Environmental Engineering and Management Journal

December 2023, Vol. 22, No. 12, 2003-2018
http://www.eemj.icpm.tuiasi.ro/; http://www.eemj.eu
http://doi.org/10.30638/eemj.2023.173

"Gheorghe Asachi" Technical University of Iasi, Romania

EXPERIMENTAL AND STATIC SIMULATION STUDY FOR ENHANCING WASTEWATER TREATMENT BY ELECTROCOAGULATION USING MAGNETIC FIELDS

Jawaher Al Mahrouqi[1], Nour Al Meqbali[1], Mohamed S. Mahmoud[1,2], Nasser A.M. Barakat[2*], Taha E. Farrag[3], Marwa M. Abdel-Aty[2]

[1]Department of engineering, University of Technology and Applied Sciences, Suhar, 311, Oman
[2]Faculty of Engineering, Chemical Engineering Department, Minia University, El-Minia, 61516, Egypt
[3]Faculty of Engineering, Chemical Engineering Department, Port Said University, Port Said, Egypt

Abstract

Wastewater treatment by electrocoagulation (EC) process has been investigated as a potential process for a sustainable wastewater management scheme. In this work, a process for the treatment of three different pollutants by the EC process in the presence of a magnetic field (MF) has been tested experimentally. The main aim of this study is to prepare the EC unit for scaling up and utilization with real wastewater. In this work, we introduce a novel configuration of MF using four solenoids to induce the motion of ions generated in the vicinity of the anodes. The efficiency of the EC process was quantified as the total pollutant removed compared to the influent concentration of the pollutant. The treatment is performed in batch mode using four sets of iron electrodes connected in a monopolar assembly. Three operating variables were examined for their effects on removal efficiency: the applied voltage, electrolyte concentration, and the effect of the MF. The experiments revealed that an applied voltage of 8 volts (3.44 mA/cm^2) was sufficient to pursue 90% removal of pollutants in almost 20 minutes, and it is recommended from an economic point of view. Using four sets of iron-cored solenoids at a MF intensity of 1T, the removal efficiency has been enhanced for dye and oil wastewater, while it has not been enhanced for dairy wastewater. Moreover, using the finite element method magnetic simulator (FEMM), it was indicated that only 11% of the magnetic flux is directed to the electrochemical cell region. To shed some light on the economics of the process, energy requirements and anode consumption were calculated for 20 minutes of contact time under different operating conditions. The results revealed that the EC system utilized energy of around 0.3 kWh/kg of pollutants. Energy consumption was proven to be comparable to other commercial processes.

Key words: electrocoagulation, industrial effluents, magnetic field, wastewater treatment

Received: April, 2023; Revised final: August, 2023; Accepted: October, 2023; Published in final edited form: December, 2023

* Author to whom all correspondence should be addressed: e-mail: nasbarakat@mu.edu.eg; Phone: +201116859697