catalysts

MDPI

Supplementary Materials

Abatement of Naphthalene by Persulfate Activated by Goethite and Visible LED Light at Neutral pH: Effect of Common Ions and Organic Matter

Andrés Sánchez-Yepes, David Lorenzo, Patricia Sáez, Arturo Romero and Aurora Santos *

Chemical Engineering and Materials Department, Complutense University of Madrid, 28040 Madrid, Spain; andsan28@ucm.es (A.S.-Y.); dlorenzo@ucm.es(D.L.); patrisae@ucm.es (P.S.); aromeros@ucm.es(A.R.)
* Correspondence: aursan@ucm.es

Abstract: Naphthalene (NAP) has received particular attention due to its impact on the environment and human health, mandating its removal from water systems. In this work, the abatement of NAP in the aqueous phase was achieved using persulfate (PS) activated by Fe (III) and monochromatic LED light at a natural pH. The reaction was carried out in a slurry batch reactor using goethite as the Fe (III) source. The influence of the PS concentration, goethite concentration, irradiance, temperature and presence of organic matter, chloride, and bicarbonate on the abatement of NAP was studied. These variables were shown to have a different effect on NAP removal. The irradiance showed a maximum at 0.18 $W \cdot cm^{-2}$ where the photonic efficiency was the highest. As for the concentration of goethite and PS, the influence of the first one was negligible, whereas for PS, the best results were reached at 1.2 mM due to a self-inhibitory effect at higher concentrations. The temperature effect was also negative in the PS consumption. Regarding the effect of ions, chloride had no influence on NAP conversion but carbonates and humic acids were affected. Lastly, this treatment to remove NAP has proved to be an effective technique since minimum conversions of 0.92 at 180 min of reaction time were reached. Additionally, the toxicity of the final samples was decreased.

Keywords: goethite; LED light; naphthalene; persulfate; PAHs

Citation: Sánchez-Yepes, A.; Lorenzo, D.; Sáez, P.; Romero, A.; Santos, A. Abatement of Naphthalene by Persulfate Activated by Goethite and Visible LED Light at Neutral pH: Effect of Common Ions and Organic Matter. *Catalysts* **2022**, *12*, 732. https://doi.org/10.3390/catal12070732

Academic Editor(s): Jaime Carbajo

Received: 15 June 2022
Accepted: 28 June 2022
Published: 1 July 2022

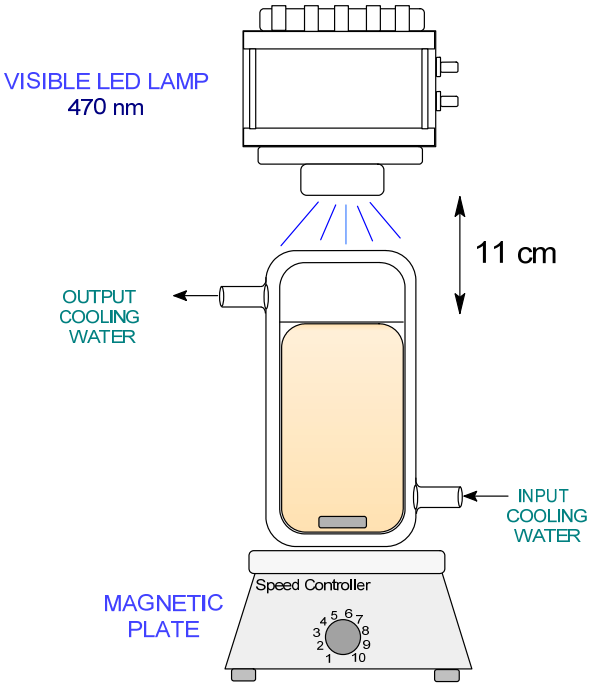

Figure S1. Schematic representation of the experimental setup.

Table S1. Initial and end pH of the different experiments summarized in Table 1.

