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Application of the electrosorption technique to remove Metribuzin pesticide

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abstract

The present work deals with the removal of Metribuzin from aqueous solutions in a batch and continuous mode using electrosorption technique. This technique is based on the combination of two processes: the adsorption of Metribuzin into activated granular carbon (GAC) column and the application of the electrochemical potential. The effects of various experimental parameters (electrochemical potential, volumetric flow rate and initial Metribuzin concentration) on the removal efficiency were investigated. The pesticide sorption capacity at the breakthrough point of the GAC column reached 22 $mg_{pesticide}\ g_{GAC}^{-1}$. It was increased by more than 100% when the desired electrical potential (−50 mV/SCE) was applied in comparison with the conventional GAC column in similar experimental conditions without electrical potential. Evenmore, the electrosorption technique reduced considerably the drastic decrease encountered when passing from batch mode to continuous column mode.

1. Introduction

The intensive utilisation of various and recalcitrant organic compounds composing the pesticides in agriculture induces serious health problem to the population [1–3]. This situation leads to severe norms in terms of pesticides concentrations in water or food destined to the consummation.

Several techniques have been developed, for the last decade, in the treatment of pesticides. One can note, as an example, processes based on advanced oxidation, on the electrocoagulation, the membranes techniques etc.[4–7]. These processes have been efficient in terms of removal of the pesticide. On the other hand, it has been observed that these techniques are unable to permit the treatment of the contaminated water without transferring the pollutants or with risk of formation of undesirable organo-chlorine compounds [8]. The conventional adsorption on granular activated carbon bed column appeared to be an attractive simple technique to remove pesticides and various organic matters contained in water but more expensive in terms of treatment cost.

The electrosorption has been used in the present study to enhance the adsorbent capacity. An increase of the adsorption capacity reduces the quantity of the adsorbent used and then decreases the cost of the treatment. In a previous work, the authors demonstrated that the electrosorptive technique could be introduced to increase the adsorption capacity of activated alumina adsorbent during defluoridation of water [9].

Most of the previous electrosorption studies were conducted to determine the sorption capacity of a variety of ions and of neutral organic compounds on metallic electrodes [10–13].

1.1. Adsorption

Equilibrium isotherms may be attributed to theoretical or empirical models proposed by many authors who have established a relationship between a fixed adsorbed mass and the solution concentration (C_e) at the equilibrium state [14].

Isotherms are usually interpreted by monolayer adsorption or by multilayer adsorption. The monolayer adsorption may be represented by the Langmuir Eq. (1) which can be transformed to linear form (Eq. (2))

$$\frac{X}{m} = \frac{Q_m b c_e}{1 + b c_e} \quad (1)$$

$$\frac{c_e}{X/m} = \frac{1}{Q_m b} + \frac{c_e}{Q_m} \quad (2)$$

Adsorption through a packed bed may be explained by the exchange zone method (EZM) developed for a fixed bed ion exchange [15] and extended to the fixed bed adsorbent [16]. This model is based on a simplified method of interpreting the kinetic data in a fixed bed represented by the characteristic *S* curve commonly called the breakthrough curve.

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