Decolorization of the azo dye Reactive Violet 5 by UV-A-Fenton and ultrasound-Fenton processes

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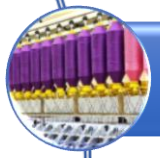
Introduction

Contributes to fulfilling the basic living (clothing) requirements of human life;



The wastewater discharged from textile dyeing industry contains a total of 72 toxic chemicals, out of which 30 chemicals cannot be removed by waste treatment processes;

Formation of many types of cancers of different organs such as bladder, spleen, liver and normal aberrations in model organisms and chromosomal deformities in mammalian cells;

Textille dyes are characterized by high color density, high concentration of recalcitrante organics and pH and high turbidity.

Textile dye factory

River polluted by textile dyes

Water Environment Federation

Textiles wastewater treatment technology: A review

Dongyang Deng [1,*], Mehdi Lamssali [1], Niroj Aryal [2], Andrea Ofori-Boadu [1], Manoj K. Jha [3], Raymond E. Samuel [4]

CRITICAL REVIEWS IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY
2017, VOL. 47, NO. 19, 1836–1876
https://doi.org/10.1080/10643389.2017.1393263

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Biological methods for textile dye removal from wastewater: A review

Deepika Bhatia[a], Neeta Raj Sharma[a], Joginder Singh [a], and Rameshwar S. Kanwar[a,b]

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Heliyon 5 (2019) e02711

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Review article

Textile finishing dyes and their impact on aquatic environs

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Mohamed Berradi [a,**], Rachid Hsissou [a,b,*], Mohammed Khudhair [c], Mohammed Assouag [b], Omar Cherkaoui [d], Abderrahim El Bachiri [e], Ahmed El Harfi [a]

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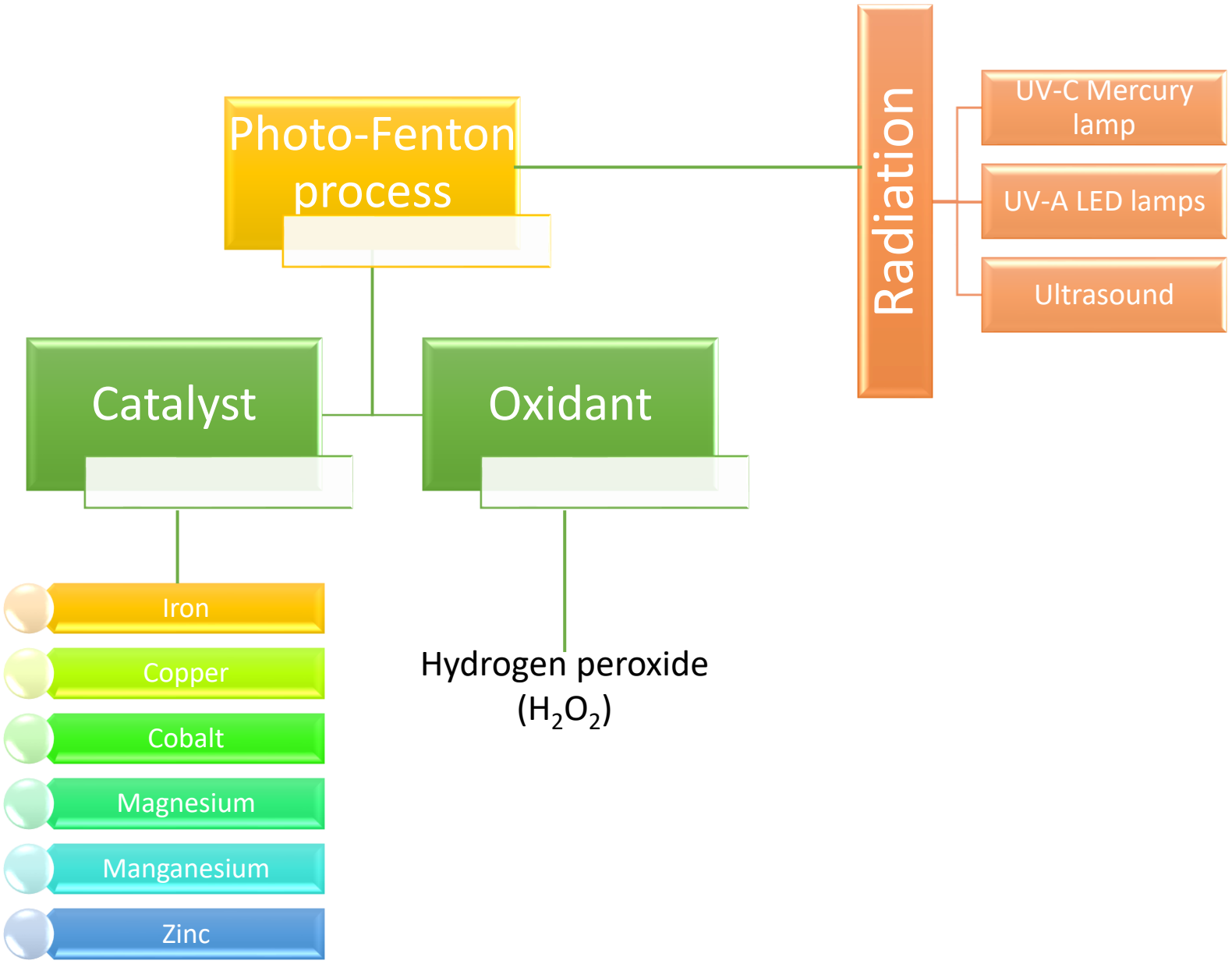
[c] Faculty of Engineering and Information Technology, Amran University, Amran, Yemen
[d] Laboratory REMTEX, High School of Textile and Clothing Industries, Casablanca, Morocco
[e] Royal Naval School, University Department, Boulevard Sour – Jdid, Casablanca, Morocco