Experiment	pH_0	pH_f
B1	7	5.01
B2	7	6.50
B3	7	5.55
R1	7	3.09
R2	7	3.33
R3	7	3.17
R4	7	3.19
R5	7	3.19
R6	7	3.25
R7	7	3.19
R8	7	2.94
R9	7	3.02
S1	7	3.06
S2	7	6.72
S3	7	6.95

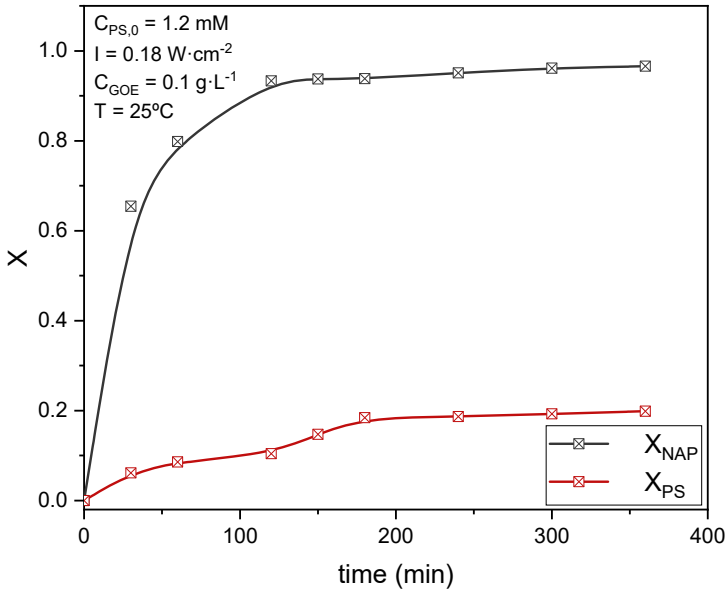

Figure S2. Temporal evolution of NAP and PS conversion, (R1). Determination of reaction time and study. Maintaining $C_{NAP,0} = 0.1\,mM, C_{PS,0} = 1.2\,mM,\ I = 0.18\,W \cdot cm^{-2}, C_{GOE} = 0.1\,g \cdot L^{-1}$ *and* 25ºC.

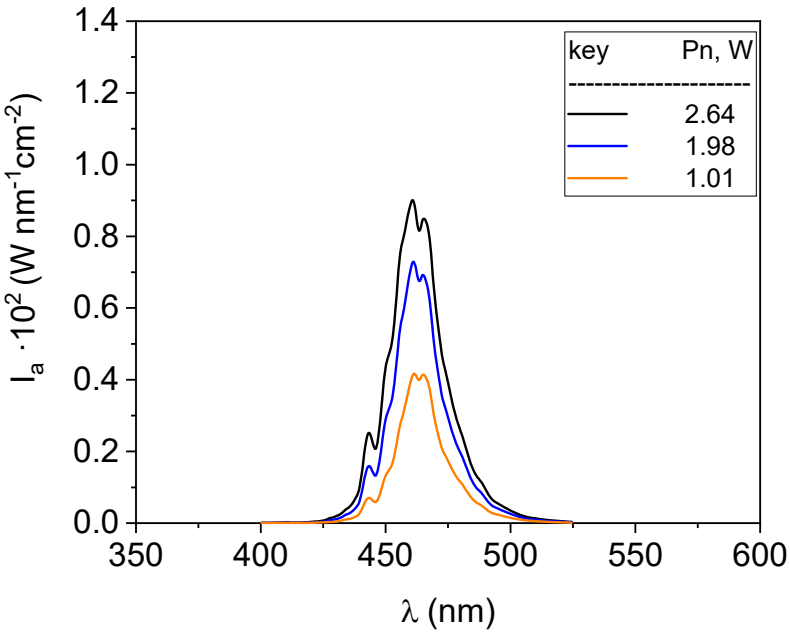

Figure S3. Discretized spectral irradiance measured at the reactor window for different lamp nominal powers (Pn).

