NANOREMEDIATION THE TANNERY WASTEWATER: A CASE STUDY FROM THE UPPER BASIN OF THE BOGOTÁ RIVER (COLOMBIAN)

POSTER

Presented by Yaneth Vasquez

Tuesday, 11 July 2023

10:30 - 12:30

Exhibit and Poster Hall (Lyon Congress Center) - Poster #432

Session: 12hP2 - Anthropogenic contaminants in the environment: geochemical fate, transport, modelling, and novel remediation approaches

Symposium Session: 12h - Anthropogenic contaminants in the environment: geochemical fate, transport, modelling, and novel remediation approaches

Theme: Theme 12: Environmental geochemistry and human health

Abstract

Leather tanning industry have left a trail of environmental problems, including the generation of the tannery wastewater from tanning stage (TTW) with high concentrations of Cr (III and VI) and organic matter represented by chemical oxygen demand (COD). The TTW is responsible for physical, chemical, and biological degradation of aquatic habitats. In the Colombia, this has been a significant problem especially in the upper basin of the Bogotá River. To avoid detrimental impacts, the TTW must be collected and treated before being discharged into the environment. Heterogeneous Fenton oxidation treatment (HFO) is one possibility of the treatment.

In this study, we determined of the performance of HFO using commercial zerovalent iron nanoparticles (nZVI) as catalyst and compare it with the conventional Fenton, involving $FeSO_4 \cdot 7H_2O$ as control. Laboratory tests were carried out with real TTW with high concentration of Cr VI (49.6 ± 9.2 mg L^{-1}), Cr III (886.5 ± 43.5 mg L^{-1}) and COD (8400 ± 105.5 mg L^{-1}). The main operating parameters, such as pH, temperature and reagents amount, contact time, and sedimentation time were optimized using Plackett–Burman, central composite design and response surface

methodological approaches. Finally, to confirm the reliability of the model, an additional laboratory experiment was conducted applying the oxidant (H_2O_2) in a on single-step or two-step dosing.

The optimal conditions found for HFO were H_2O_2/COD (w/w) = 0.5, nZVI/H_2O_2 (w/w) = 1.25, and pH=3, when the oxidizer is applied in two-step dosing with 24 h of difference. The two-step dosing was found to be a crucial influencing factor to improve the overall HFO performance by effectively utilizing the hydroxyl radicals (•OH) and avoiding the scavenging reactions. The two-step dosing resulted in more efficient removal of Cr VI, Cr III, and COD (> 98%, > 70% and > 60%, respectively) with respect to the control process (> 90%, > 62% and > 49%, respectively).

These results clearly showed that the proposed HFO processes lead to higher treatment efficiency in removal of hazardous pollutants, giving an option to leather businessmen to deal with TTW.

Presenting Author

V

Yaneth Vasquez

Universidad Central

Authors

G

Jose Galvis

Universidad Central

Universidad del Rosario

F

Jan Filip

Regional Centre of Advanced Technologies and Materials, Czech Advanced Technology and Research Institute (CATRIN), Palacký University Olomouc, Šlechtitelů 241/27, 779 00, Olomouc – Holice, Czech Republic

A

Felipe Agudelo

Universidad Central

F

Jair Franco

Universidad Central

V

Julio Vasquez

Universidad Central

C

Gabriel Cardenas

Universidad Central

P

Eleni Petala

Regional Centre of Advanced Technologies and Materials, Czech Advanced Technology and Research Institute (CATRIN), Palacký University Olomouc

H

Oscar Herrera

Universidad Central

NANOREMEDIATION OF TANNERY WASTEWATER: A CASE STUDY FROM THE UPPER BASIN OF THE BOGOTÁ RIVER (COLOMBIA)

Yaneth Vasquez[1*], Jair Franco[1], Felipe Agudelo[1],, Mario Vasquez[1], Gabriel Cardenas[1], Eleni Petala[2] and Jan Filip[2], Oscar Herrera[1]

(1)Universidad Central, (2) Regional Centre of Advanced Technologies and Materials, Czech Advanced Technology and Research Institute (CATRIN), * E-mail: ovasquezo@ucentral.edu.co

