Sewage sludge biochar-supported nano zerovalent iron (nZVI) as an effective catalyst in Fenton process of decolorization

A. Leovac Maćerak, A. Kulić Mandić, V. Pešić, D. Tomašević Pilipović, M. Bečelić-Tomin, Đ. Kerkez
Department of Chemistry, Biochemistry and Environmental Protection, University of Novi Sad, Novi Sad, Autonomous Province of Vojvodina, 21000, Serbia (E-mail: anita.leovac@dh.uns.ac.rs)

Introduction

The main focus of this study is on sewage sludge based biochar supported with “green” syntesized nZVI that can be used beneficially in a heterogeneous Fenton treatment of colored wastewaters. Such application is an alternative to landfill disposal and promotes industrial symbiosis. Anthraquinone dye (Reactive Blue 4 - RB 4) was effectively treated by a promising technology based on degradation reaction catalysed by “green" nano zero valent iron supported biochar (nZVI-BC) in this work.

Experimental

1 Synthesis of nZVI-BC catalyst

’Green’’ synthesis method of nZVI particles was conducted using oak leaves, as source of polyphenols as reductive substances. Then, the extract was mixed with 0.1 M Fe(III) and BC in a ratio of 3:1:1 for 60 min. in ultrasonic bath (Machado et al. 2013; Mortazavian et al. 2019)

2 Characterization of nanomaterial

The morphology of synthesized nanomaterial was examined by using scanning electron microscopy (SEM) followed with energy-dispersive X-ray spectroscopy (EDS).

3 Definitive Screening Design

The series of 28 experiments included the examination of the following operational conditions on the removal efficiency of dye: [nZVI-BC], [H_2O_2] and [RB4].

4 Physico-chemical analysis of RB 4 before and after treatment

pH, conductivity, chemical oxygen demand (COD), biochemical oxygen demand (BOD), total organic carbon (TOC), Fourier transform infrared spectra (FTIR)

Results & Discussion

1

Figure 1. nZVI-BC synthesis

2

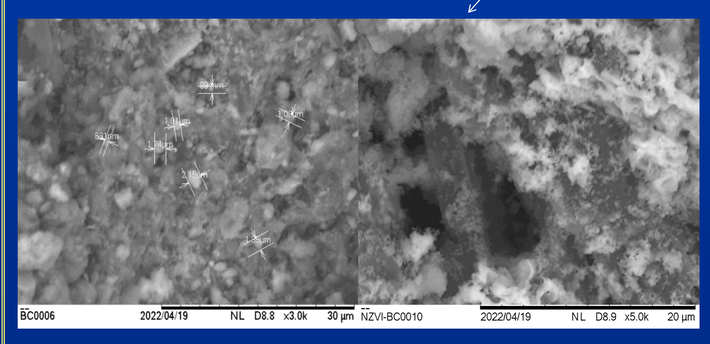

Figure 2 : SEM images of bare BC and nZVI-BC

2

Table 1 : Results of EDS analysis

Element, %	BC	nZVI-BC
C	37	28
O	29	22
Fe	4	25
Cl	-	19
P	6	2
Ca	7	2

Click to add text

3

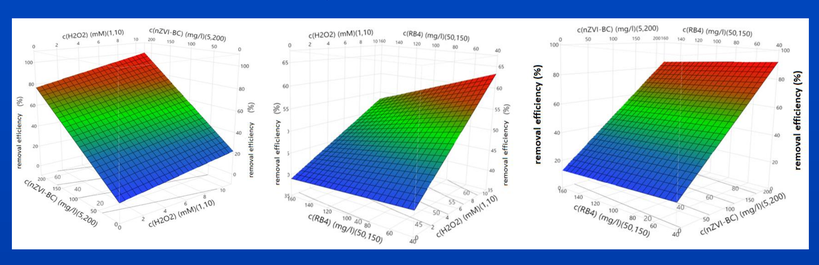

Figure 3. 3D graphics of response surfaces

3

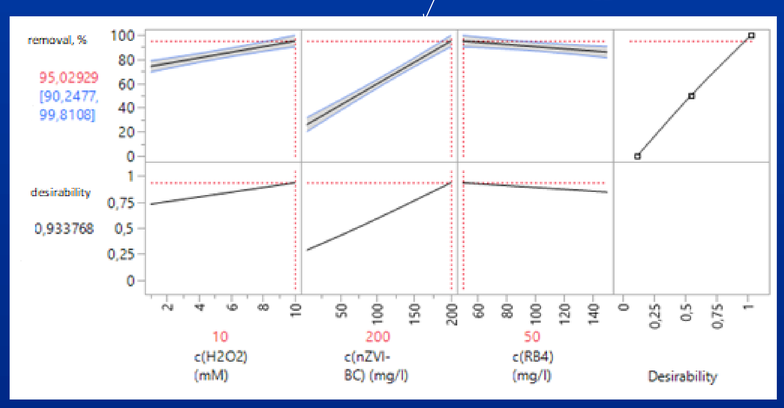

Figure 4. Fenton process optimization diagram

4

Table 2 Results of physico-chemical characterization of the effluent before and after treatment

Parameter	Before treatment	After treatment	Mineralization, %
pH	6,4	3,4	-
Conductivity (µS/c)	72	280,6	-
BOD (mgO_2/L)	0	16	-
COD (mgO_2/L)	280	105	62,5%
TOC (mgC/L)	16	10,15	36,6%

Conclusions

- nZVI-BC is an efficient catalyst and source of iron in the Fenton process
- Very low concentrations of the obtained nano-biochar and hydrogen peroxide were required to achieve decolorization efficiency.
- Destruction of chromophore groups as well as degradation of the entire dye molecule occurs
- Reuse of sewage sludge for production of efficient nano-biochar – contribution to circular economy practice.

This research was supported by the Science Fund of the Republic of Serbia, PROMIS call, Project no. #6066881, WasteWaterForce and CarbIrON project no. 36025/ 3, 2020-1-RD–Nanobiotech call. The authors would like to thank BioSense Institute from Novi Sad, Republic of Serbia (Goran Kitic and Jovana Stanojev), for the use of measurement equipment and data analysis.