Treatment & reuse of industrial wastewater with the aid of advanced membrane processes

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Abstract

Industry is one of the largest consumers of freshwater, as water is used for various purposes in industrial production processes (e.g. for cleaning plant and equipment, for cooling purposes and for the personal use of workers). At the same time, water stress is a major and growing global problem, while climate change is expected to exacerbate the problem as droughts become more frequent, larger and more severe. Consequently, it is a fact that the world needs to use water efficiently, reduce pressure on freshwater resources and seek alternatives to reuse treated wastewater. In this sense, the water industry is increasingly shifting from wastewater treatment plants, where compounds such as organic matter, nitrogen and phosphorus are removed, to wastewater resource recovery facilities (WWRFs), where wastewater is seen as an important source for the recovery of water, energy and valuable solutes, with digitalisation being an important tool to promote the industrial sector's transition to circularity and climate neutrality. Over the last decade, advances in membrane technology have intensified the implementation of WWRFs, with related research and innovation activities focusing on compact, hybrid processes that combine membrane processes with biological and advanced redox techniques. Typical examples are the membrane bioreactors (anaerobic and aerobic), the photocatalytic membrane reactors and the reactors combining powdered carbon adsorption with ultra- or nanofiltration, for which extensive research efforts have been undertaken in the authors' laboratory in the framework of competitive national, European, Euro-Mediterranean and industrial projects. Experiences and lessons learnt from the relevant R&D efforts are shared and recommendations for future research priorities are given.

Keywords: water reuse, circular economy, zero liquid discharge, advanced membrane processes

References:

[1] Karanasiou A. et al. (2025) *Membranes* 15: 189

[2] Sarasidis V.C. et al. (2021) *J. Chem. Eng. Res. Updates* 8: 60-72

[3] Petsi P.N. et al. (2021) *J. Env. Manag.* 298: 113526

[4] Patsios S.I. et al. (2021) *J. Chem. Tech. Biotechnol.* 96(4): 1030–1039