76th Annual Meeting

of the International Society of Electrochemistry

7 - 12 September 2025

Mainz, Germany

PROGRAM

https://annual76.ise-online.org

e-mail: events@ise-online.org

Enhancing H_2O_2 electro-generation through statistical planning for the treatment of different aquatic matrices contaminated by emerging contaminants

R.J.A. Felisardo[a,*], F.E. Durán[a], C.H.M. Fernandes[a], G.O.S. Santos[a], M.A. R. Rodrigo[b], M.R.V. Lanza[a]

[a]*São Carlos Institute of Chemistry, University of São Paulo, 400 São Carlos, SP 13566-590, Brazil.*
[b]*Universidad de Castilla La Mancha, Ciudad Real, 13071, Spain.*

**rfelisardo@usp.br*

Water pollution caused by emerging contaminants has become a major environmental concern. Conventional wastewater treatment processes often fail to effectively remove these compounds, necessitating the development of advanced treatment strategies (Shamshad and Rehman, 2025). Hydrogen peroxide (H_2O_2) plays a crucial role in advanced oxidation processes (AOP) due to its oxidative potential and its ability to be activated by UVC light. Electrochemical methods for *in situ* H_2O_2 generation offer a promising, energy-efficient, and chemical-free alternative for water treatment (Dan *et al*., 2022). This study explores the optimization of electrochemical H_2O_2 generation using a Printex L6 carbon-based gas diffusion electrode for application in the treatment of different water matrices contaminated with trace amounts of emerging compounds such as paracetamol (PCT), caffeine (CAF), and norfloxacin (NOR). A central composite rotational design (CCRD) was employed to evaluate key operational parameters, including the concentration of the supporting electrolyte ($[K_2SO_4]$ = 0.025, 0.050, and 0.075 mol L^{-1}), current density (15, 30, and 45 mA cm^{-2}), and solution pH (3.0, 6.0, and 9.0), in relation to the accumulated H_2O_2 production after 90 min of electrolysis. Under optimized conditions, the parallel degradation of PCT, CAF, and NOR was analyzed in different AOP (electrochemical oxidation (EO), EO/H_2O_2, EO/H_2O_2/UVC and UVC) and in various water matrices (ultrapure water, real river water, and synthetic water with organic interferents such as urea, creatinine and uric acid). The regression model generated from the CCRD was highly significant (p-value < 0.001), validating its predictive capability for electrochemical H_2O_2 generation. Additionally, the concentration of H_2O_2 increased with higher operational parameters but only up to specific thresholds, beyond which interactions between variables became more complex. Under optimized conditions, the EO/H_2O_2/UVC process was the most efficient, achieving 100% degradation of all target compounds within approximately 15 min of electrolysis, with partial mineralization up to 40% after 90 min. The degradation rate varied across different water matrices, with the synthetic matrix exhibiting significant interference due to the presence of organic compounds, as urea, creatinine and uric acid, that also underwent partial degradation. These findings support the use of electrochemical processes for *in situ* H_2O_2 generation as a viable strategy for treating wastewater contaminated with emerging pollutants.

Acknowledgements
This study was financed, in part, by the São Paulo Research Foundation (FAPESP), Brazil. Process Number #2024/20854-9, #2023/13260-2, #2023/06558-5, #2020/02743-4, #2023/05895-8, #2018/22210-0, #2018/22211-7, #2018/22022-0, #2019/06650-3 and #2022/12895-1) and the Brazilian National Council for Scientific and Technological Development – CNPq (grant #303943/2021-1).

References
Shamshad, J., Rehman, R. U. Innovative approaches to sustainable wastewater treatment: a comprehensive exploration of conventional and emerging technologies. *Environmental Science: Advances*, 4, 189-222, 2025.
Dan, M., Zhong, R., Hu, S., Wu, H., Zhou, Y., & Liu, Z. Q. Strategies and challenges on selective electrochemical hydrogen peroxide production: Catalyst and reaction medium design. *Chem Catalysis*, *8*, 1919-1960, 2022.