Optimization and electrocoagulation of purification process.

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Abstract

The electrocoagulation (EC) process has been widely studied in recent years to remove a wide range of contaminants present in different types of water: fluorides, arsenic, heavy metals, organic matter, colorants, oils, and recently, pharmaceutical compounds. However, most of the studies have been aimed at understanding the process factors that have the most significant effect on efficiency, and these studies have been mainly on a batch process. Therefore, this review is focused on elucidating the current state of development of this process and the challenges it involves transferring to continuous processes and the recent exploration of its potential use in the removal of pharmaceutical contaminants and its implementation with other technologies.

Keywords: Electrocoagulation, reactor design, Pharmaceuticals removal, Hybrid systems.

Introduction

Various pollutants in water for human use and consumption, municipal wastewater, and industrial effluents represent a public health problem and a threat to ecosystems. Contaminants such as fluoride, arsenic, heavy metals, dyes, fats and oils, and pharmaceuticals, to name a few, come from various sources, and their removal represents a challenge due to the characteristics of each type of water. Even so, the EC process has shown high versatility since it allows one to efficiently remove these contaminants in underground, surface, and residual water [1].

Until now, extensive studies have been carried out on the parameters that have a more significant effect on the batch-scale EC process. For example, the initial concentration of the pollutant, current density, pH, applied voltage or current, treatment time, temperature, the distance between electrodes, electrode arrangement, stirring speed, and support electrolyte are the parameters that have been most evaluated. However, evaluating the removal of pollutants in a continuous process, determining which aspects significantly influence removal efficiencies, and keeping the operating system efficient are some of the aspects to be addressed urgently to implement this technology. In addition, being able to scale up to larger dimensions than those used in the laboratory, to couple this process to other removal processes, purification plants, or wastewater treatment, has to be considered [2].

In the last decade, in addition to efforts to understand the removal mechanisms and the most critical operational parameters, some research has focused on bringing the process to continuous flow. For this, some authors have chosen to evaluate the process in batch and subsequently in continuous from the exploration of the batch process, the authors obtain the optimal parameters of the process. Then, the experiments in the continuous process are carried out, generally in the same reactor. Designing an EC reactor through modeling tools is crucial since it affects performance and is decisive when scaling. Having so many parameters to consider, some authors have focused on the cell geometry and the effect that it has on the flow regime. Other authors have focused on the design of the electrodes to minimize energy consumption or through an analysis of the current and potential distribution, as well as the design of processes where sedimentation and sludge separation units are considered .The flow rate and residence time have been the most evaluated operational parameters inherent to a continuous process [3].

There is no universal design; instead, reactor designs have been developed for each pollutant evaluated by various authors. However, although the geometric and electrode configurations are different, it can be said that all the continuous processes designs come from a deep understanding of the EC process's theoretical principles evaluated on a batch scale Furthermore, in recent years, the new research trend has been directed to incorporate this process with other water treatment technologies to increase efficiencies or attack different pollutants, organic and inorganic. Due to the EC's success, its application has recently been explored in pharmaceuticals removal, detected in surface and groundwater. This review aims to present the current panorama of the development of the EC process concerning its implementation in a continuous flow, which brings this technology closer to the application on a larger scale and its coupling with other processes. This fact makes its application more feasible to remove pharmaceutical contaminants present in the water [4,5].

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