Removal amoxicillin by Fenton reagent in aqueous solutions

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Introduction

The development of pharmaceutical industrial fields and other important sectors of the world economy the water consumption increased which led to the degradation of its quality. In the anthropogenesis impacts, contamination of natural water by the pharmaceutical waste effluents plays an essential role. Under action of different external factors (light, temperature, humidity etc.), there comes to pass degradation of toxicants and formation of new substances including the more toxic ones.

Motivation and Description of Work

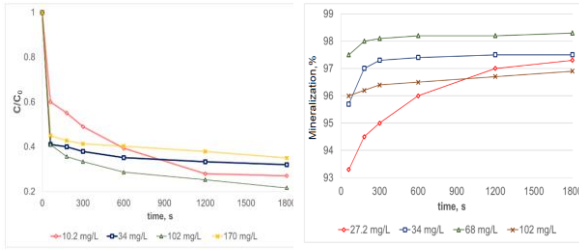
According to the studied references, it was concluded that catalytic process can be some potential methods for removal AMX in optimal conditions at low concentrations but this process must be adapted to real substrate concentrations.

The aim of this study is to establish the physico-chemical parameters of catalytic oxidation and to release degradation/mineralization of the AMX in the range of initial concentrations from 100 up to 300 mg/L which represents the real concentrations in the residual effluents.

Results

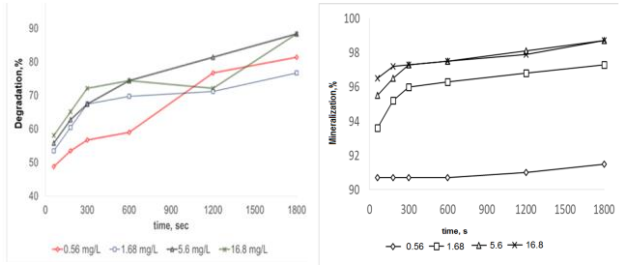
Among AOPs, it has been shown that oxidation processes involving Fenton-type reactions are quite effective in drug degradation .

$$AMX + \cdot OH \longrightarrow CO_2 + H_2O + intermediate\ products$$



a b

Effect of the H_2O_2 concentration in the degradation rate (a) and mineralization rate (b) of amoxicillin; $[AMX]_0$=215 mg/L, $[Fe^{2+}]_0$=16.8 mg/L, pH=2.2, t=25 °C

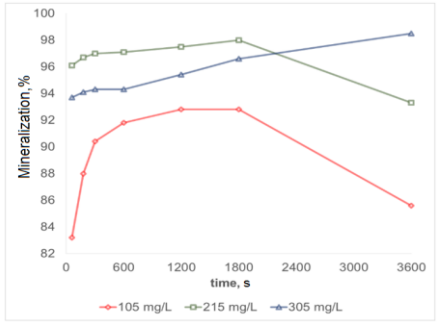


a b

Effect of the catalyst concentration (Fe^{2+}) on degradation rate (a), mineralization rate (b) of amoxicillin; $[AMX]_0$=215 mg/L, $[H_2O_2]_0$ =102 mg/L, pH=2.2, t=25 °C

Kinetic degradation of AMX under different concentration of antibiotic; $[Fe^{2+}]_0$=16.8 mg/L, pH= 2,2, reaction time=60 s, t=25 °C

C_0AMX, mg/L	ΔC/Δt, M/s	k, s^{-1}	$t_{1/2}$, s
	$[H_2O_2]_0$ =34 mg/L		
105	2.81×10^{-6}	1.48×10^{-2}	47
215	5.70×10^{-6}	1.45×10^{-2}	48
305	1.08×10^{-5}	2.53×10^{-2}	28
	$[H_2O_2]_0$ =102 mg/L		
105	2.73×10^{-6}	1.41×10^{-2}	49
215	5.70×10^{-6}	1.45×10^{-2}	48
305	8.06×10^{-6}	1.44×10^{-2}	48



Effect of the reaction time on mineralization rate at 3 initial concentration of AMX

Conclusions

The data obtained reveal that the homogenous process are a promising treatment for the degradation of amoxicillin with a concentration of 200-300 mg/L at a reaction rate $5\text{-}10\times10^{-6}$ M/s only 60 s contact time. Degradation and mineralization rate has reached, on average, 88-95% and 96-98%, respectively within 30 min contact time. The mass ratio of Fe^{2+} : H_2O_2 : AMX being 1: 6: 12.

It was concluded that Fenton process can be a potential method for degradation of AMX in optimal conditions at real concentrations.

References

[1] Chen, B., Lin, L., Fang, L., Yang, Y. (2018). Complex pollution of antibiotic resistance genes due to beta-lactam and aminoglycoside use in aquaculture farming. Water Resource, 134, 200-208.

[2] Correa, C., Franco, A., González, F. (2020). Advanced Oxidation Processes for the Removal of Antibiotics from Water. An Overview. Water, 12(102).