# Simulating Electrocoagulation for Water Treatment: Effect of Applied Current on Energy Consumption

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## Abstract

Electrocoagulation (EC) is emerging as a low-footprint, chemical-minimal water treatment technology. Yet, its design and optimization are constrained by trial-and-error methods that lack insight into internal electrochemical dynamics. This study presents a validated 3D COMSOL Multiphysics model of a batch EC reactor, simulating electric potential and current density distribution under varying current inputs. The model integrates experimentally relevant conditions and parametric sweeps to identify optimal energy-efficient operating windows. Electric potential varied from -2.72V to -1.77V across a 0-2A current sweep. Current density visualizations revealed significant edge concentration at lower currents, which improved with increased current input, achieving uniformity at 1.5-1.75 A. Energy consumption was calculated directly from the simulation outputs using electric potential, total current, and process time, enabling realistic energy consumption analysis. The study links current field distribution with energy optimization, offering an insight to scalable, resource-efficient EC design framework aligned with SDGs 6 (Clean Water), 9 (Industry Innovation), and 12 (Responsible Production). This COMSOL Multiphysics-based approach aims to reduce experimental runs, minimize waste, and support predictive engineering for sustainable water treatment systems. 


## Author keywords

electrocoagulation; energy analysis; simulation

## Indexed keywords

**Engineering controlled terms**

Computer aided design; Current density; Energy management; Waste treatment; Water treatment

**Engineering uncontrolled terms**

Applied current; Current input; Design and optimization; Electro coagulations; Energy analysis; Energy-consumption; Simulation; Treatment effects; Trial-and-error method; Water treatment technologies

**Engineering main heading**

Electric potential

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