Società Chimica Italiana

SCI2021

XXVII CONGRESSO NAZIONALE DELLA SOCIETÀ CHIMICA ITALIANA

LA CHIMICA GUIDA LO SVILUPPO SOSTENIBILE

14–23 SETTEMBRE 2021

Experimental evaluation of Fenton oxidation coupled with membrane distillation for produced water treatment: benefits, challenges and effluent toxicity

Marco Minella[a], Giulio Farinelli [b], Marco Coha [b], Debora Fabbri [a], Marco Pazzi [a], Claudio Minero [a], Davide Vione [a], Alberto Tiraferri [b]*

[a] *Department of Chemistry, Università di Torino, Via Pietro Giuria 5, 10125 Turin (Italy)*

[b] *Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, C.so Duca degli Abruzzi 24, 10129, Turin (Italy);*

The treatment of the wastewater resulting from the extraction of oil and gas - produced water (PW) - is a challenging task as this stream contains a large amount of contaminants and salts. Membrane distillation (MD) is a promising technology to desalinate hypersaline solutions such as produced waters. [1] However, due to the hydrophobic membranes used in MD, the large organic content of these waters can foul and wet the membranes, allowing for some fractions to pass into the distillate and impair its quality.

In this work, the application of the traditional Fenton process was preliminarily optimized and investigated as a pre-treatment step for a synthetic hypersaline PW, before the MD step. The traditional Fenton reaction was also compared to Fenton processes whereby iron ligands, e.g., Ethylenediamine-N,N'-disuccinic acid (EDDS) and citrate, were used to overcome practical limitations of traditional Fenton (e.g., the need to work at pH≈3). [2]

The oxidation pre-treatments achieved up to 55% removal of the dissolved organic carbon, measured as TOC, and almost complete degradation of the low molecular weight toxic organic contaminants. No increase in MD productivity was observed after the Fenton pre-treatment, but the final effluent had significantly improved quality in terms of organic content and toxicity, with EC_{50} values of up to 25 times higher than those measured for the raw PW. The addition of iron ligands during the oxidation step simplified the process, but resulted in an effluent having slightly lower quality in terms of toxicity compared to that obtained with traditional Fenton (Figure 1).

The coupled Fenton-MD process is a promising strategy to treat PWs for safe discharge in a streamlined train. Moreover, this investigation pointed to challenges that require further research advances.

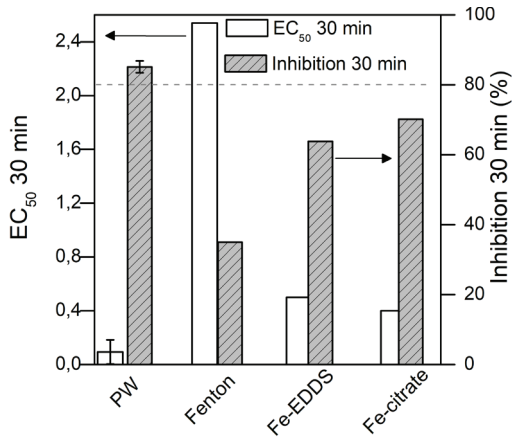

Figure 1 Residual toxicity (right axis) and EC_{50} (left axis) values after 30 minutes of contact with the *Vibrio Fischeri* culture for PW, and for PW after the coupled Fenton-MD process. The dash line (80% of inhibition) is the law limit for safe discharge in the sewage system in Italy.

[1] F. Ricceri, M. Giagnorio, G. Farinelli, G. Blandini, M. Minella, D. Vione, A. Tiraferri, *Sci. Rep.* **2019**, *9*, 14964.

[2] J.J. Pignatello, E. Oliveros, A. MacKay, *Crit. Rev. Environ. Sci. Technol.* **2006**, *36*, 1.