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CWPO Degradation of Natural Organic Matter: Synthetic Water vs. Real Surface Water

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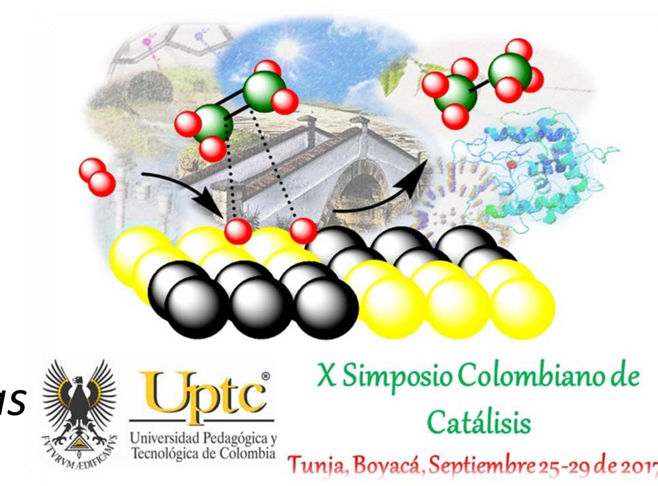
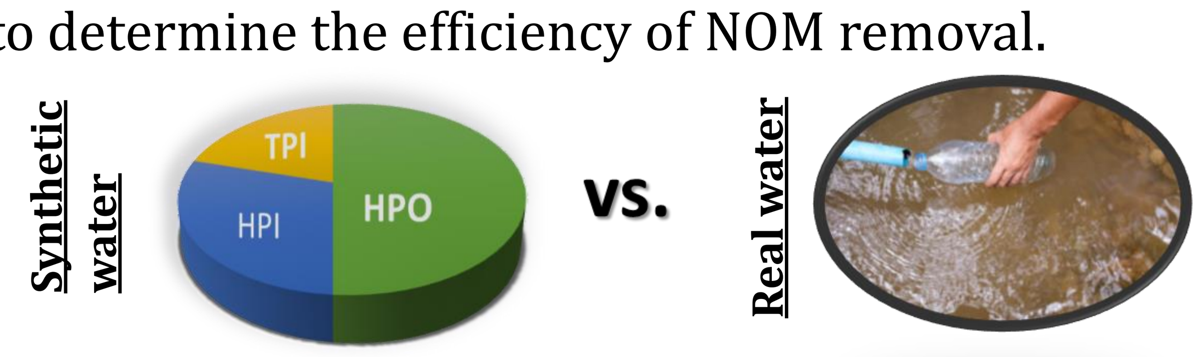


Introduction

Advanced Oxidation Processes (AOPs) are feasible and very promising methods to oxidize NOM from raw waters. Catalytic Wet Peroxide Oxidation (CWPO) degradation of NOM present in *(i)* a synthetic model water and *(ii)* raw surface, real water was carried out in order to determine the efficiency of NOM removal.



$$NOM + H_2O_2 \xrightarrow{mineralization} CO_2 + H_2O \text{ and by} - \text{products}$$

Materials and methods

Table 1. Preparation of synthetic water surrogate based on standards of different polarity.

Reagent[1]		NOM-fraction modelled[2]	Molecular weight (Da)	Abundance in synthetic water (TOC %)
Polyacrylic acid (PAA)		TPI	130.000	20
Polystyrene sulfonate (PSS)	PSS-1	HPO	1´000.000	12.5
	PSS-2	HPO	200.000	12.5
Polygalacturonic acid (PGUA)		HPI	25.000-50.000	30
Humic acids (HA)		HPO	-	25

[1]All reagents Sigma-Aldrich used as received
[2]HPI: hydrophilic; TPI: transphilic; HPO: hydrophobic

Fig. 1 Preparation of synthetic water.

Table 2. Physicochemical properties of real and synthetic water samples.

