PhD Open Days

Development of porous materials for sustainable water purification

CHEMICAL ENGINEERING

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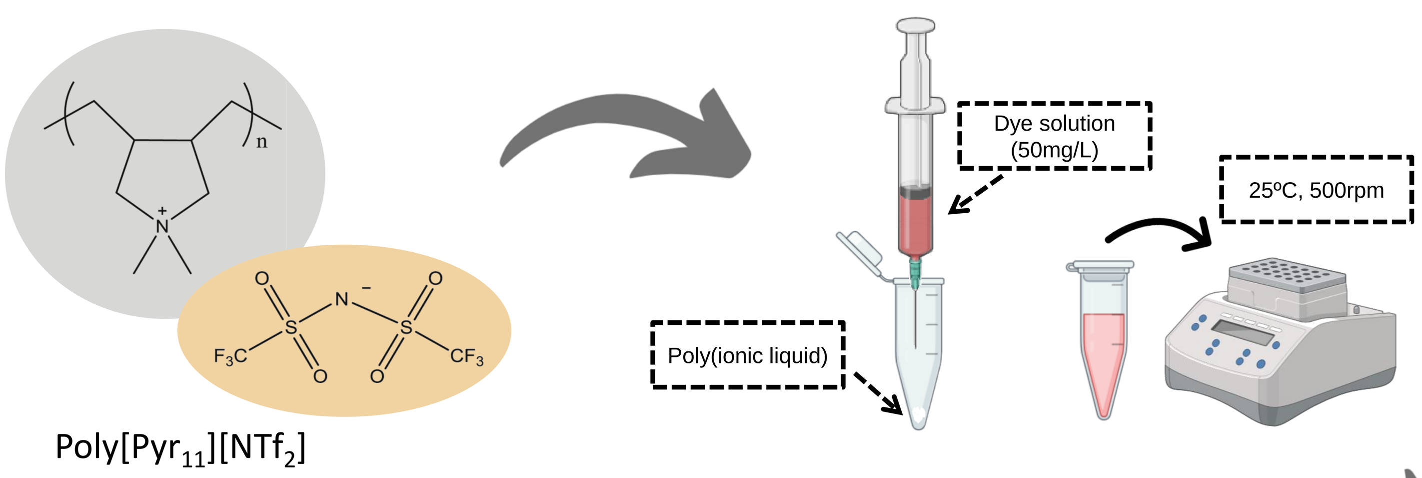
Introduction

Textile industry

In the textile sector, in addition to consuming a lot of water during the manufacturing process, it also releases a lot of trash and pollutants in its effluent. During the dyeing process, the dyes are hydrolysed, and as a result, about 10% to 15% of the initial amount of dye remains unused and is discharged into the effluents, with dye concentrations in textile wastewater in the range of 10 - 200mg/L [1]. However, even at low concentrations, many dyes are visible in water due to the presence of chromophore groups, not only causing aesthetic damage, but preventing light penetration, impairing the photosynthesis process and consequently reducing dissolved oxygen levels, inhibiting plant growth and increasing bioaccumulation and recalcitrance [2–4]. On the other hand, these low biodegradable compounds act as toxic, mutagenic and carcinogenic agents, persisting in the environment for a long period of time and resulting in a high incidence of diseases, which have already been reported by workers in this industry [2,5–7].

Adsorbent material

Removal of textile dyes, Direct Red 80 (DR80) and Reactive Blue 5 (RB5), from water using the poly(ionic liquid) Poly[pyr_{11}][NTf_2] by adsorption.



Results

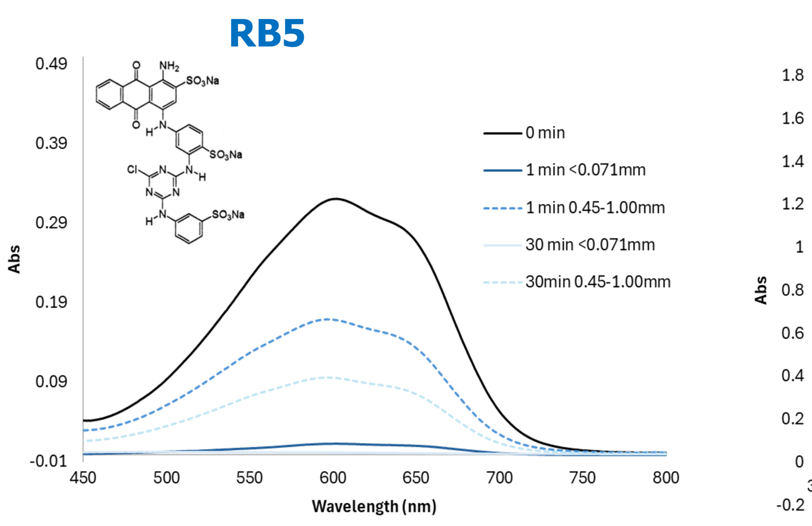


Fig. 1 - UV-vis spectra of the solution with RB5 after adsorption onto PIL over time.

