Desalination and Water Treatment
www.deswater.com

doi: 10.5004/dwt.2022.28789

271 (2022) 176–191
September

Optimization of diclofenac sodium adsorption onto graphene nanosheets: capacity, kinetics, isotherms and removal

Glauber da Rocha Medeiros[a,*], Adison da Silva Pereira Júnior[b], Felipe Mendonça Fontes Galvão[b], José Heriberto Oliveira do Nascimento[b,c], Juliana Delgado Tinôco[a,d]

[a]*Graduate Program in Sanitary and Environmental Engineering, Technology Center, Federal University of Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil, Tel. +5584998404265; emails: glauber.medeiros.045@ufrn.edu.br (G. da Rocha Medeiros), juliana.tinoco@ufrn.br (D. Tinôco)*
[b]*Research Group in Micro and Nanotechnology Innovation – GPIMN, Department of Textile Engineering, Technology Center, Federal University of Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil, emails: adsonjunior.sk8@hotmail.com (A. da Silva Pereira Júnior), felipe.galvao@goldentecnologia.com (F.M. Fontes Galvão), joseheriberto@ct.ufrn.br (J.H.O. do Nascimento)*
[c]*Graduate Program in Chemical Engineering, Technology Center, Federal University of Rio Grande do Norte, Natal, Rio Grande do Norte, Brazil*
[d]*Laboratory of Water Resources and Environmental Sanitation – LARHISA, Department of Civil Engineering, Federal University of Rio Grande do Norte – UFRN, 3000, CEP 59078-970, Natal, RN, Brazil*

Received 15 December 2021; Accepted 24 July 2022

ABSTRACT

Recently, emerging contaminants have been studied with greater attention due to their growing presence in aquatic environments, medications being one of the major pollutants owing to their global consumption. Among the main pharmaceuticals detected, the anti-inflammatory diclofenac sodium (DS) is considered the most ecotoxic and features on the European list of priority substances for monitoring as part of Water Framework Directive 39/2013. Among the water treatment processes available, adsorption is a highly effective technical and economic alternative. As such, this study aimed to assess DS removal efficiency using graphene oxide (GO) as an adsorbent. DS was analyzed using a central composite design, with four factors: diclofenac sodium concentration (DS_C of 50 to 450 mg L^{-1}), adsorbent concentration (ADS_C of 0.2 to 5 g L^{-1}), contact time (C_t of 5 to 45 min) and pH (5 to 9). The results confirmed the modeling of adsorption capacity, adsorbate removal, pseudo-first-order and pseudo-second-order kinetics, intraparticle diffusion, and Langmuir and Freundlich isotherms. DS demonstrated an affinity for adsorption onto GO nanosheets. Maximum adsorption capacity for GO was 669.50 mg g^{-1} (DS_C of 450 mg L^{-1}, ADS_C of 0.2 g L^{-1}, C_t of 34.3 min and pH 5) obtained by duplicate identification batches. The data also supported the creation of an equation that indicates the adsorbent dose needed for total DS removal (100%) from a solution.

Keywords: Adsorption; Central composite design; Diclofenac; Graphene oxide

* Corresponding author.