Parameters	Raw water (RW)[1]	Synthetic water (SW)
UV_{254} (cm^{-1})	0.385	0.418
$Color_{456}$ (PCU)[2]	0.021	0.047
TOC (mg C/L)	18.1	15.4
DOC (mg C/L)	10.9	15.4
SUVA (L mg^{-1} m^{-1})	3.526	2.709
Alcalinity ($mgCaCO_3$/L)	46	----
Conductivity (µS/cm)	16.9	17.9
Turbidity (UNT)	173.0	----
Dissolved oxygen (mg/L)	159	11

[1]Raw water was collected from Vereda Charandú surface source, near Ipiales – Nariño, Colombia
[2]PCU: platinum cobalt color units

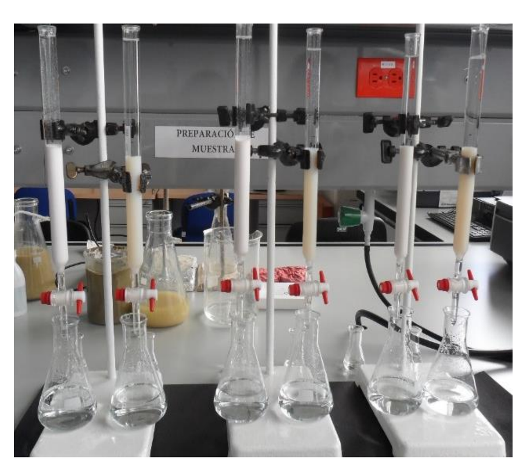


Fig. 2 DAX-8 and XAD-4 resins packed columns.

