Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2023.29534

293 (2023) 170–181
May

Photodegradation and mineralization of ciprofloxacin by consecutive application UV/iodide process and biological treatment

Norouz Mahmoudi[a,b,c], Ahmad Jonidi Jafari[a,b], Mahdi Farzadkia[a,b], Majid Kermani[a,b], Amir Sheikhmohammadi[d], Hasan Pasalari[a,b], Ali Esrafili[a,b,*]

[a]*Research Center for Environmental Health Technology, Iran University of Medical Sciences, Tehran, Iran, emails: a_esrafily@yahoo.com (A. Esrafili), m.n.noroz@gmail.com (N. Mahmoudi), jonidi.a@iums.ac.ir (A.J. Jafari), farzadkia.m@iums.ac.ir (M. Farzadkia), majidkermani@yahoo.com (M. Kermani), hasanpasalari1370@gmail.com (H. Pasalari)*
[b]*Department of Environmental Health Engineering, School of Public Health, Iran University of Medical Sciences, Tehran, Iran*
[c]*Health Research Center, Life style Institute, Baqiyatallah University of Medical Sciences, Tehran, Iran*
[d]*Department of Environmental Health Engineering, School of Health, Khoy University of Medical Sciences, Khoy, Iran, email: a_sheikhmohammadi@khoyums.ac.ir*

Received 6 December 2022; Accepted 31 March 2023

ABSTRACT

This research was developed to examine the progressive degradation process of ciprofloxacin (CIP) via reductive species generated in iodide excitation under ultraviolet light as advanced reduction processes. The highest CIP degradation (98.46%) were achieved under optimal condition: pH = 9, CIP:iodide molar ratio = 2:1, and reaction time = 30 min. In UV/iodide process, the reaction rate constant (k_{obs}), reaction rate (r_{obs}), range were 0.182–0.0351 min^{-1}, and 9.135–7.02 $mg{\cdot}L^{-1}$, respectively. Moreover, energy consumption (E_{EO}) was calculated using two methods of kinetics and International Union of Pure and Applied Chemistry (IUPAC). The results indicated that when CIP concentration increases from 50 to 200 $mg{\cdot}L^{-1}$, the amount of E_{EO} increases from 1.54 to 8.02 $kWh{\cdot}m^{-3}$ at kinetic model. In addition, in the IUPAC model. The energy consumption increased from 1.22 to 6.48 $kWh{\cdot}m^{-3}$. Gas chromatography–mass spectrometry was used to study the intermediate products and probable photodegradation routes of CIP in the UV/iodide process; most of the intermediates were calcified into simple linear molecules such as acetic acid ($C_2H_4O_2$), formate (CHO_2^-), and formaldehyde (CH_3OH), and then to CO_2, H_2O, NH_4^+, and NH_3. The modified Kirby–Bauer disc diffusion test was used to investigate bacterial inhibition, the starting concentration of CIP without treatment was lowered from 39 to 11.4 mm after 30 min of reaction time. This decrease in bacterial growth inhibition and intermediate production suggests that the UV/iodide method produces effluent with a high biodegradability. After 30 min, the UV/iodide process led to decreased chemical oxygen demand (COD) by 37.5%. Within 11 h, the COD removal efficiency reached 63.8% (130 to 47 $mg{\cdot}L^{-1}$) when the biological reactor as post-treatment was run at an mixed liquor suspended solids (MLSS) concentration of 1,000 $mg{\cdot}L^{-1}$. However, in case of MLSS concentration (3,000 $mg{\cdot}L^{-1}$), the COD removal efficiency increased to 78.4% (from 185 to 39.7 $mg{\cdot}L^{-1}$), while, 88.16% COD removal efficiency was obtained at an MLSS dosage of 5,000 $mg{\cdot}L^{-1}$ (from 245 to 29 $mg{\cdot}L^{-1}$).

Keywords: Iodide; Photoreductive; International Union of Pure and Applied Chemistry; Bacterial susceptibility test; Biological treatment

* Corresponding author.