Chemical Engineering Journal 219 (2013) 361–370

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Adsorption characteristics of triclosan from aqueous solution onto cetylpyridinium bromide (CPB) modified zeolites

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HIGHLIGHTS

- Surfactant modified zeolites as adsorbents were firstly used to remove triclosan.
- Sorption capacities of triclosan were remarkably enhanced with surfactant loading.
- Solution pH and organo-zeolites' surface nature had effects on tricloan adsorption.

ARTICLE INFO

Article history:
Received 2 September 2012
Received in revised form 13 December 2012
Accepted 15 December 2012
Available online 11 January 2013

Keywords:
Triclosan
Adsorption
Organo-zeolite
Cetylpyridinium bromide

ABSTRACT

Organo-zeolites (OZs) were prepared by loading cetylpyridinium bromide (CPB) onto natural zeolite (NZ) and were firstly used to remove triclosan (TCS) from aqueous solution. Surface properties and adsorption characteristics of OZs were evaluated in this study. Batch experiments were conducted as a function of contact time, initial TCS concentration, temperature, and pH. The results indicated that NZ surface properties were considerably altered with CPB modification, but its mineral structures were not significantly affected. The adsorption capacities of OZ 0.5, OZ 1.0 and OZ 2.5, prepared with different initial concentrations of CPB, toward TCS at 298 K were greatly enhanced from 0.91 mg g^{-1} for NZ to 31.85, 45.25 and 46.95 mg g^{-1}, respectively. The adsorption equilibrium data of OZs were found to follow the Langmuir isotherm better. The adsorption kinetics data could be well-described by the pseudo-second-order model. Further thermodynamic investigations indicated that TCS adsorption onto OZs was an exothermic and spontaneous process. The TCS adsorption capacities were found to be strongly dependent on the solution pH and the nature of surface charge of OZs, which were a little higher in acidic and neutral pH conditions. The main mechanisms controlling the adsorption of TCS onto OZs with CPB monolayer were presumed to be hydrophobic interaction and hydrogen bonding, while the main mechanisms controlling the adsorption of TCS onto OZs with CPB bilayer may involve organic portioning and electrostatic interaction. As a result, OZs could be used as effective adsorbents for TCS removal from wastewater.

1. Introduction

Triclosan [5-chloro-2-(2,4-dichlorophenoxy)-phenol] (TCS), a widely used antimicrobial agent in pharmaceuticals and personal care products (PPCPs), has attracted worldwide attention due to its frequent detection in natural environment [1–4] and its potential toxicity to ecosystem [5,6]. As a simple and efficient method, adsorption has been extensively applied in the removal of TCS from aqueous solution. Activated carbon [1,7] and carbon nanotubes [8,9] have been proven to show high effectiveness in the removal of TCS. However, these materials are too costly to be used in practical applications. Recently, researchers began to develop more economic adsorbents for TCS removal, such as kaolinite and montmorillonite [1]. However, the adsorption capacities of these materials were limited due to their poor interaction ability with TCS molecules.

As a natural mineral, natural zeolite is attracting more and more attention in environment applications due to its worldwide availability and excellent physiochemical properties [10]. However, owing to the weak affinity of natural zeolite towards hydrophobic

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http://dx.doi.org/10.1016/j.cej.2012.12.099