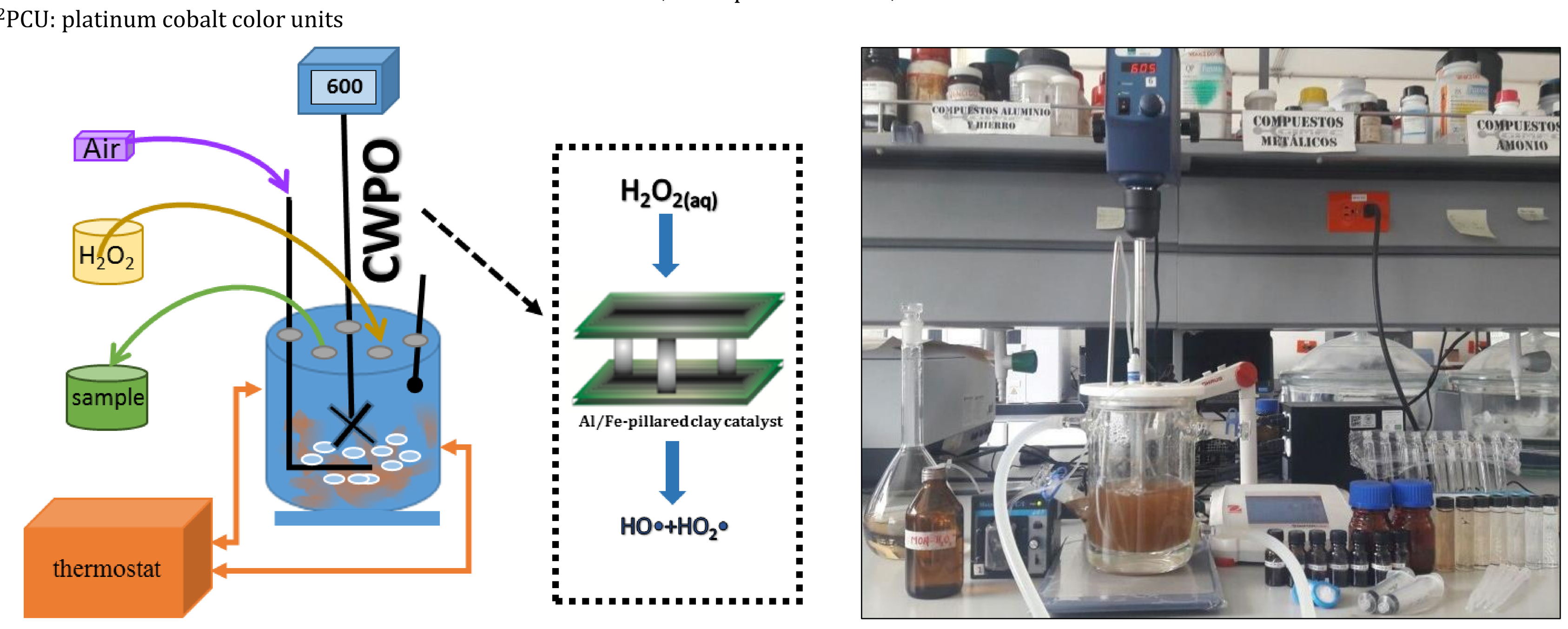


Fig. 3 Schematic (left) and real laboratory (right) set-up for CWPO-degradation of NOM. Experimental parameters: Peroxide Dose $[H_2O_2]_d$= 64.42 % stoichiometric (SW: 87 mg/L, RW: 50 mg/L); Catalyst concentration **[Al/Fe-PILC]*:** 5.1 g/L; pH_{SW} 7.0 and pH_{RW} 7.3; $Temperature_{SW}$: 25 °C and $Temperature_{RW}$: 14 °C (RT on sampling); full reaction time: 180 min; full recorded time: 240 min.

* (Al/Fe-PILC: Atomic Metal Ratio $AMR_{(Fe)}$ = 3.17 %; Total Metal Concentration (TMC) = 5.73 mol/L; Interlayering solution: Auto-hydrolysis[1] with starting ratio (Al^{3+}/Al^0) = 14/86; Final heating: 400 °C/2 h). Fe_{active} content: 0.62 wt. %.

Conclusions

H_2O_2 was slightly more efficiently used by the catalytic system on RW, in good agreement with the highest percentage of color removal on this sample **(~ 93 %)**; however, the NOM mineralization was significantly higher **(75 %)** on the SW against RW **(37 %)**. It probably was related with higher fraction of more refractory hydrophilic substances formed in the real water (SUVA~ 3, **HPI: 12.37 %**, HPO: 30.88 %) vs. synthetic water (SUVA>4, **HPI: 2.30 %**, HPO: 14.63 %)**.** Finally, the HPO fraction significantly decreased in both waters, but in RW the change was less significant due to the presence of more refractory substances than SW.

Results

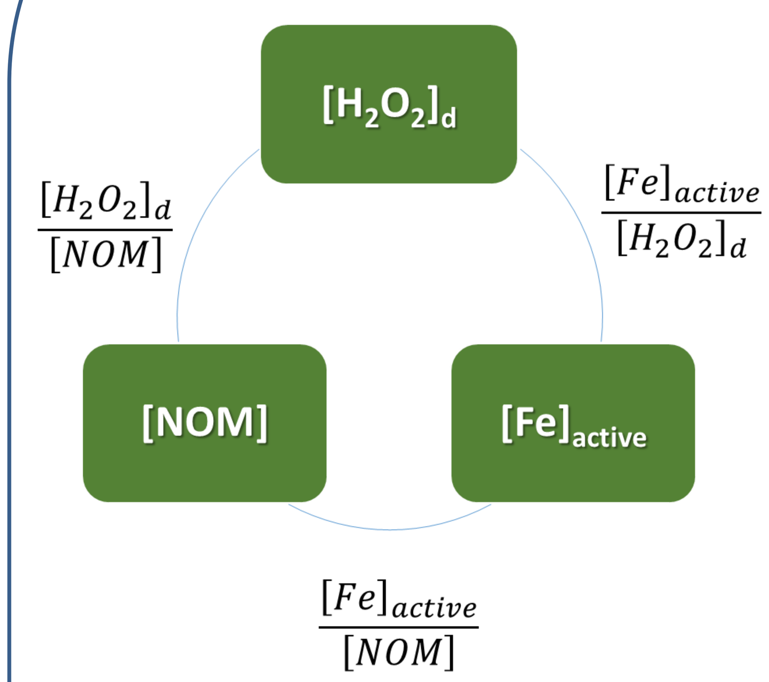


Fig. 4 Relationship between three main factors in CWPO.

