Chemical Engineering Journal Advances 17 (2024) 100535

Contents lists available at ScienceDirect

Chemical Engineering Journal Advances

journal homepage: www.sciencedirect.com/journal/chemical-engineering-journal-advances

Advanced treatment for non-conventional aqueous matrices: editorial

A R T I C L E I N F O

Keywords
Non-conventional aqueous matrices
Advanced treatments
Adsorption
Photocatalysis
Biodegradation
Organic pollutants
Biological pollutants

Editorial

In recent years, there has been a surge of interest in the development of advanced treatments aimed at controlling, treating, or remediating various aqueous matrices. These novel solutions hold tremendous potential, but their successful implementation across different cases and varieties of effluents is still a significant challenge. While their focus has traditionally been on treating conventional matrices like municipal wastewater or drinking water, our attention must also be directed toward non-conventional effluents/water sources. These matrices, including industrial waters, highly saline/brackish waters, and produced water, demand proper treatment to remediate their contamination or enhance their quality at the source of generation.

The importance of addressing these non-conventional aqueous matrices must be properly highlighted. By improving water quality for production processes, achieving specific characteristics for reuse, or decontaminating them before disposal, we can ensure the well-being of both our environment and human health. However, diverse and crucial knowledge gaps exist within this field. The influence of environmental conditions and the constituents of water matrices must be scrutinized, and the effectiveness of advanced treatments should be rigorously evaluated. Therefore, to foster progress in environmental protection, novel, advanced, and/or unique water treatment methods must be studied and developed before their implementation.

This Special Issue "Advanced treatment for non-conventional aqueous matrices" within Chemical Engineering Journal Advances focuses on diverse aspects of treatment for water matrices with special features, in terms of composition, quantity or origin. Therefore, studies focused on engineered water systems that need to develop treatment processes are covered, with a focus on different target contaminants: organic, inorganic [1–3] or of biological nature [4,5].

The treatment of textile effluents has been studied by Semião et al. [1], where a residual diatomaceous earth adsorption process has been addressed for the removal of Acid Blue 277 and Acid Red 361 in single and binary solutions in the presence of inorganic salts. Interestingly, different mechanisms were revealed depending on the composition of the aqueous solutions. The addition of inorganic salts interfered negatively with the removal of dyes in single solutions by biosorption because of competition between anions and molecules for the binding sites. However, in binary solutions (sum of dyes), the maximum biosorption capacity increased with higher concentrations of NaCl and $CaCl_2$ due to different electrostatic interactions by the cations.

Salinity effects have also been studied by Silveira et al. [2], who addressed nitrate reduction in saline waters employing a combined ilmenite ($FeTiO_3$)/oxalic acid photocatalytic process. Although salinity has a small influence on nitrate reduction, working at 50 °C and acidic pH could overcome oxalic acid scavenging by Ca^{2+} present in the water matrix, which is the main challenge when working in saline water. Accordingly, saline water containing nitrates can be effectively treated through photocatalytic reduction using ilmenite as a photo-catalyst and oxalic acid as a hole scavenger.

Leong et al. [3] addressed the biodegradation of triclosan, an antiseptic agent present in effluents from sports clubs, hospitals, or industrial wastewater treatment plants. Triclosan biodegradation was studied using TCSmix100, a mixed culture highly adapted to degrade triclosan. The biodegradation process has been addressed through the addition of different solubilizers or a non-aqueous phase. Thus, the triclosan conversion rate was limited in the case of solubilizer-free tests due to the limited solubility of crystals in the aqueous phase. On the other hand, the use of solubilizers resulted in a significant improvement in mass transport as well as microbial kinetics, showing a high capability of mineralizing triclosan by TCSmix100. This allows the application of this technology to highly contaminated point sources.

Furthermore, the inactivation of bacteria and cyanobacteria has been studied using an rGO/TiO_2/polysiloxane photocatalytic process or the application of calcium peroxide granules, respectively. Levchuk et al.

https://doi.org/10.1016/j.ceja.2023.100535

Available online 16 July 2023

[4] developed TiO_2/polysiloxane(SiBi) thin films modified with different concentrations of graphene oxide (0%, 1%, 5%, 10%) to inactivate naturally occurring microorganisms in recirculation aquaculture systems (RAS) under UVA and solar irradiation. The best disinfection rates were obtained with 1 and 5% of rGO under UVA irradiation, showing slightly higher photocatalytic inactivation compared to solar disinfection. Even so, the reduction of graphene oxide within the printed TiO_2/SiBi was achieved within the first 30 min of each photocatalytic test under both UVA and natural solar irradiation.

Finally, Keliri et al. [5] studied the application of calcium peroxide granules for the abatement of cyanobacterial harmful algal blooms in algae-laden water. CaO_2 granules were enclosed in four different fabrics and textiles, and both H_2O_2 release and *Microcystis* sp. mitigation has been addressed. The study concluded that fabrics of nonwoven interline, or polyester netting materials, can be used as delivery systems, while paper filters should be avoided due to their adsorption/reacting properties for oxidants. Thus, with interlining textile or polyester netting, the photosynthetic activity of *Microcystis* species was sufficiently reduced, suggesting that CaO_2 granules-enclosed fabrics may offer a novel and alternative H_2O_2 delivery system.