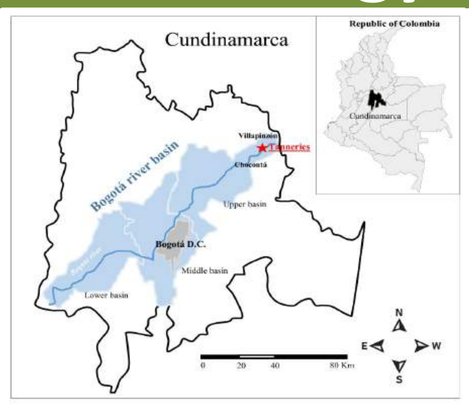
Introduction

The leather tanning industry have left a trail of environmental problems, including the generation of tannery wastewater from the tanning stage (TTW) that contains high concentrations of Cr (III), Cr (VI) and organic matter (COT). In the Colombia, this has been a significant problem especially in the upper basin of the Bogotá River. To avoid detrimental impacts, the TTW must be collected and treated before being discharged into the environment. The use of the heterogeneous Fenton process (nHF) with Zero-valent iron nanoparticles (nZVI) as a catalyst and H_2O_2 as oxidant is one possibility of the treatment.

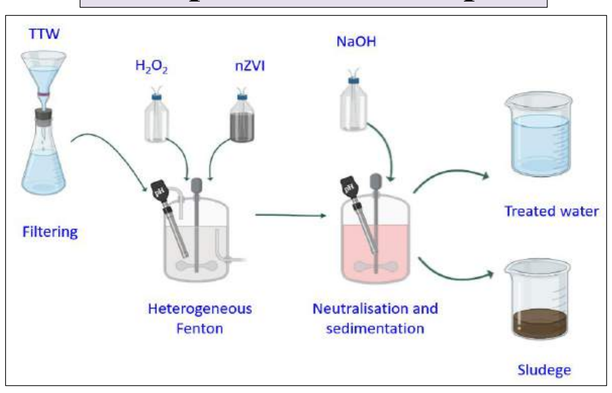
Main objective

Evaluate the performance of nHF for the treatment of real TTW samples by implementing the parametric optimization by response surface methodology to find the optimal operating conditions.

Methodology



Experimental Setup



Plackett-Burman Design (PB)

Factor	High levels (-1)	low levels (+1)	Units
H2O2/COD	0.5	0.75	w/w
nZVI/H2O2	1.0	0.75	w/w
pH	3.0	5.0	
Contact time	0.5	1.0	h
Agitation	100	200	rpm
sedimentation time	2	4	h
Temperature	17	30	°C

Identify the variables

Central Composite Design (CCD)

Optimal variables → 20 treatments

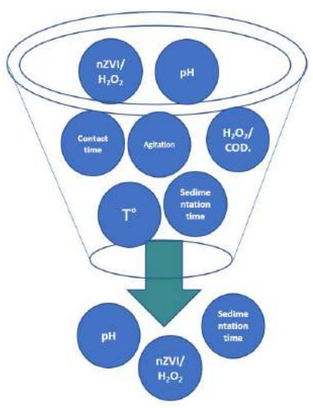
Response surface methodology (MSR)