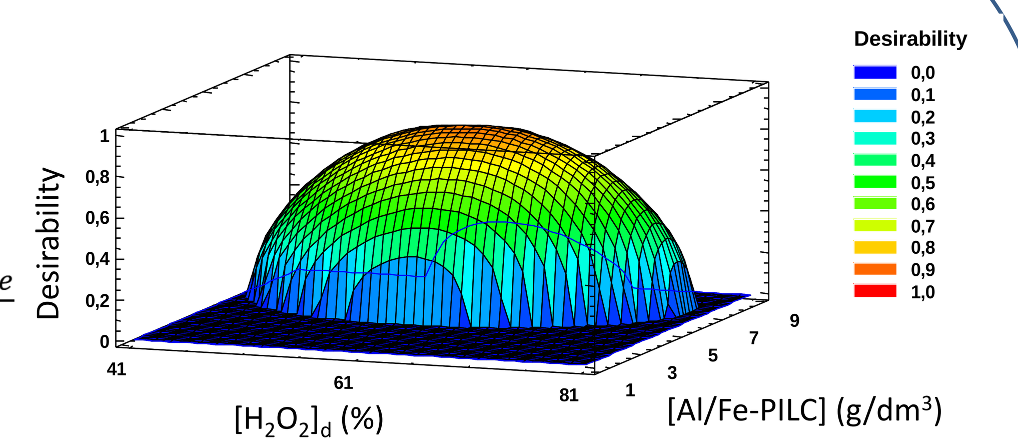
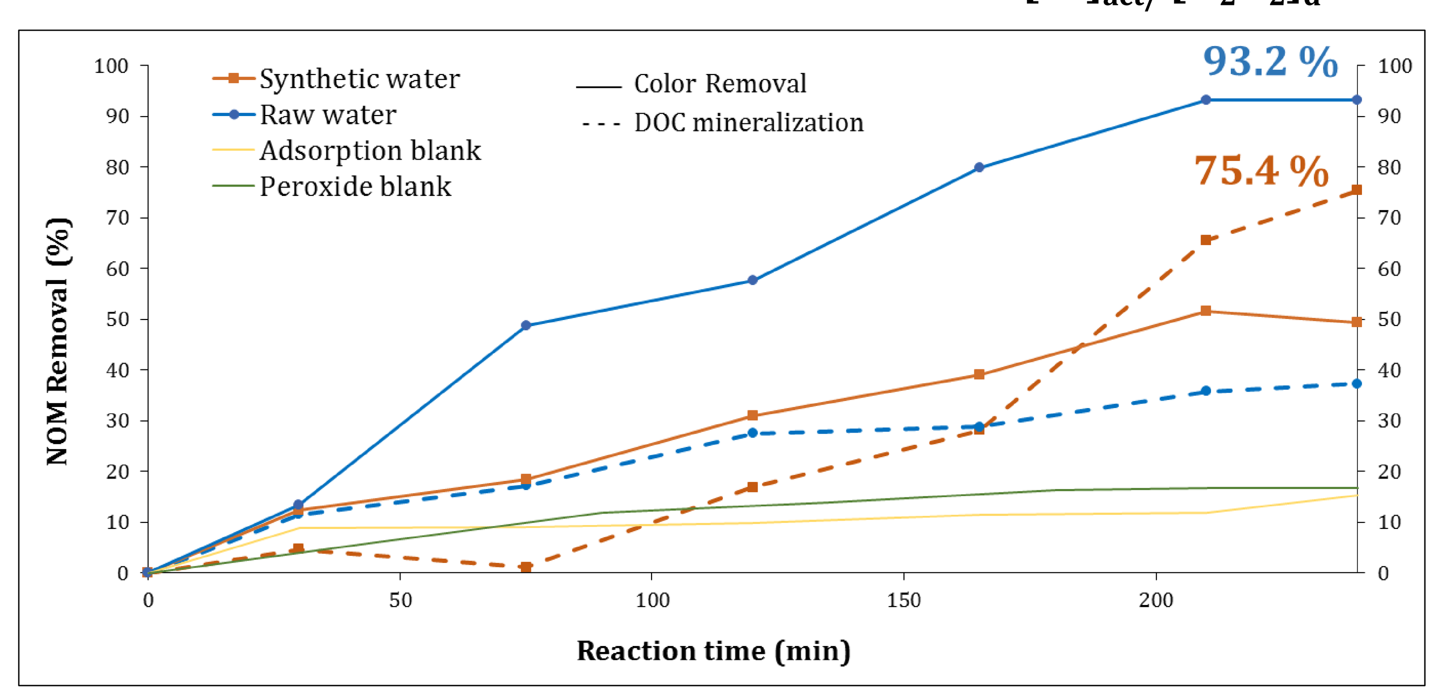


Fig. 5 Estimated multi-response surface plot for simultaneous optimization of [Al/Fe-PILC] loading and $[H_2O_2]_d$ experimental factors.