Introduction



Chemical Engineering Journal 256 (2014) 316–323

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Enhanced decolorization of Orange G in a Fe(II)-EDDS activated persulfate process by accelerating the regeneration of ferrous iron with hydroxylamine

Donghui Han [a], Jinquan Wan [a,c,d,*], Yongwen Ma [a,c,d], Yan Wang [a], Mingzhi Huang [b], Yangmei Chen [e], Dongya Li [a], Zeyu Guan [a], Ying Li [a]

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Chemical Engineering Journal 309 (2017) 80–88

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Chemical Engineering Journal

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Degradation of ethylbenzene in aqueous solution by sodium percarbonate activated with EDDS–Fe(III) complex

Hang Cui [a], Xiaogang Gu [a], Shuguang Lu [a,*], Xiaori Fu [a], Xiang Zhang [a], George Y. Fu [b], Zhaofu Qiu [a], Qian Sui [a]

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Chemical Engineering Journal 310 (2017) 473–483

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Chemical Engineering Journal

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Treatment of winery wastewater by sulphate radicals: HSO_5^-/transition metal/UV-A LEDs

Jorge Rodríguez-Chueca [a], Carlos Amor [a], Tânia Silva [a], Dionysios D. Dionysiou [b], Gianluca Li Puma [c], Marco S. Lucas [a,c,*], José A. Peres [a]

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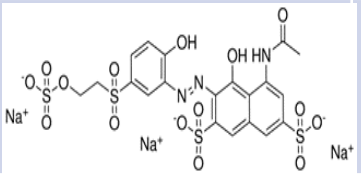
[b] Environmental Engineering and Science Program, Department of Biomedical, Chemical and Environmental Engineering (DBCEE), 705 Engineering Research Center, University of Cincinnati, Cincinnati, OH 45221-0012, USA
[c] Environmental Nanocatalysis and Photoreaction Engineering, Department of Chemical Engineering, Loughborough University, Loughborough LE11 3TU, United Kingdom

