

# Effect of pH on Electrocoagulation of Bentonite Suspensions in Batch Using Iron Electrodes

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The electrocoagulation of a synthetic wastewater has been studied in this work. The electrochemical process was carried out in a batch electrochemical cell equipped with iron electrodes without agitation. Bentonite suspensions were used as a model of wastes polluted with colloids, as clays behave as hydrophobic colloids in water. The results obtained were useful to clarify the mechanisms that are involved in the electrocoagulation of this kind of waste and also to study the influence of pH in the process. Two primary coagulation mechanisms can explain the experimental behavior of the system: at acid pH the neutralization of the superficial charges of the clays and at alkaline pH the enmeshment of the kaolin particles into a sweep floc. At neutral pH, the formed cations ( $\text{Fe}^{2+}$  and  $\text{Fe}^{3+}$ ) neutralize colloidal particles and conduct to the hydroxides ( $\text{Fe}(\text{OH})_{2(s)}$  and  $\text{Fe}(\text{OH})_{3(s)}$ ) which adsorbate colloids and enhance sweep flocculation.

**Keywords** Bentonite, electrochemical precipitation, electrocoagulation

## INTRODUCTION

In recent years, several studies have focused on the study of electrocoagulation and its applications. Recent research has shown that electrocoagulation is a competitive technology for removing pollutants from supply water, urban wastewaters, and also in the treatment of actual and synthetic industrial effluents, as those generated in the agro-alimentary, metalworking, and textile industries. The results obtained allow us to classify this technique as one of the most promising methods for treating wastewater streams polluted with colloids or consisting of oil-in-water emulsions.<sup>[1,2]</sup>

Electrocoagulation involves the in situ generation of coagulants by electrolytic oxidation of an appropriate sacrificial anode (e.g., iron or aluminum) upon application of a direct current. The metal ions generated hydrolyze in the electrochemical cell to produce metal hydroxide ions and neutral  $\text{M}(\text{OH})_3$ . The low solubility of the neutral  $\text{M}(\text{OH})_3$ , mainly at pH values in the range of 6.0 to 7.0, promotes the generation of sweep flocs inside the treated waste and the removal of the pollutants by their enmeshment into these flocs. The charge of the metal hydroxide species promotes the neutralization of the charged pollutant particles, minimizing the electrical repulsion between them, and favoring their later flocculation. Through in situ

generation of coagulants, electrocoagulation processes do not require any addition of chemicals. Other advantages of electrocoagulation include the promotion in the flocculation process caused by the electric field generated in the electrochemical cell, the promotion in the separation process caused by the improvements in the flotation of the flocs with the hydrogen bubbles generated on the cathode, and the easy automation of the process, as the dosing of coagulant reagents depends directly on the cell potential (or current density) employed.<sup>[1,3]</sup>

Although electrocoagulation has been an available technique for more than a century, the design of an electrocoagulation cell is mainly based on empirical knowledge, with little consideration of the electrocoagulation mechanism.<sup>[1]</sup>

Water treatment feasibility by electrocoagulation in batch, at laboratory scale, is studied in our laboratory. For this object, electrocoagulation tests have been realized on bentonite suspension samples.

Bentonite was selected to represent clays which are often present as mineral colloids in surface waters. Clays behave as hydrophobic colloids in water. These compounds consist of flat sheets of alternating layers of silicon oxides and aluminum oxides, held together by ionic attraction for cations sandwiched between the sheets. In water solutions, aluminum (+3) or silicon (+4) can be replaced with sodium (+1), potassium (+1), or ammonium (+1) ions resulting in an overall negative charge of the particle. This charge is responsible of the electric repulsion of bentonite particles and, thus, of the stability of the colloidal suspension.<sup>[1]</sup>

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