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Electrochemical behaviour and degradation of methyl parathion on platinum electrode

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Abstract

Methyl parathion adsorption from the solution of 0.5 M H_2SO_4 (M = mol dm^{-3}) on the surface of platinum electrode has be proven. When Pt electrode covered by adsorbed product is cycled between potentials of 0.4 V to -0.23 V, the split of adsorbed molecules of methyl parathion occur and molecules of p-nitrophenol are released. We assume that molecules of methanol are also released besides p-nitrophenol and molecules of methylthiophosphoric acid remain adsorbed on the surface of the platinum electrode. If oxidation of adsorbed product is realized by cycling between potentials of -0.23 V to 1.32 V, the split of adsorbed molecules of methyl parathion occur and molecules p-nitrophenol and methanol are released. The adsorbed methylthiophosphoric acid is completely mineralized. Degradation of methyl parathion was observed in the electrochemical cell with separated electrode compartments. After 12 hours of cycling between potentials of -0.23 V to 1.32 V, the concentration of the methyl parathion decreased to 2.5% of starting value (5.3×10^{-5} M).

Key words: Methyl parathion, adsorption, electrochemical reduction, electrochemical oxidation, rate of degradation

1. Introduction

During last years, serious attention has been given to processes of destruction of toxic compounds. These are not only high-temperature incineration processes, but also processes using UV light and hydrogen peroxide [1-3], mercury promoted hydrolysis [4], reactive sorbents based on some (nano)crystalic metal oxides as CeO_2 [5] and other processes. There has recently been a growing interest in the processes of degradation of hazardous substances by electrochemical oxidation. Electrochemical oxidation can be carried out with a hydroxyl radical, which is generated by oxidation of water [6-8] or by previously generated oxidation agent like hydrogen peroxide [8,9] or Fenton agent [10,11].

The possibility of degradation by electrochemical oxidation was verified for example for phenol [6,10,12], pentachlorophenol [11], chlorobenzen[10], 1,4-benzoquinone[13], for pesticides metholachlor [2], methyl parathion [2,4,14-16]. Electrochemical oxidation was successfully verified even for treatment of textile dye wastewaters [17], tannery waste liqouors [18], sewage wastewaters [19], olive oil wastewaters [20] landfill leachate [21] leachate from a domestic solid waste sanitary landfill [22] or treatment of plant waste leachate [16]. Anodic oxidation was performed on various anode materials – Ti/SnO_2 (Ti covered by layer of the SnO_2) [12, 13, 23-25], Ti/IrO_2 [12,13,23], graphite [19], Ti/PbO_2 [21, 24, 25], Ti/(TiO_2+RuO_2) (Ti covered by a layer of binary oxides Ru and Ti, the so called DSA® , dimensionally stable anode) [21], SPR anode (Ti covered by layer of Sn, Pd and Ru oxides [21], but usually Pt or Ti/Pt anodes are used [6,10,14-18,20,22-25].