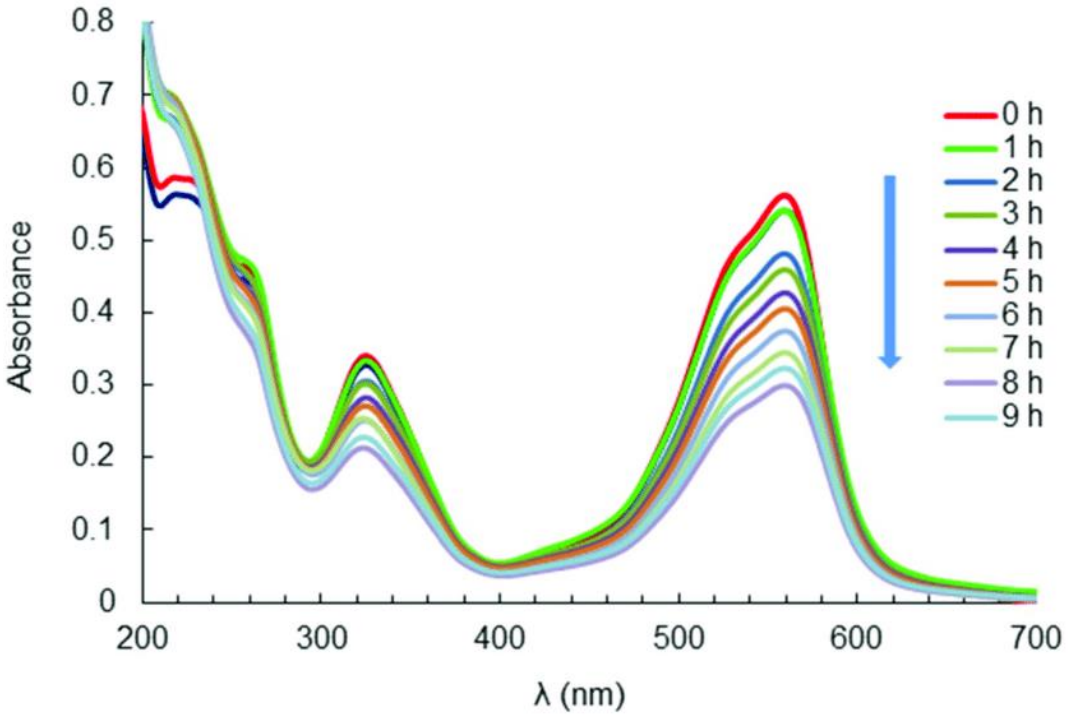
The aim of this work is:

(1) The application of a self-made UV-A LED reactor for the removal of RV5 from an aqueous solution

(2) The comparison of the efficiency of the UV-A reactor with and ultrasound reactor

Name, chemical structure, maximum absorbance and molecular weight of RV5

Name	Chemical structure	λ_{max} (nm)	Molecular weight (g/mol)
Reactive violet 5 (azo dye)		560 and 320	735.59



The maximum absorbance wavelength (λ_{max}) of RV5 was found at 560 nm, and the concentration of the residual dye in solution was calculated by Beer-Lambert's law (Equation 1), using the optical density and molar extinction observed at the characteristic wavelength:

$A=l\varepsilon C$ (Equation 1)

where A is the absorbency, l the path length (cm), ε the molar extinction coeffi-cient (L/mol/cm) and C the dye concentration at time t (mol/L).

