The influence of anode material on electro-Fenton process efficiency

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Electro-Fenton process is an indirect electrochemical technology for efficient removal of organic pollutants from water. It is based on Fenton's reagent (mixture of H_2O_2 and Fe^{2+}) that produced in situ electrocatalitically: H_2O_2 by 2-electrone reduction of dissolved oxygen on the cathode and Fe^{2+} from 1-electrone reduction of initially added (in a catalytic amount) Fe (III) salt. Once produced in the aqueous medium, this reagent leads to the formation of hydroxyl radical (OH) a very powerful oxidant (with E° = 2.8 0 V/SHE) following the Fenton reaction:

$$H_2O_2 + Fe^{2+} + H+ \rightarrow Fe^{3+} + H_2O + {}^{\bullet}OH$$

Hydroxyl radicals produced this way are very reactive reagent and react with organic matter till its total or quasi total mineralization giving CO_2, H_2O and inorganic ions at the end of electrolysis (Oturan, 2000; Brillas et al., 2009). The efficiency of the process depends on several parameters; one of them being anode material (Sirés et al., 2007).

In place of the classical electro-Fenton process that take place with Pt anode, the use of high O_2 evolution overpotential anodes, supplementary hydroxyl radicals can also be produced at the anode surface by water discharge:

$$M + H_2O \rightarrow M({}^{\bullet}OH) + H^+ + e^-$$

Where M denotes the anode material and M(${}^{\bullet}$OH) the heterogebeous hydroxyl radical. In this case the anode material become particularly important since the reactivity and amount of supplementary M(${}^{\bullet}$OH) generated on the anode is conditioned by the anode material used.

In this work four different anode materials have been tested on the performance of electro-Fenton process: platine (Pt), boron doped diamond (BDD), dimensionly stable anode,DSA (RuO_2-IrO_2/Ti) and lead oxide (PbO_2) during degradation kinetics and mineralization efficiency of antibiotic Sulfamethazine. In all cases a carbon felt piece was employed as cathode. Sulfamethazine (an antibiotic widely used in human and veterinary medicine.) was selected as a model compound to perform the comparative study. The degradation and mineralization kinetics of Sulfamethazine as well as the identification and evolution of released mineral ions during electrolysis were investigated. The effect of current intensity and catalyst (Fe^{2+}) concentration on oxidative degradation kinetics and mineralization degree of the model compound were examinated. The degradation kinetics was monitored by HPLC

analysis of samples withdrawn during electrolysisi. The mineralization course was followed by the measurements of total organic carbon (TOC). Each anode test showed that the degradation rate increased with increasing current, tending towards a limiting current that was 500 mA. The highest degradation rates were achieved in the presence of 0.1 M and 0.2 M of Fe^{2+} with no significant difference between these two concentration values. The mineralization extent also rose for higher currents, especially for BDD anode. Higher degradation and mineralization rates are accounted for by to more hydroxyl radical generation at elevated currents (Oturan et al., 2010; Garcia-Seguera et al., 2011). The difference on mineralization power between anodes was remarkable. The efficacy of pollutant removal for these four anodes was found as following: BDD>PbO_2>Pt>IrO_2.

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