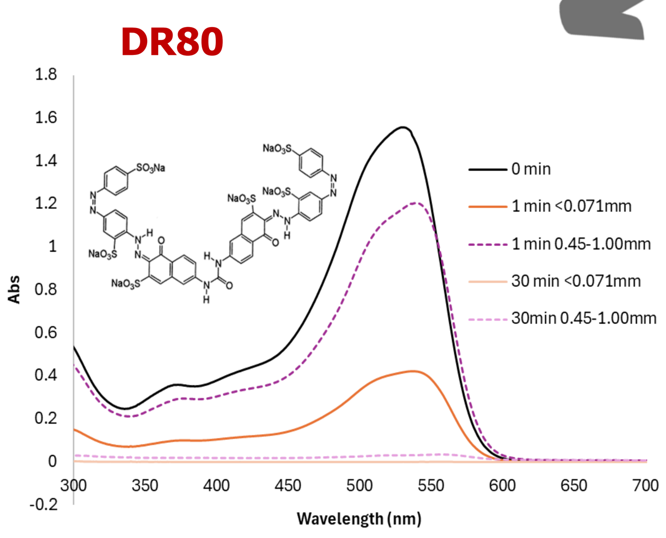


Fig. 2 - UV-vis spectra of the solution with DR80 after adsorption onto PIL over time.

Extraction efficiencies for DR80 were 99.3% and 88.3%, and for RB5, 99.4% and 97.0%, using particle sizes <0.071 mm and 0.45-1.00 mm, respectively, after 30 minutes

Dye degradation and electrochemical regeneration

Study of the ideal conditions to degrade DR80 and RB5 dyes by 2D electrooxidation

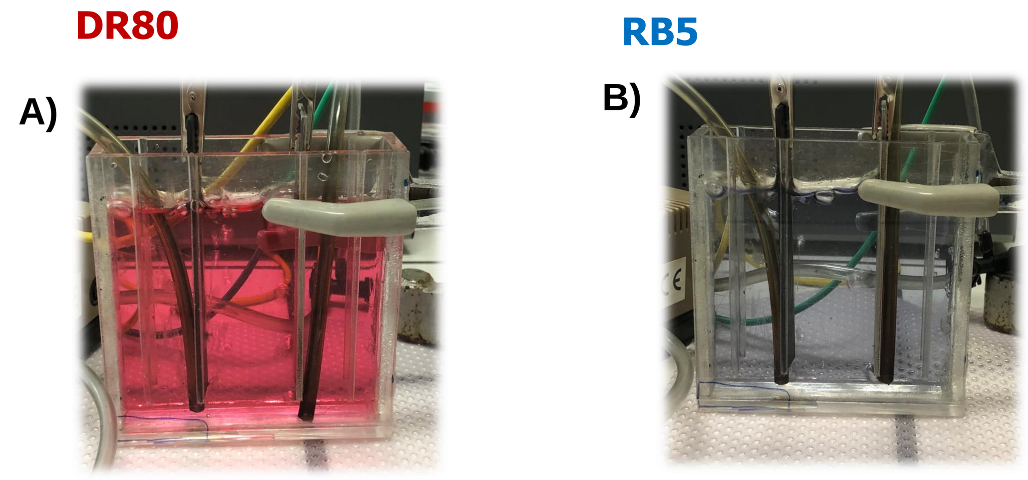


Figure 3. Experimental setup to study the degradation of dye A) Direct Red 80 and B) Reactive Blue 5.

