Mediated Electrochemical Oxidation of Pollutants in Crude Oil Desalter Effluent

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Wastewater samples from a crude oil desalting process were subjected to extensive physicochemical characterization and electrolysis to evaluate the two main reaction pathways, electrochemical incineration and mediated oxidation, that occur during an electrochemical oxidation process (EOP) with a boron-doped diamond (BDD) anode. The effects of the main operating variables (pH, current density, and ionic composition) on the oxidation of organic pollutants and the production of hydroxyl radicals ($\bullet\text{OH}$) were evaluated via spectroelectrochemistry, quantification of the total organic carbon (TOC), and fluorescence spectroscopy. The predominance of each reaction pathway was evaluated using tert-butyl alcohol (50 mM) as a $\bullet\text{OH}$ scavenger, the main oxidant species in electrochemical incineration. The results indicated that the action of $\bullet\text{OH}$ was minimal compared to that of active chlorine species (ClO^- , HClO , and Cl_2), oxychlorine radicals ($\text{ClO}^\bullet$, $\text{ClO}_2^\bullet$, $\text{Cl}^\bullet$, and $\text{HOCl}^\bullet$), and oxychlorine anion radicals ($\text{Cl}_2^{\bullet-}$, and $\text{HOCl}^{\bullet-}$). Under the optimal operating conditions (pH 8.5, $j = 100 \text{ mA cm}^{-2}$, and $t_r = 3 \text{ h}$), a 98.2% mineralization rate in terms of TOC was achieved. Mediated electrochemical oxidation was the predominant reaction pathway and was thus responsible for the high degradation efficiency obtained.

Keywords: desalter effluent; boron-doped diamond; electrochemical incineration; mediated electrochemical oxidation; active chlorine.

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