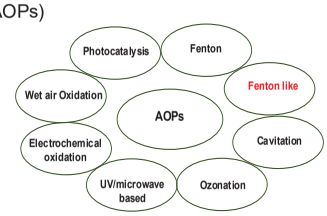
ELIMINATION OF SULFAMETHOXAZOLE BY ACTIVATED PERSULFATE WITH NETTLE BIOCHAR

A. Ioannidi[1], A. Petala [1], Z. Frontistis[2], D. Mantzavinos[1] ,
(1) Department of Chemical Engineering, University of Patras, GR-26504 Patras, Greece
(2) Department of Chemical Engineering, University of Western Macedonia, GR-50132 Kozani, Greece
*Contact: alex.ioannidi@chemeng.upatras.gr , phone +30 2610996137

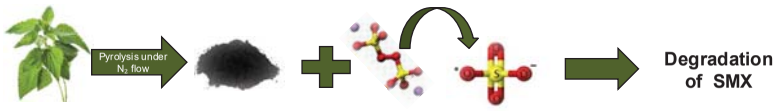
INTRODUCTION

Possible solution→ advanced oxidation processes (AOPs)

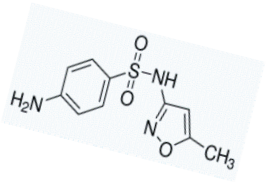


Aim of the study

The main purpose of this project was the development of nettle biochar catalyst/sodium persulfate process for the removal of antibiotic Sulfamethoxazole (SMX) from several water matrices. SMX is a representative pharmaceutical of the antibiotics family typically found in environmental samples at relevant concentrations from ng/L to mg/L [1]



EXPERIMENTAL



Materials.

- Antibiotic: sulfamethoxazole (SMX)
- Catalyst: material nettle biochar (B(T°C))
- Oxidant: Sodium persulfate (SPS)
- Water matrix:
  - Ultrapure water (UPW)
  - Wastewater (WW) containing ca 4.5 mg/L organic carbon and inorganics
  - Bottle Water (BW) containing mainly ca 250 mg/L $NaHCO_3$
  - 10 mg/L of humic acid (HA) to simulate the organic content of WW

Experiment conditions

- Reactant mixture volume: 60 mL
- Constant temperature at 25 °C
- Atmospheric pressure
- HPLC: Alliance 2695, Waters

RESULTS

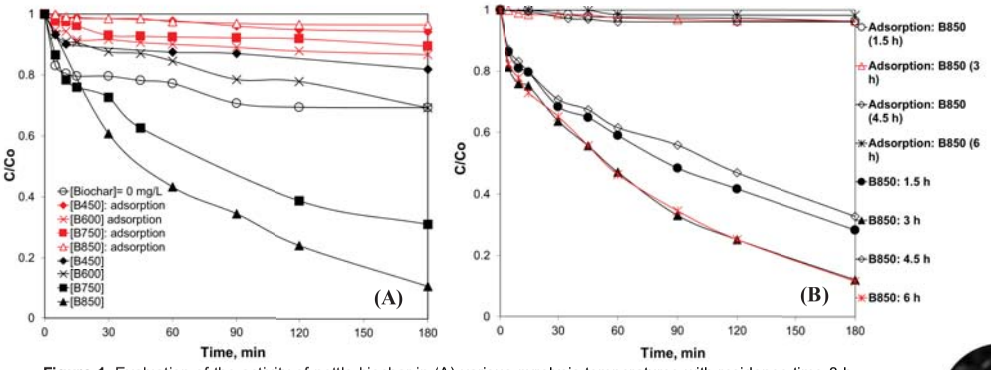


Figure 1. Evaluation of the activity of nettle biochar in (A) various pyrolysis temperatures with residence time 3 h and (B) several residence time at 850 °C. Experimental conditions: [SMX]= 500 μg/L, [BT(°C)] = 500 mg/L and [SPS]= 500 mg/L in Ultrapure water (UPW).

- **Fig. 1A** shows that B850 sample exhibited the greatest efficiency of the tested samples with 90% SMX removal at 180 min.
- **Fig. 1B** shows that B850: 6 h and B850: 3 h sample exhibit the same degradation rate of SMX. Thus, all the following experiments were carried out with B850: 3h.