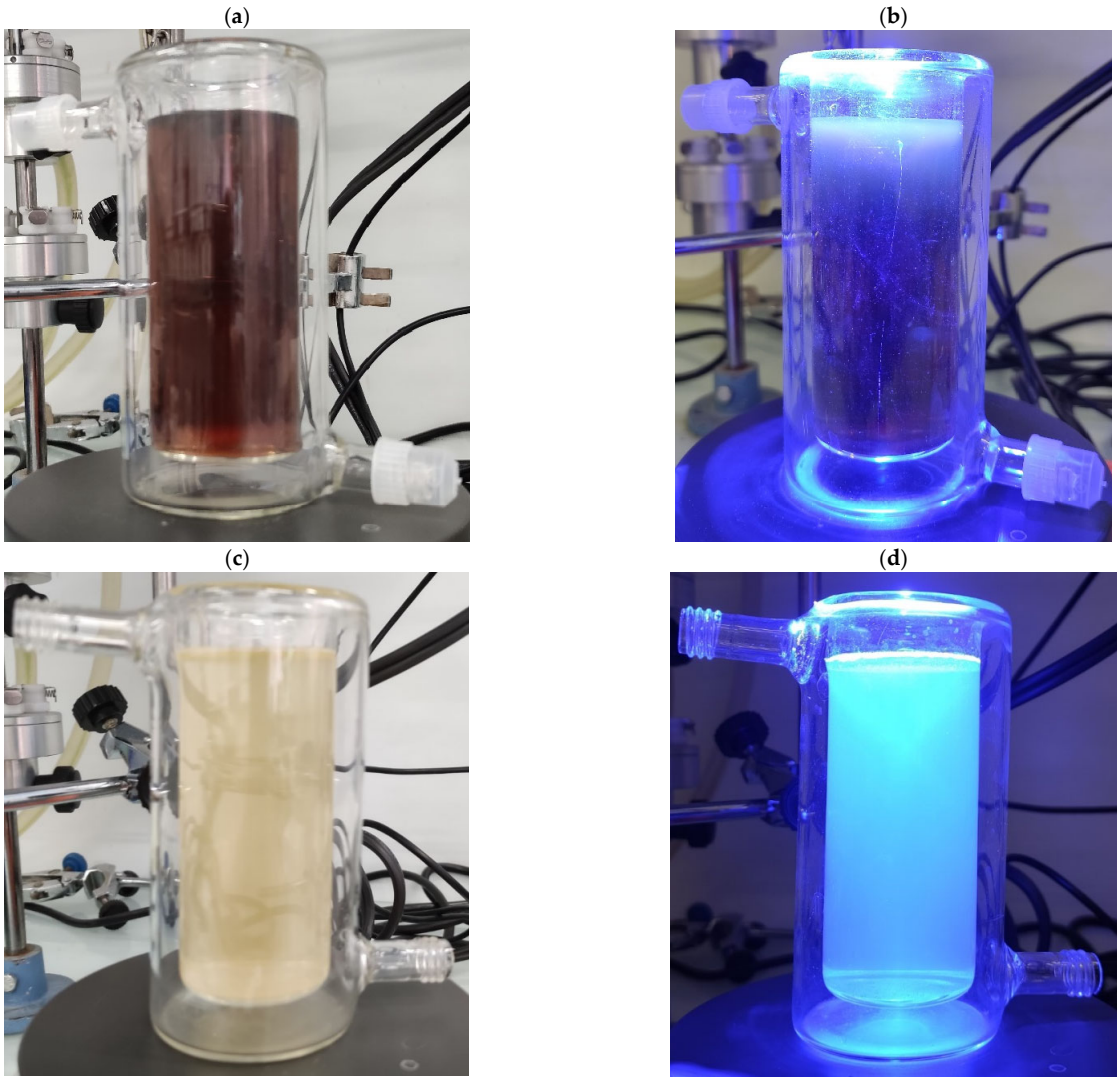

Figure S4. Images of the physical appearance of the reactor medium corresponding to run S3 $C_{NAP,0} = 0.1\,mM, C_{PS,0} = 1.2\,mM,\ I = 0.18\,W \cdot cm^{-2}, C_{H.Ac} = 50\,ppm\ and\ C_{GOE} = 0.1\,g \cdot L^{-1}$.. a) Medium without illumination b) Medium illuminated by LED lamp. Images of the physical appearance of the reactor medium corresponding to run R3 $C_{NAP,0} = 0.1\,mM, C_{PS,0} = 1.2\,mM,\ I = 0.18\,W \cdot cm^{-2}\ and\ C_{GOE} = 0.1\,g \cdot L^{-1}$.. c) Medium without illumination d) Medium illuminated by LED lamp.