

APPLICATION OF UV/SULFITE ADVANCED REDUCTION PROCESS FOR ELIMINATION OF THE PFOA, A „FOREVER CHEMICAL“

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Advanced oxidation processes (AOP) are effective for the elimination of most organic pollutants. However, its effectiveness is limited in the case of “forever chemicals”, such as per- and polyfluorinated compounds (PFs), responsible for several environmental and public health risks [1,2]. PF removal requires an advanced reduction process (ARP) [3-5], where a reducing agent, primarily the hydrated electron (e_{aq}^-), is formed. Photochemical water treatment practices typically use low-pressure mercury vapor lamps (LPM) emitting 254 nm UV light, and less often, 254/185 nm UV/VUV light. The wavelength determines the radical set and is decisive for the efficiency of radical generation and the transformation of target substances. UV light is generally absorbed by the additive (oxidizing or reducing agent), while VUV light is absorbed by the water, resulting in the formation of $\bullet OH$, $\bullet H$, and, with less efficiency, e_{aq}^- . Besides the formation of radicals from water, the direct VUV photolysis of the target substances cannot be excluded.

The UV-ARP substrate scope is weighted heavily toward contaminant classes that are resistant to degradation by AOPs, like PFs [23]. The underreported information about quality and the formation rates of reactive species has made it difficult to fully evaluate the impact of operating conditions and the role of water matrix components on efficiency. Investigating the impact of dissolved organic matter, inorganic ions, and dissolved O_2 content on efficiency is necessary. In this work, the effects of sulfite concentration, pH, dissolved oxygen, and biologically treated domestic wastewater as a matrix were investigated. Results showed that low-intensity VUV light can enhance the transformation efficiency. Besides direct VUV photolysis of PFOA, 185 nm light is responsible for the enhanced transformation of sulfite ions, and most probably, the photolysis of sulfate ions also contributes to the formation of e_{aq}^- . The effect of dissolved O_2 , pH, and radical scavengers proved the decisive role of e_{aq}^- in the transformation of PFOA. The HCO_3^- content of the matrix decreased the efficiency, while Cl^- had no effect.

Our results demonstrated that the UV/sulfite and UV/VUV/sulfite processes are capable of removing hardly oxidizable PFOA. The efficiency of the process is sensitive to the pH, and the presence of components that can compete with PFOA for e_{aq}^- . 185 nm low-intensity VUV light can significantly enhance the transformation rate of PFOA through various mechanisms; the contributions of direct VUV photolysis of PFOA and enhanced transformation of both sulfite and sulfate ions require further investigation.

References

- [1] <https://www.who.int/teams/environment-climate-change-and-health/water-sanitation-and-health/chemical-hazards-in-drinking-water/per-and-polyfluoroalkyl-substances>
- [2] <https://www.eea.europa.eu/en/analysis/publications/pfas-pollution-in-european-waters>
- [3] M. Gar Alalm, D.C. Boffito, Chemical Engineering Journal 450 (2022) 138352.
- [4] S. Wu, L. Shen, Y. Lin, K. Yin, C. Yang, Chemical Engineering Journal 414 (2021) 128872.
- [5] A. Mojiri, J.L. Zhou, N. Ozaki, B. KarimiDermeni, E. Razmi, N. Kasmuri, Chemosphere 330 (2023) 138666.