Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2023.29355

287 (2023) 67–79
March

Electrochemical purification of Disperse Red 167 azo dye-based synthetic wastewater through the electrooxidation and electrocoagulation with Fe ions derived from Cu/Fe macro-corrosion galvanic cell

Mateusz Łuba[a,b], Tomasz Mikołajczyk[a,*], Mateusz Kuczyński[a], Bogusław Pierożyński[a], Agnieszka Jasiecka-Mikołajczyk[c], Bartosz Rasiński[d], Paweł Wojtacha[e]

[a]*Department of Chemistry, Faculty of Agriculture and Forestry, University of Warmia and Mazury in Olsztyn, Łódzki Square 4, 10-727 Olsztyn, Poland, emails: tomasz.mikolajczyk@uwm.edu.pl (T. Mikołajczyk), mateusz.luba@uwm.edu.pl (M. Łuba), mateusz.kuczynski@uwm.edu.pl (M. Kuczyński), bogpierozynski@yahoo.ca (B. Pierożyński)*
[b]*Łukasiewicz Research Network, Institute of Electrical Engineering, Mieczysława Pożaryskiego 28, 04-703, Warsaw, Poland, email: mateusz.luba@iel.lukasiewicz.gov.pl (M. Łuba)*
[c]*Department of Pharmacology and Toxicology, Faculty of Veterinary Medicine, University of Warmia and Mazury in Olsztyn, Oczapowskiego 13, 10-719 Olsztyn, Poland, email: agnieszka.jasiecka@uwm.edu.pl (A. Jasiecka-Mikołajczyk)*
[d]*Waters Corporation, Wybrzeze Gdynskie 6b, 01-531 Warszawa, Poland, email: bartosz_rasinski@waters.com (B. Rasiński)*
[e]*Department of Industrial and Food Microbiology, Faculty of Food Science, University of Warmia and Mazury in Olsztyn, Cieszyński Square 1, 10-726, Olsztyn, Poland, email: pawel.wojtacha@uwm.edu.pl (P. Wojtacha)*

Received 14 September 2022; Accepted 19 January 2023

ABSTRACT

Introduction of novel wastewater treatment technologies plays an important role in sustainability and environmental management. Commonly used wastewater purification processes are based on a combination of physical, chemical and biological methods. Despite their relatively good effectiveness in the removal of dyes, these treatments involve employment of various chemicals and biological additives, where their operational costs are very high. Thus, researchers continuously work to develop new ways of wastewater treatment, for example, electrochemical techniques. Unfortunately, a traditional electrochemical method for the removal of pollutants requires large amounts of electrical energy. Thus, in this work, we report a wastewater purification method carried-out through a continuous anodic dissolution of iron (mild steel) anode for artificially aerated Cu/Fe galvanic (macro-corrosion) cells and synthetically prepared industrial wastewater solutions. Electrochemical experiments were performed by means of a laboratory size electrolyzer reactor, where the electrocoagulation process along with surface-induced electrooxidation phenomena were examined for wastewater containing Disperse Red 167 (DR167) dye. The above was visualized through the employment of electrochemical (cyclic voltammetry and AC impedance spectroscopy techniques) and instrumental spectroscopy analyses. As a result, the total removal of DR167 azo dye from the synthetic wastewater solution (evaluated by means of UV-Vis spectroscopy) reached about 85% and 97% after 900 and 3,600 s, correspondingly.

Keywords: Electrocoagulation; Electro-oxidation; Fe sacrificial anode; Galvanic cell; Anodic dissolution; Synthetic wastewater treatment

* Corresponding author.