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Research article

Electrochemical disinfection of bacterial contamination: Effectiveness and modeling study of *E. coli* inactivation by electro-Fenton, electro-peroxi-coagulation and electrocoagulation

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ABSTRACT

The present work undertakes an examination and comparison of electro-Fenton (EF), electro-peroxi-coagulation (EPC) and electrocoagulation (EC) applied to the *E. coli* inactivation in batch reactor. Indeed, platinum (Pt (anode), EF), stainless steel (SS (cathode), EF, EPC) and ordinary steel (Fe (anode), EPC) and aluminum (Al, EC) were used respectively. The current intensity, nature of electrolytic support, bacterial density and hydrogen peroxide (H_2O_2) concentration are the most influenced study parameters. The obtained results showed that the high current intensities were significant for better inactivation and destruction of *E. coli* cells and caused a maximum of energy consumption. Both disinfection and energy consumption were improved by adding NaCl (or Na_2SO_4) in the three processes. Higher cellular density limited the electrochemical process and has negative effect in *E. coli* inactivation and the energy consumption. Only in the EPC case, the disinfection was considerably increased in function with H_2O_2 concentration. The modeling parameters of the inactivation kinetics of *E. coli* showed a good fitting of the established model ($0.9560 < R^2 < 0.9979$, $0.9267 < R^2$ adjusted < 0.997 and $0.0189 < \mathrm{RMSE} < 0.4821$), faster kinetics of *E. coli* inactivation (significant values of K_{max} and Sl) in the case of high current intensity ($0.2442 < K_{max} < 0.7440$ and $10.50 < Sl < 24.69$), the presence of chlorides or sulfates ($0.6662 < K_{max} < 0.7818$ and $11.67 < Sl < 18.59$), and the sufficient H_2O_2 concentration ($0.4712 < K_{max} < 0.9204$ and $13.00 < Sl < 16.38$). Moreover, the analysis of the results revealed that the EF is more effective in terms of the *E. coli* inactivation and the energy consumption comparatively to the other studied processes.

1. Introduction

In most countries, water quality remains a serious problem from both the economic and medical points of view. In the developed countries, industry (paper making, alimentary, slaughter effluents…) and agriculture activity represent the major source and vectors of infections by the intense use of organic and inorganic products that constitute a favorable environment for the growth and transmission of different microorganisms (Abderrahmane et al., 2008).

Current progress develops the disinfection processes in order not only to reduce the risks of the diseases that can be transmitted in water, but also to preserve the environment. Generally, the disinfection of water (drinking water or wastewater) can be carried out by chemical processes (chlorination, ozonization) after a series of treatment steps, such as coagulation/flocculation, decantation and filtration. Briefly, as reported in several research works, the treatment of the rejections liquidate by chemical coagulation/flocculation with ferric chloride under optimal conditions can eliminate only 50% of the total bacterial contamination (Abdelaziz et al., 2013). On other hand and until now, chlorination has been the most common disinfection step applied for water treatment. Besides, more problems have appeared, such as unfavorable taste, and most importantly carcinogenic diseases (Delaedt et al., 2008; Feng et al., 2004). As environment-friendly, the electrochemical process is considered as a water-disinfection promising methods with very encouraging results (Delaedt et al., 2008; Feng et al., 2004; Li et al., 2011). Furthermore, it is successfully applied in the inactivation of different microorganisms (bacteria, viruses and microalgae) (Li et al., 2011). Among electrochemical disinfection

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