

# **A comprehensive review on contaminants removal from pharmaceutical wastewater by electrocoagulation process**

*B.K. Zaied<sup>a</sup>, Mamunur Rashid<sup>b</sup>, Mohd Nasrullah<sup>a,c</sup>, A.W. Zularisam<sup>a</sup>, Deepak Pant<sup>d</sup>, Lakhveer Singh<sup>e</sup>*

<sup>a</sup>Faculty of Civil Engineering Technology, Universiti Malaysia Pahang (UMP), Gambang, 26300 Kuantan, Pahang, Malaysia

<sup>b</sup>Faculty of Electrical and Electronics Engineering Technology, Universiti Malaysia Pahang (UMP), 26600 Pekan, Pahang, Malaysia

<sup>c</sup>Faculty of Chemical and Process Engineering Technology, Universiti Malaysia Pahang (UMP), Gambang, 26300, Kuantan, Pahang, Malaysia

<sup>d</sup>Separation and Conversion Technology, Flemish Institute for Technological Research (VITO), Boeretang 200, Mol 2400, Belgium

<sup>e</sup>Department of Environmental Science, SRM University-AP, Amaravati, Andhra Pradesh - 522502, India

## **ABSTRACT**

The pharmaceuticals are emergent contaminants, which can create potential threats for human health and the environment. All the pharmaceutical contaminants are becoming enormous in the environment as conventional wastewater treatment cannot be effectively implemented due to toxic and intractable action of pharmaceuticals. For this reason, the existence of pharmaceutical contaminants has brought great awareness, causing significant concern on their transformation, occurrence, risk, and fate in the environments. Electrocoagulation (EC) treatment process is effectively applied for the removal of contaminants, radionuclides, pesticides, and also harmful microorganisms. During the EC process, an electric current is employed directly, and both electrodes are dissolved partially in the reactor under the special conditions. This electrode dissolution produces the increased concentration of cation, which is finally precipitated as hydroxides and oxides. Different anode materials usage like aluminum, stainless steel, iron, etc. are found more effective in EC operation for efficient removal of pharmaceutical contaminants. Due to the simple procedure and less costly material, EC method is extensively recognized for pharmaceutical wastewater treatment over further conventional treatment methods. The EC process has more usefulness to destabilize the pharmaceutical contaminants with the neutralization of charge and after that coagulating those contaminants to produce flocs. Thus, the review places particular emphasis on the application of EC process to remove pharmaceutical contaminants. First, the operational parameters influencing EC efficiency with the electroanalysis techniques are described. Second, in this review emerging challenges, current developments and techno-economic concerns of EC are highlighted. Finally, future recommendations and prospective on EC are envisioned.

**KEYWORDS:** Pharmaceuticals; Contaminants removal; Electrocoagulation; Operating parameters

DOI: <https://doi.org/10.1016/j.scitotenv.2020.138095>

#### **ACKNOWLEDGMENT**

The authors wish to express their appreciation to the Faculty of Civil Engineering Technology, Universiti Malaysia Pahang (UMP) for providing financial support (RDU1803143).