



Study on mechanism of electrocoagulation with iron electrodes in idealised conditions and electrocoagulation of humic acids solution in batch using aluminium electrodes

D. Ghernaout^{a*}, B. Ghernaout^b, A. Boucherit^a, M.W. Naceur^a, A. Khelifa^a, A. Kellil^a

^aChemical Engineering Department, Engineering Sciences Faculty, Saâd Dahlab University of Blida, P.O. Box 270, Blida 09000, Algeria

Tel./Fax +213 (25) 43 36 31; email: djamel_andalus@yahoo.fr

^bAlgerian Waters, Medea 26000, Algeria

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ABSTRACT

This work consists to use distilled water as a solution in electrocoagulation (EC) tests using iron electrodes in order to bear witness to EC mechanisms and concerns EC of humic acids (HA) solution (10 mg L^{-1}) in batch using aluminium electrodes with pH modification and magnetic agitation. The pH of the distilled water is adjusted to three representative values: 2 (acid), 7 (neutral) and 12 (alkaline). Based on the current intensity as a function of applied voltage variation and the pertinent literature, three mechanisms are proposed for acid, neutral and alkaline pH. For pH 2, *Mechanism 1* explains $\text{Fe}(\text{OH})_{2(\text{s})}$ formation; for pH 7, *Mechanism 2* concerns both the varieties $\text{Fe}(\text{OH})_{2(\text{s})}$ and $\text{Fe}(\text{OH})_{3(\text{s})}$ production; and for pH 12, *Mechanism 3* is characterised by $\text{Fe}(\text{OH})_{3(\text{s})}$ apparition. From these results, it can be seen that there is an extremely high dependence of iron species on pH in EC system. Finally, EC process using aluminium electrodes (better than iron ones) is proved highly efficient for HA removal (more than 70%) by charge neutralisation and adsorption (current density 16.6 A m^{-2} during 30 min at pH 7).

Keywords: Electrocoagulation; Mechanism; Iron; Humic acids; Aluminium

1. Introduction

The interest in electrochemical methods for wastewater treatment such as EC is permanently growing [1–3]. Electrochemical methods are also considered as promising methods for water treatment [4–6]. EC process consists to generate in water metallic cations by electrodisolution of soluble anodes (e.g. in iron or aluminium). The *in situ* formed cations (Fe^{2+} and/or Fe^{3+} or Al^{3+}) destabilise finely dispersed particles by charge neutralisation and conduct near the anodes to hydroxide forms ($\text{Fe}(\text{OH})_{n(\text{s})}$, $n = 2$ or 3, or $\text{Al}(\text{OH})_{3(\text{s})}$) which

adsorb the dissolved matter by constitution of large and stable flocs containing less bound water [7]. The flocs can be separated by flotation (transport to the surface by fixation on the $\text{H}_{2(\text{g})}$ bubbles produced at the cathode), sedimentation, or filtration [3,6,8–17]. Indeed the greater part of $\text{H}_{2(\text{g})}$ bubbles combine additively because hydrogen is a hydrophobic gas [18], and iron is dense to settle out at the recipient bottom [4,11]. It has been demonstrated [9,19] that $\text{Fe}(\text{OH})_{n(\text{s})}$ has alkaline properties and a very high adsorption capacity 100 more important than chemical $\text{Fe}(\text{OH})_{n(\text{s})}$.

On the other hand, several EC process mechanisms have been proposed mostly without specifying solution pH or it was supposed neutral [1,4,6,19–24]. Due

*Corresponding author