AOPs application

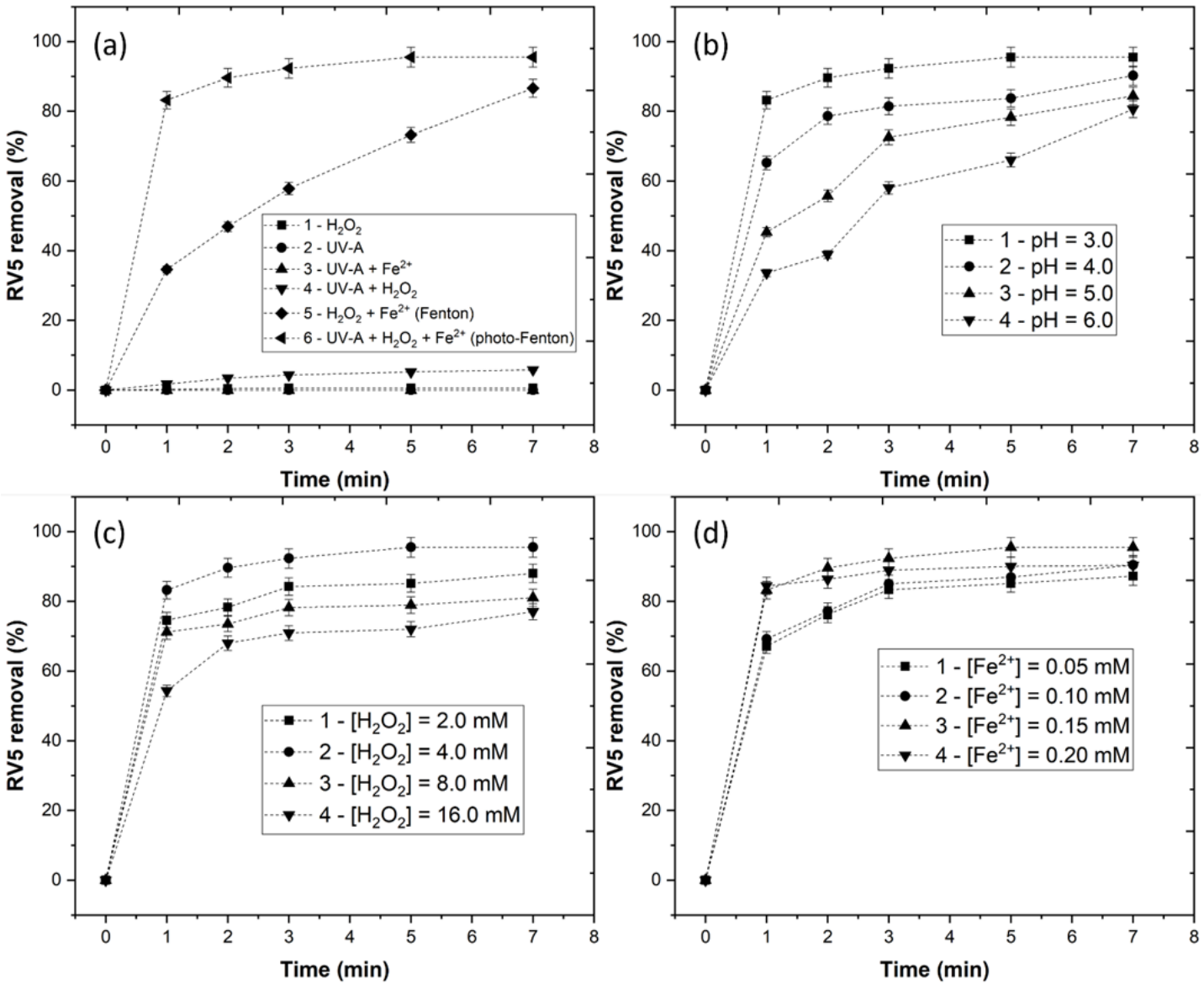


Figure 1. RV5 removal with variation of (a) AOPs, (b) pH (3.0 – 7.0), (c) H_2O_2 concentration (2.0 – 16.0 mM) and (d) Fe^{2+} concentration (0.05 – 0.20 mM).

- Considering the difficulty of treatment of wastewaters contaminated by RV5, it were performed several AOPs, to evaluate the efficiency and benefit of each conditions on the dye degradation.
- Figure 1(a) shows the RV5 removal obtained by different AOPs as a function of time (min) under the operational conditions as follows: pH = 3.0, [RV5] = 0.28 mM, [H_2O_2] = 4.0 mM, [Fe^{2+}] = 0.15 mM, radiation UV-A (365 nm), IUV = 32.7 W m^{-2}, time = 7 min.
- The results showed the highest removal of 95.5 and 86.6% with application of photo-Fenton and Fenton processes respectively. These results can be explained by the high generation of HO• radicals by these processes, leading to the removal of RV5 from aqueous solution.
- As the pH increased above 3.0, the degradation efficiency decreases due to (1) iron precipitation as hydroxide derivate, reducing the Fe^{2+} availability, (2) to the dissociation and auto-decomposition of H_2O_2 (Figure 1(b)).
- The results showed the highest RV5 removal with application of 4.0 mM H_2O_2 (95.5%) (Figure 1(c)).
- As the Fe^{2+} concentration increases to 0.15 mM a higher generation of HO• radicals occurs and simultaneously a higher concentration of RV5 is degraded