Optimal conditions:
$[H_2O_2]_d$= 64.42 % Stoich.
[Al/Fe-PILC]: 5.1 g/L
RW$[Fe]_{act/}$ $[H_2O_2]_d$= 1.219
SW$[Fe]_{act/}$ $[H_2O_2]_d$= 0.701



1000 mg/dm^3 H_2O_2 → 470.6 mg O_2/dm_3 de DQO [2] (141.32 mg/L COT)

Fig. 6 CWPO degradation of NOM: organic color removal at 456 nm (2120C-Standard Methods) and DOC mineralization (TOC-L Analyzer Shimadzu).

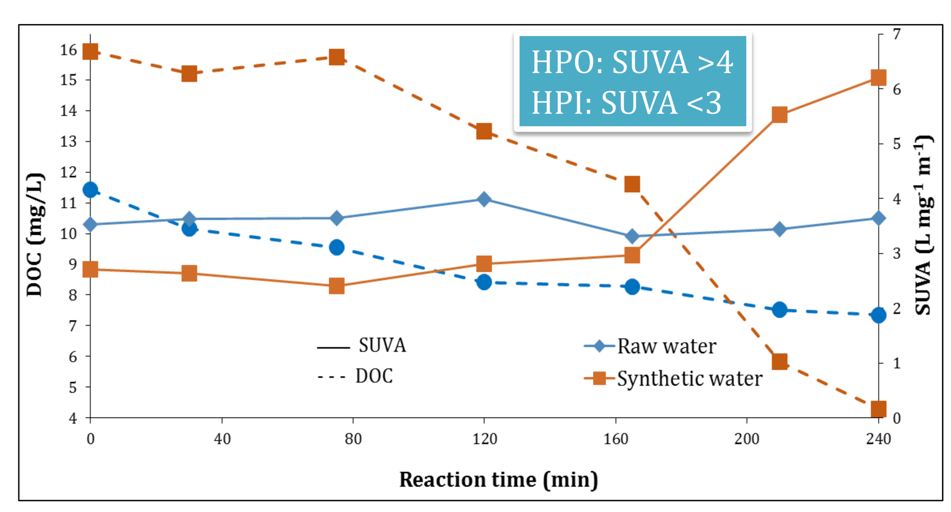


Fig. 7 Evolution of DOC and Specific UV Absorbance (SUVA) through the CWPO tests.

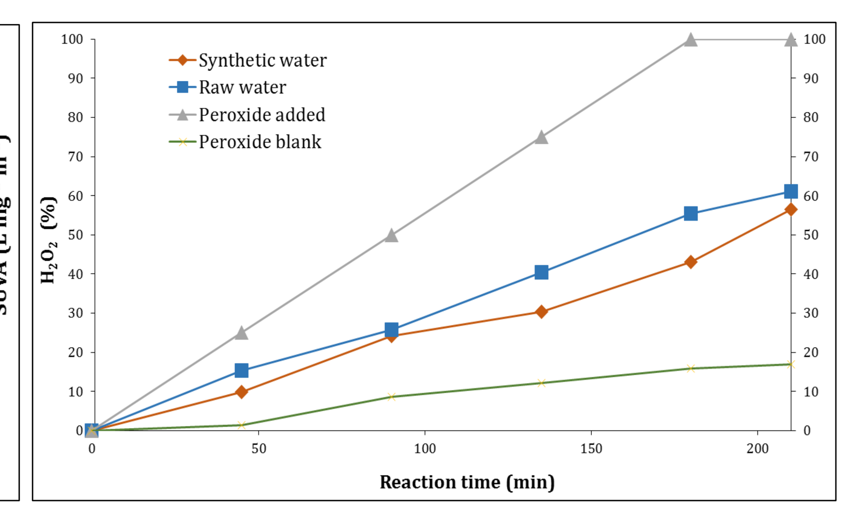


Fig. 8 Fraction of H_2O_2 reacted vs. added through the CWPO catalytic tests.

