

Performance, cytotoxicity and transformation products of sulfonamide antibiotics oxidation with ferrate(VI)

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1. Introduction – Nowadays, the use of Fe(VI) as a system for water treatments is receiving great interest due to its high oxidant power; thus, it reduces the risk of forming disinfection byproducts and these byproducts have a low toxicity [1]. Sulfonamides (SNs) are synthetic antimicrobial antibiotics widely used in human and veterinary medicine. The objective of this work was to study the oxidation of SNs with Fe(VI) in aqueous solution under different operational conditions, identifying the degradation byproducts and determining their toxicity.

2. Experimental - The degradation of SNs by Fe(VI) was carried out in a batch reactor. Fe(VI) was determined by measuring the absorbance in a UV/Vis spectrometer. SNs concentration was determined by reverse-phase high-performance liquid chromatography (HPLC). Degradation byproducts were identified by using an Acquity ultra performance liquid chromatographer (Waters). The cytotoxicity was evaluated by MTS assay to determine the viability of human embryonic kidney cells (HEK-293) and J774 cell lines.

3. Results and Discussion – The results obtained pointed out that the maximum degradation rate of SNs occurred at pH = 3.0 with a 6:1 ratio of Fe(VI):SN. Fe(VI) also showed a significant reactivity towards SNs ($k_{app} = 110-220 \text{ M}^{-1} \text{ s}^{-1}$) at pH = 7. The influence of the pH on the values of k_{app} can be explained by considering the specific reaction of Fe(VI) with SNs. The degradation byproducts detected were benzenesulfonic acid and p-nitrophenol. According to our proposed mechanism, the attack of SNs by Fe(VI) occurred in the sulfonyl group or in the para-amino group by H-abstraction, hydroxyl transfer, and electrophilic addition. The presence of inorganic ions in groundwater enhanced the SNs degradation. The quantitative cytotoxicity assay of HEK-293 and J774 cells exposed to Fe(VI) indicated that transformation byproducts have lower toxicity than original SNs, 75% and 25% viability, respectively.

4. Conclusions - This research suggests that Fe(VI) can act as a chemical oxidant to remove SNs antibiotics from aqueous solution. As a novelty, the HEK 293 and J774 cell lines were used for the first time to evaluate the byproducts cytotoxicity, which resulted to be very low.

5. References

[1] H. Dong, Z. Qiang, S. Liu, J. Li, J. Yu, J. Qu, Oxidation of iopamidol with ferrate (Fe(VI)): Kinetics and formation of toxic iodinated disinfection by-products, *Water research*, 130 (2018) 200-207.