In overall, the studies presented in Special Issue are only the tip of the wastewater treatment iceberg, but emphasize the significance of understanding how environmental conditions, technical applications, and the physicochemical constituents of water matrices influence the efficacy of advanced treatments. This understanding is a priority matter for perfecting said processes and developing tailored approaches for the variety of the existing non-conventional aqueous matrices. To further advance the field, future studies should focus on bridging the existing knowledge gaps, including, but not limited to, elucidating the underlying treatment mechanisms of the interactions between treatment process components and matrix constituents, while continuing to explore novel approaches. By doing so, we can pave the way for more sustainable and efficient treatment strategies, ensuring environmental protection and improving effluent water quality of non-conventional matrices.

Acknowledgments

J. Moreno-Andrés would like to acknowledge the financial support through the project TED2021–130994B-C31 and Grant IJC2020–042741-I funded by MCIN/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. In addition, to the project PID2021-123155OB-I00 funded by MCIN/AEI/10.13039/501100011033 and by "ERDF A way of making Europe". Jorge Rodríguez-Chueca has received financial support from Spanish MCIN/AEI/10.13039/501100011033 through the project PHOTORAS (PID2021-128165OA-I00). Stefanos Giannakis would like to acknowledge the DETRAS Project, "*Desinfección-Descontaminación de Efluentes Contra la Transmisión de la Resistencia en Antibióticos*" (APOYO-JOVENES-21-UXUKHL-88-WQWWQF), funded by the Comunidad de Madrid through the call "*Research Grants for Young Investigators from Universidad Politécnica de Madrid*".

References

[1] M.A. Semião, C.W.I. Haminiuk, G.M. Maciel, Modeling the effect of salts in single and binary biosorption of acid dyes by residual diatomaceous earth for sustainable treatment of textile wastewaters, Chem. Eng. J. Adv. 14 (2023), 100469, https://doi.org/10.1016/j.ceja.2023.100469.

[2] J.E. Silveira, A.L. Garcia-Costa, J. Carbajo, A.R. Ribeiro, G. Pliego, W.S. Paz, J. A. Zazo, J.A. Casas, Nitrate removal in saline water by photo-reduction using natural $FeTiO_3$ as catalyst, Chem. Eng. J. Adv. 12 (2022), 100387, https://doi.org/10.1016/j.ceja.2022.100387.

[3] Y.L. Leong, M. Kiel, A. González-Sánchez, K.H. Engesser, D. Dobslaw, Enhanced triclosan biodegradation by a biphasic bioreactor, Chem. Eng. J. Adv. 13 (2023), 100429, https://doi.org/10.1016/j.ceja.2022.100429.

[4] I. Levchuk, T. Homola, G. Singhal, J.J. Rueda-Márquez, J. Vida, P. Souček, T. Svoboda, E. Villar-Navarro, O. Levchuk, P. Dzik, A. Lähde, J. Moreno-Andrés, UVA and solar driven photocatalysis with rGO/TiO_2/polysiloxane for inactivation of pathogens in recirculation aquaculture systems (RAS) streams, Chem. Eng. J. Adv. 10 (2022), 100243, https://doi.org/10.1016/J.CEJA.2022.100243.

[5] E. Keliri, P. Adamou, N. Efstathiou, D. Kokkinidou, K. Kapnisis, A.S. Anayiotos, H. Mazur-Marzec, M.G. Antoniou, Calcium peroxide (CaO_2) granules enclosed in fabrics as an alternative H_2O_2 delivery system to combat Microcystis sp, Chem. Eng. J. Adv. 11 (2022), 100318, https://doi.org/10.1016/J.CEJA.2022.100318.

Javier Moreno-Andrés[a,*], Jorge Rodríguez-Chueca[b], Stefanos Giannakis[c], Dionissios Mantzavinos[d]

[a] *Department of Environmental Technologies, Faculty of Marine and Environmental Sciences, INMAR-Marine Research Institute, CEIMAR-International Campus of Excellence of the Sea, University of Cadiz, Campus Universitario de Puerto Real, 11510 Cádiz, Spain.*

[b] *Department of Industrial Chemical & Environmental Engineering, Escuela Técnica Superior de Ingenieros Industriales, Universidad Politécnica de Madrid, C/José Gutiérrez Abascal 2, 28006, Madrid, Spain.*

[c] *Universidad Politécnica de Madrid (UPM), E.T.S. de Ingenieros de Caminos, Canales y Puertos, Departamento de Ingeniería Civil: Hidráulica, Energía y Medio Ambiente, Unidad docente Ingeniería Sanitaria, c/ Profesor Aranguren, s/n, ES-28040 Madrid, Spain*

[d] *Dept. of Chemical Engineering, University of Patras. Caratheodory 1, University Campus, GR-26504 Patras, Greece*

[*] Corresponding author.
E-mail address: javier.moreno@uca.es (J. Moreno-Andrés).