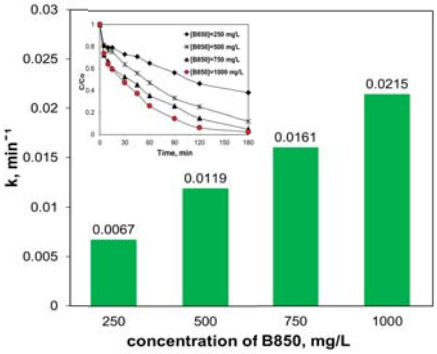


Figure 2: Effect of B850 concentration on the kinetics of [SMX]= 500 μg/L in UPW with [SPS]= 500 mg/L and inherent pH. Inset graph: concentration profiles of SMX degradation in UPW with several concentration of B850

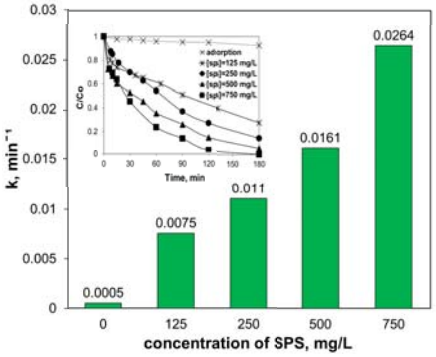


Figure 3: Effect of SPS concentration on the kinetics of [SMX]= 500 μg/L in UPW with [B850]= 750 mg/L and inherent pH≈8.5. Inset graph concentration profiles of SMX degradation in UPW with several concentration of SPS and adsorption.

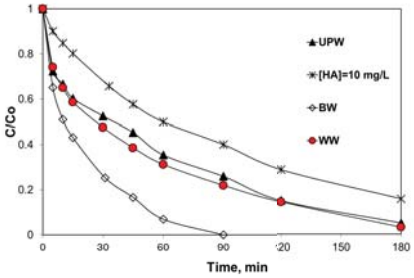


Figure 4: Effect of water matrix on 500 μg/L SMX degradation with [B850]= 750 mg/L and [SPS]= 500 mg/L.

- **Fig. 2** shows that the degradation rate enhances with enhancing B850 concentration because the number of active sites that are available for reaction is increased.
- **Fig. 3** display that increasing the persulfate concentration expectedly accelerated the degradation rate of SMX, while the removal due to adsorption was insignificant [2,3].
- **Fig. 4** shows that BW appears to favor SMX decomposition; it can be accomplished 100% SMX conversion at 90 min. Also, experiments in UPW and WW give nearly identical SMX degradation while 10 mg/L HA slow down the conversion of SMX [2].

CONCLUSIONS

✓Nettle biochars pyrolyzed at 750 °C and 850 °C were able to activate persulfate for the degradation of SMX in UPW. B850 sample showed the greatest performance.
✓The optimal residence time at 850 °C is 3 h.
✓The degradation rate of SMX in WW is slightly enhanced compared in UPW while in bottle water is remarkable faster than in UPW.

ACKNOWLEDGMENT

Alexandra Ioannidi acknowledge that this work is part of the project " Hybrid oxidation processes in tertiary wastewater treatment" which is implemented under the Action "H.F.R.I. – 2nd Call of Scholarships H.F.R.I for PhD Candidates" funded by H.F.R.I. Hellenic Foundation for Research and Innovation.

REFERENCES

1. Y. Yang, X. Lu, J. Jiang, J. Ma, G. Liu, Y. Cao, W. Liu, J. Li, S. Pang, X. Kong, C. Luo, Degradation of sulfamethoxazole by UV, UV/H2O2 and UV/persulfate (PDS): Formation of oxidation products and effect of bicarbonate, Water Res. 118 (2017) 169-207.
2. A. Ioannidi, Z. Frontistis, D. Mantzavinos, Destruction of propyl paraben by persulfate activated with UV-A light emitting diodes, J. Environ. Chem. Eng. 6 (2018) 2992-2997.
3. L. Kemmou, Z. Frontistis, J. Vakros, I. D. Manariotis, D. Mantzavinos, Degradation of antibiotic sulfamethoxazole by biochar-activated persulfate: Factors affecting the activation and degradation processes, Catal. Today. 313 (2018) 128–133