Scaling Up

Confirm the reliability of the model and evaluation effect of dosing

Results

PB-Desing



pH: 3,0
nZVI / H_2O_2: 1,0
Sedimentation time: 3 h

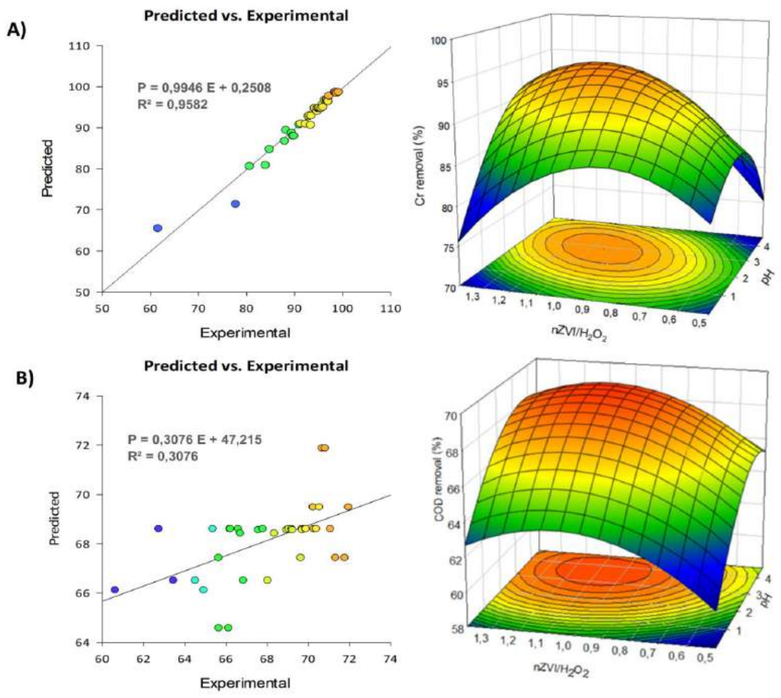
CCD-Desing

pH: 3,0
nZVI / H_2O_2: 1,25
Sedimentation time: 3 h

Cr_{total} removal: 97.74 ± 1.38%
COD removal: 70.26 ±1.60%,

Results

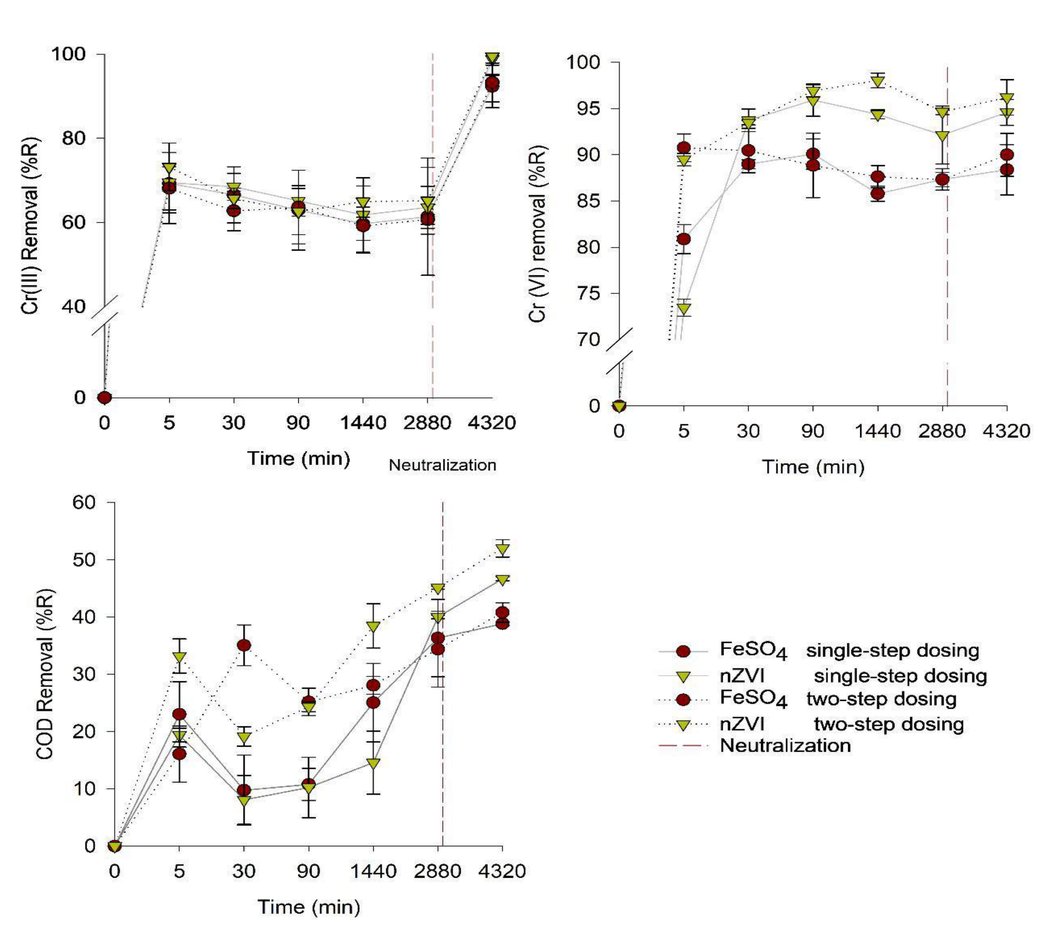
Response Surface Methodology (MSR)



$$\%\ R\ Cr_{total} = 39.0 + 6.25\ pH + 89.6\ \frac{nZVI}{H2O2} - 1.07\ \text{pH} + \text{pH} - 42.9\ \frac{nZVI}{H2O2} * \frac{nZVI}{H2O2}$$