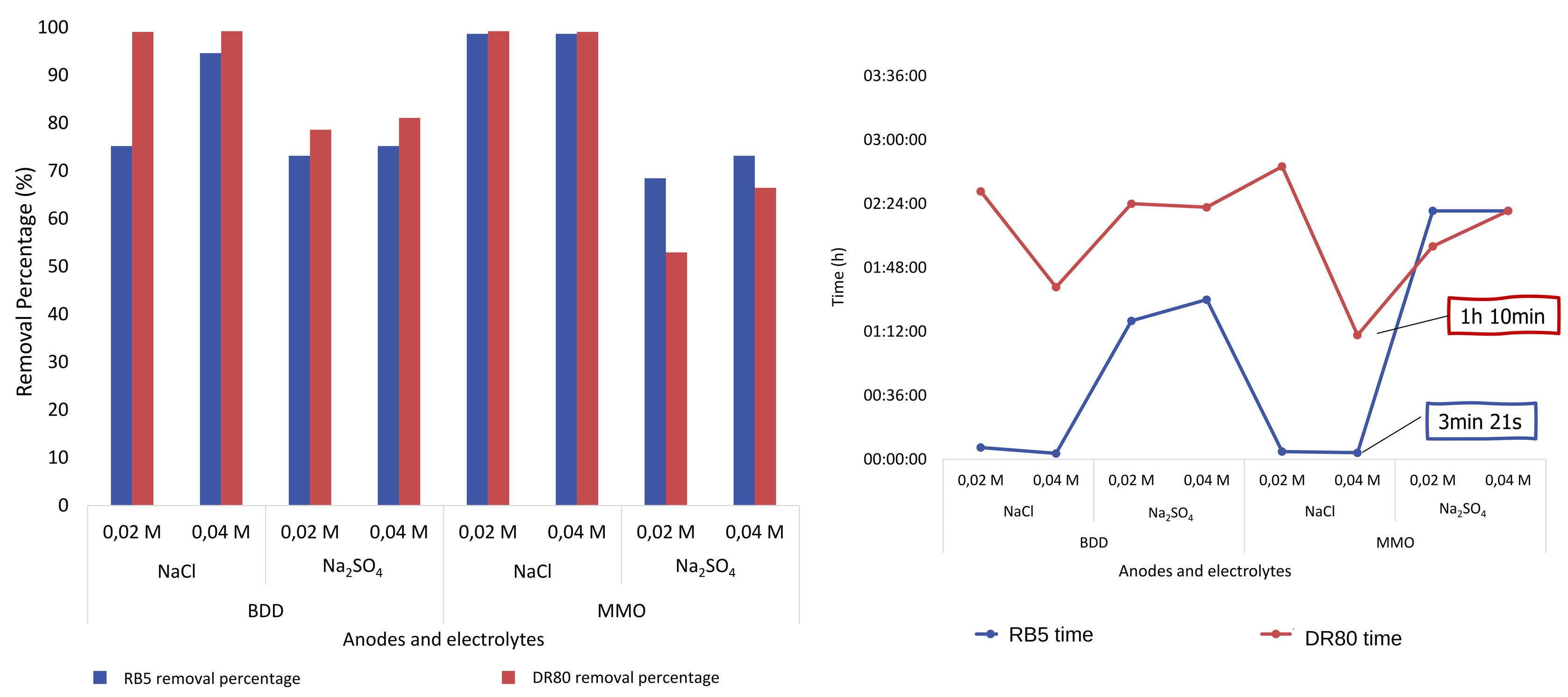
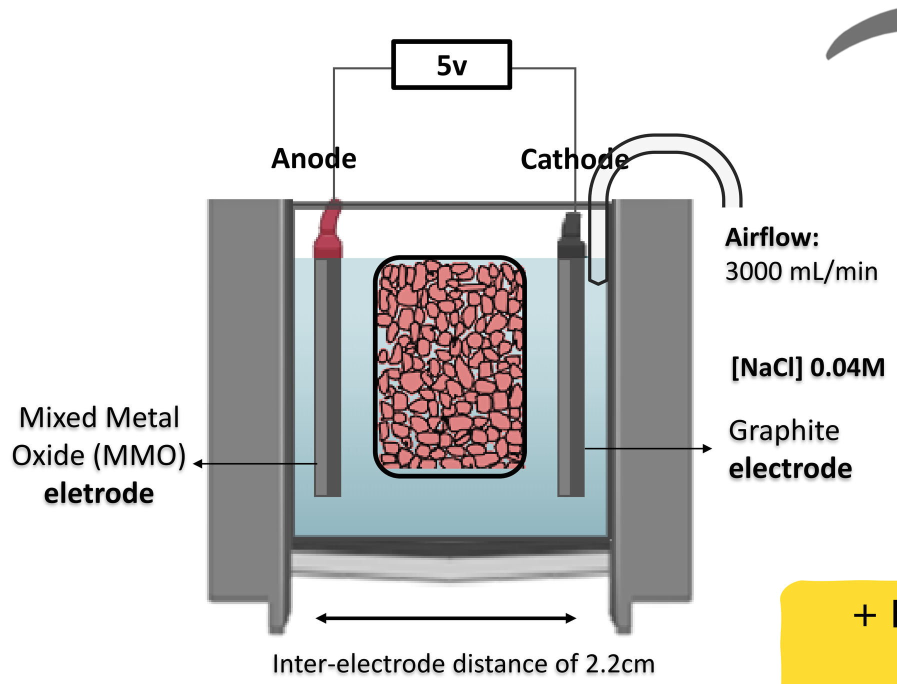


Figure 4. Time taken to oxidize the dyes and percentage of removal for different types of anodes, boron doped diamond (BDD) and mixed metal oxide (MMO), different types of electrolytes (NaCl and Na_2SO_4) and their concentrations (0.02 M and 0.04 M).

The best results were achieved with 0.04M Na_2SO_4 and MMO as the anode, obtaining 98.66% removal of RB5 in 3m21s and 99.07% removal of DR80 in 1h10m.

Electrochemical Regeneration

3D electrooxidation for the degradation of dyes and regeneration of Poly[pyr_{11}][NTf_2] with particle size of 0.45-1.00mm.



Results

Material	Electrooxidation Time	Recovery of PIL
PIL without dye adsorption	50 min	95.81%
	4h	93.60%
PIL + DR80	3h 30 min	91.76%
PIL + RB5	20 min	95.86%

+ Electrooxidation time
+ Polymer loss

References

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Acknowledgements

G. Caetano is grateful to FCT for her Doctoral (2022.11532.BD) research grant. This work was financed by CQE project (UIDB/00100/2020 and UIDP/00100/2020). This work was financed by CQE project (UID/QUI/00100/2013) and PTDC/EAMAMB/2023/2021.