ELECTROCHEMICAL MICROREACTORS FOR THE ABATEMENT OF ORGANIC POLLUTANTS IN WATER SOLUTION

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Electrochemical methods can offer new sustainable routes for the abatement of organic pollutants resistant to biological processes. These methods use a clean reagent, the electron, and very mild operative conditions (ambient temperature and atmospheric pressure) with limited operative costs. However, electrochemical processes present some important disadvantages when performed in conventional reactors. In particular, to achieve reasonable cell voltages when the medium has not an adequate conductivity, one needs adding to the system a supporting electrolyte. This is certainly a main obstacle for a wide application of electrochemical tools. Indeed, adding chemicals is often a problematic issue, since this may lead to the formation of secondary products, makes more difficult the separation procedures and increases the operative costs. Recently it has been shown that the electrochemical processes can strongly benefit from the utilization of microfluidic electrochemical reactors (i.e. cells with a distance between the cathode and the anode of tens or hundreds of micrometers) allowing to minimize or even remove some of the above mentioned disadvantages. Thus, very small distances between electrodes lead from one side to a drastic reduction of the ohmic resistances, (allowing to operate with lower cell voltages and without supporting electrolyte), and on the other side to intensify the mass transport of the reagents towards electrodes surfaces. The utilization of micro devices may present the drawback of a more easy fouling but also other potential advantages such as an easier scale-up procedure through simple parallelization of many small units.

In this work, the possible utilization of various electrochemical oxidation methods for the treatment of aqueous solutions of Acid Orange 7 (AO7) chosen as a model compound (namely, direct electrochemical oxidation, indirect oxidation with active chlorine and electro-Fenton) used alone or in a combined way was studied for the sake of comparison of various electrochemical approaches. The abatement of AO7 was performed successfully in the micro reactors under a single-pass mode without supporting electrolyte at low cell voltages. A very high conversion for passage can be achieved, allowing to operate the process under a continuous mode and to achieve a fast screening of the effect of operative parameters due to very short times of treatment.

The utilization of three micro reactors in series open interesting new perspectives, including the opportunity to modulate the current density among the reactors, in order to optimize the figures of merit of the process. The effect of various operating parameters such as the initial concentration of the AO7, the electrode surface, the flow rate and the current density was also investigated in detail.

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