PLASMA-ASSISTED FENTON OXIDATION PROCESS FOR DEGRADATION OF SULFADOXINE ANTIBIOTICS IN AQUEOUS SOLUTIONS

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ABSTRACT

Non-thermal plasmas (NTP) have emerged as a promising, electrified technology for the degradation of pharmaceutical pollutants in wastewater treatment processes [1]. In this study, the effectiveness of NTP technology is investigated by employing an air plasma at atmospheric pressure using an AC 20 kHz pin-to-liquid dielectric barrier discharge (DBD). Aqueous solutions of sulfadoxine (SDX), a widely used sulfonamide antibiotic for the treatment of malaria, serve as both the pollutant target-fluid and the dielectric barrier required for stable operation of the non-equilibrium plasma discharge. Experiments have shown that NTP treatment effectively degrades SDX molecules, leading to partial mineralization and the formation of oxidation by-products (Transformation Products – TPs). Various operational parameters that were investigated, showcased that this system tents to generate increased concentration of H_2O_2 and NO_x ions. In an effort to improve the degradation rates and mitigate the unwanted NOx species, Fe^{2+} ions were introduced into the solution, facilitating a Plasma-assisted Fenton oxidation process. The synergistic effect of Fe^{2+} ions and generated H_2O_2 in the Plasma/Fenton oxidation process contributed to more efficient degradation of SDX, highlighted by the faster SDX degradation kinetics and improved mineralization rates. Additionally, mechanistic insights into the degradation pathways of SDX under NTP treatment are elucidated through High Resolution Mass Spectrometry (MS) analyses, shedding more light on a field that so far has remained unexplored. Finally, Quantitative Structure-Activity Relationship (QSAR) software was utilized, to further assess the ecotoxicity of the newly reported transformation products.

KEYWORDS: Plasma discharges, water purification, pharmaceutical pollutants, Fenton process, advanced oxidations processes

REFERENCES

[1] Magureanu M, Mandache N B, Parvulescu V I, Degradation of pharmaceutical compounds in water by non-thermal plasma treatment, Water Research 81 (2015) 124-136.