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Removal of Malathion Pesticide from Polluted Solutions by Electrocoagulation: Modeling of Experimental Results using Response Surface Methodology

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The main purpose of this work was to assess the removal of the pesticide malathion from aqueous solution in batch mode using the electrocoagulation process. The effects of operational parameters such as initial pH, initial pesticide concentration, current density, salt concentration, and distance between electrodes on the malathion removal efficiency have been investigated in a laboratory scale study. The effects of current density and the supporting electrolyte on electrical energy consumption were also investigated. A phenomenological model was proposed using the response surface methodology method. The model indicated that the studied parameters have no effect on the experiment's design which had been established to give the final result. The other operating factors had both positive and negative effects. With an initial pH of 6, an initial pesticide concentration of 40 mg/L, current density of 10 mA/cm2, salt concentration of 2500 mg/L, temperature of 27_C, and distance between electrodes of 2 cm, over 90% of the malathion was removed after 10 min of electrolysis.

Keywords electrocoagulation; experimental design; malathion; pesticide; water treatment

INTRODUCTION

The wide use of pesticides gives rise to serious ecological problems due to their negative environmental effects. The surface and ground water contamination by pesticides is an important problem that the scientists are dealing with over the years (1,2). Malathion is an insecticide in the chemical family known as organophosphates (3). It was introduced in 1950 by a chemical company called American Cyanamid (4). It was considered to be a suitable substitute for some uses of DDT and is now one of the most widely used organophosphate insecticides in the world (5,6).

Malathion classified by the EPA as a toxicity class III pesticide and as a general use pesticide (GUP). It is widely used because of its relatively low toxicity to mammals and high selectivity for insects compared with other organophosphorus insecticides (7).

Malathion is used for insect control on agricultural crops, on stored products, in home gardens, and in outdoor sites. It is also used to kill mosquitoes and Mediterranean fruit flies (medflies) in large outdoor areas. Additionally, malathion is used to kill fleas on pets and to treat head lice on humans. It is usually sprayed on crops from an airplane over wide land areas. Malathion can potentially be released to surface waters by direct application, storm runoff from sprayed fields or urban=residential areas, atmospheric deposition following aerial application (wet deposition from rain and fog water), waste water releases from formulation, manufacturing or processing facilities, and spills (8).

Malathion in water usually undergoes chemical and microbial degradation within a few weeks, but it can remain in the environment for months. The rate and extent of its degradation is dependent on the chemical and physical properties of the water system, particularly temperature and pH, and on the composition of the microbial population present in the system. Malathion is rapidly degraded in aqueous solution at pHs 9 and 7.7, with half lives of 12–24 h, and >3 days, respectively, reported that the half-life of malathion in freshwater was 12 days and that it became undetectable 4 weeks after being experimentally released into the aquatic environment (8,9).

Different technological processes such as adsorption (10), biodegradation (11–12), nanofiltration (13), electrocoagulation, electrochemical reduction and oxidation, indirect electro-oxidation with strong oxidants, and photocatalytic degradation (14–17) for the removal of pesticides

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