The numerical optimization of the RSM/Minitab software: 2.93 of pH and 1.05 w/w of nZVI/H_2O_2 for 97.5 % of Cr_{total} removal and 71.4 % for COD removal.

Effect of dosing-Scaling Up



Changes in Cr(III), Cr(VI) and COD removal (%R) during treatment of TTW using nZVI and ferrous sulfate ($FeSO_4$•$7H_2O$) single-step or two-step dosing.

Conclusions

- The optimum process parameters for the best treatment (97.5% for Cr_{total} removal and 71.4% for COD removal) were found to be pH = 2.93 and nZVI/H2O2 = 1.05 w/w
- Two-step dosing of H2O2 in nHF had a significant effect on the removal of Cr(VI) and COD, favoring the complete reaction of the added H2O2, preventing the residue from oxidizing Cr(III) to Cr(VI), and contributing to reducing the toxicity of wate

Refereces

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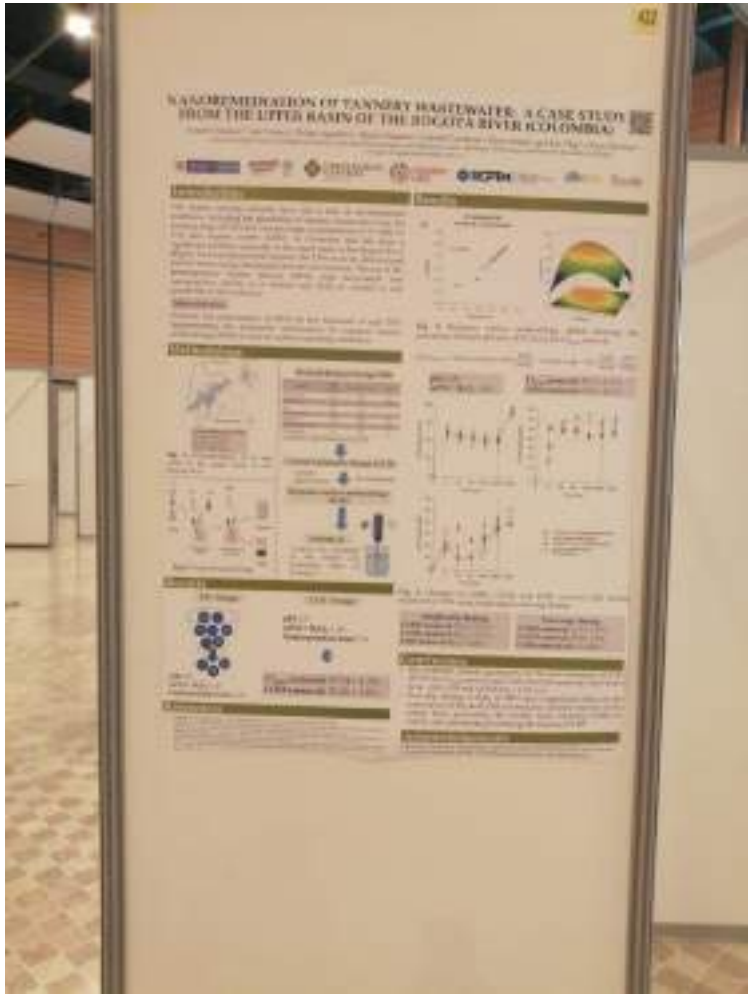
Acknowledgements

Ministry of Science, Technology and Innovation (MINCIENCIAS) and Sistema General de Regalias (SGR), Colombia [grant number: 2020000100441].

Anexo Otros Resultados

Registro Fotográfico



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