catalys and H_2O_2 enhance the mineralization rate, reaching more than 95% of mineralization [4].

Conclusions

The basic pH at the beginning of the treatment favors the degradation of pantoprazole through the indirect route of ozone due to the generation of hydroxyl radicals. It is necessary to investigate the degree of mineralization of the effluent through TOC and chromagraphic analysis.

Ozonation is improved with the addition of the bitmetallic catalyst, with the possibility of reducing treatment time.

Acknowledgments

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