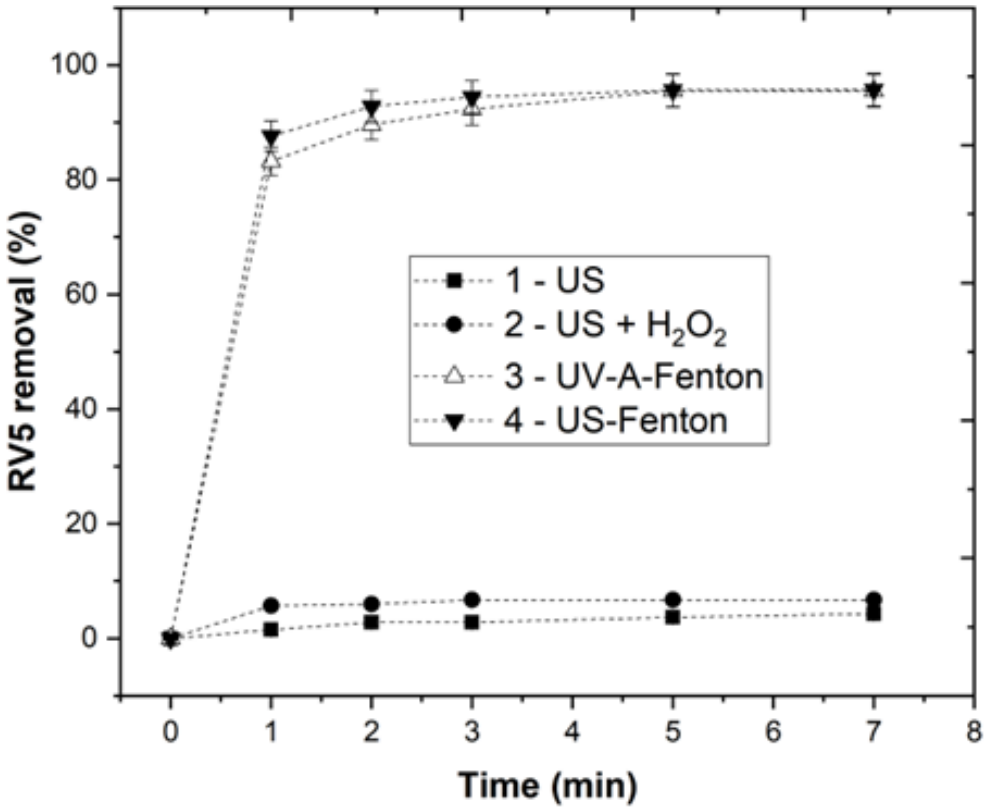


Figure 2. RV5 removal by application of US, US + H_2O_2, UV-A-Fenton and US-Fenton.

Table 2. Effect of AOPs in pseudo first-order kinetic rate (k), electric energy per order (EEO), specific applied energy (ESAE) and cost. Means in the same column with different letters represent significant differences ($p < 0.05$) within each parameter by comparing the treatment processes. n.q. – not quantified.

Processes	k (min-1)	EEO (kWh m^{-3} $order^{-1}$)	ESAE (kWh mol^{-1} $order^{-1}$)	Cost (€ m^{-3})
Fenton	0.270	n.q.	n.q.	n.q.
UV-A-Fenton	0.477	11	38	0.84
US-Fenton	0.483	159	568	12.72

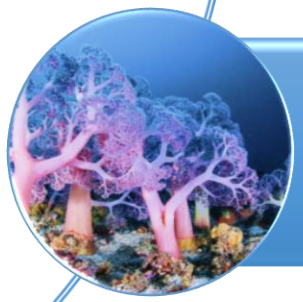
- The US-Fenton process was applied under the operational conditions: pH = 3.0, [RV5] = 0.28 mM, [H_2O_2] = 4.0 mM, [Fe2+] = 0.15 mM, P = 500 W, A = 40%, cavitation time ON 5 s, cavitation time OFF 3s, time = 7 min (Figure 2).
- The results shows that application of US and US + H2O2 were insufficient to generate a high amount of HO• radicals, thus explaining the low removal efficiency.
- The application of US-Fenton reached 95.7% RV5 removal, similar to the UV-A-Fenton.
- The results obtained by Fenton, UV-A-Fenton and US-Fenton were fitted into a pseudo first-order kinetic rate (ln([RV5]t = -kt + ln[RV5]0). The results showed that application of UV-A and US radiation increased significantly the kinetic rate of RV5 removal (Table 1). Having an effective process is not sufficient, it must also be cost effective, therefore the electric energy per order and the specific applied energy were evaluated .
- The results showed that although US-Fenton has the highest kinetic rate, the energy consumption is higher, mainly, due to the power of the reactor which is higher than the UV-A reactor. By applying the cost of electricity in Portugal (0.08 € kWh-1) it was observed that US-Fenton is more expensive than UV-A-Fenton.

Conclusions

Based in the results, it is concluded:

(1) An initial assessment shows that RV5 is very hard to degrade and only Fenton and UV-A-Fenton shows the highest efficiency with 95.5 and 86.6%, respectively

(2) The US-Fenton is concluded to be an efficient system with 95.7% RV5 removal.