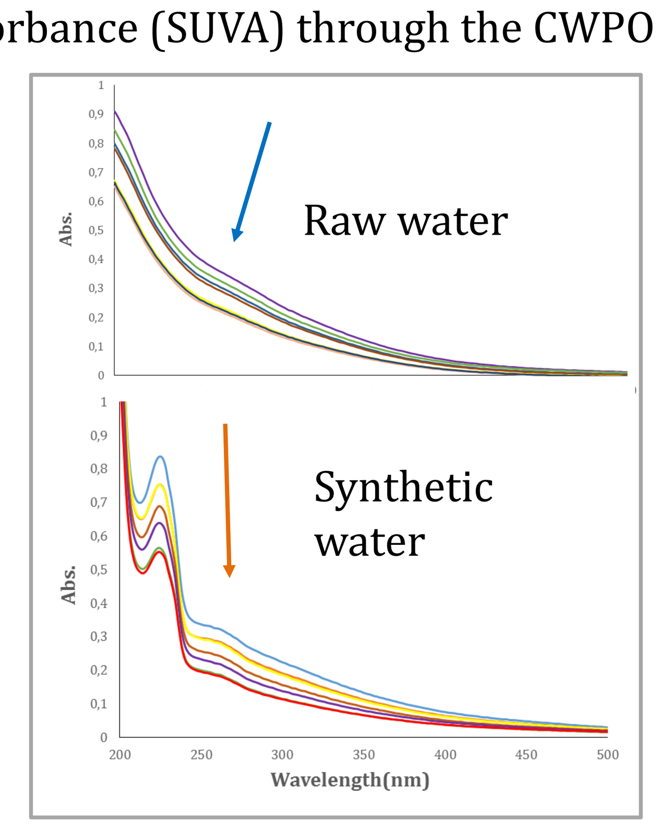


Fig. 9 RW and SW UV-Vis spectra through the CWPO catalytic experiments.

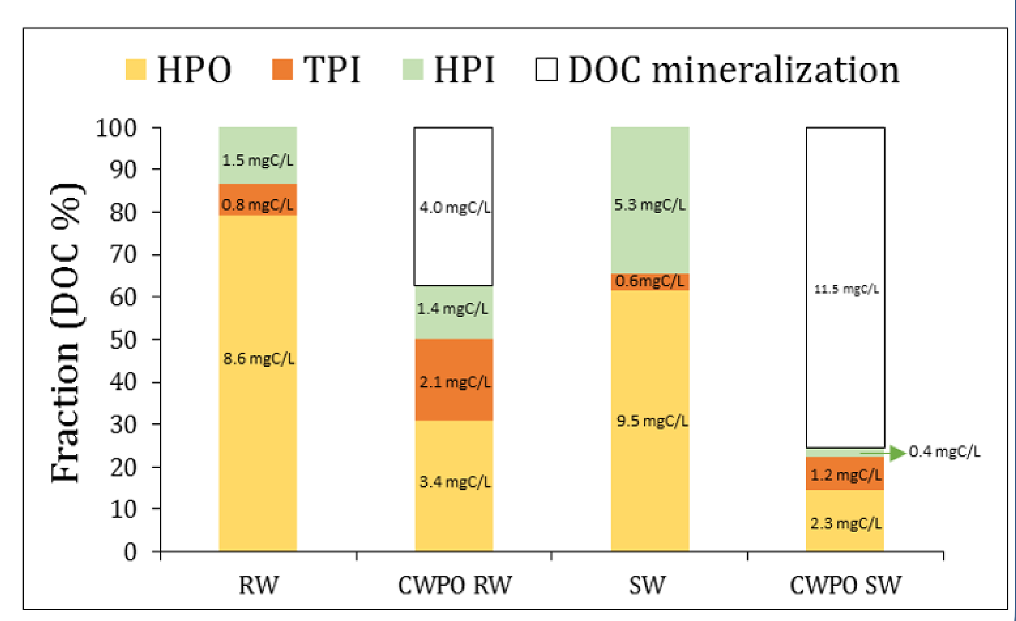


Fig. 10 DOC resin–fractionation of synthetic and real water before and after (240 min) of the CWPO catalytic tests.

Acknowledgment

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