(3) It is concluded that although US-Fenton achieves higher kinetic rate in RV5 degradation, it is more expensive that UV-A-Fenton

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Thank you for your attention

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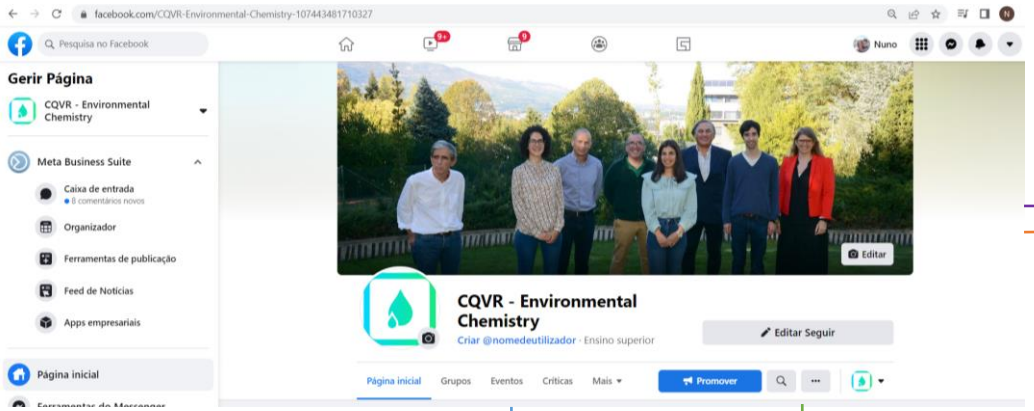

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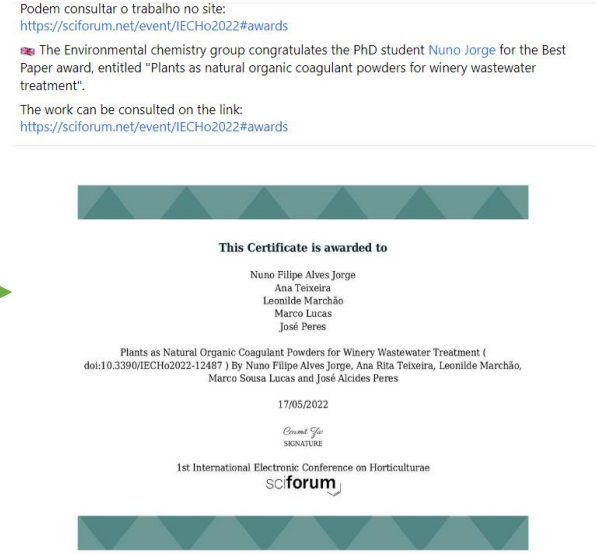

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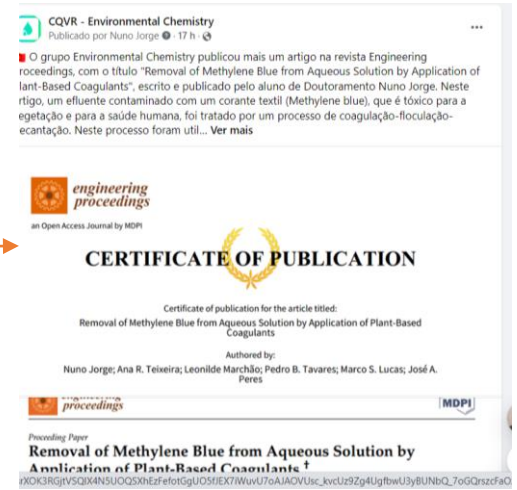

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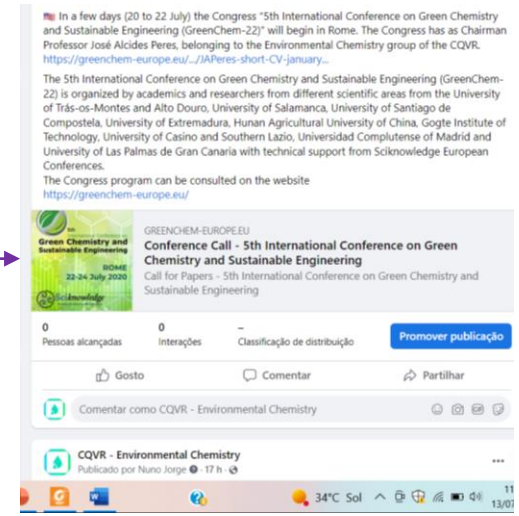

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