Chemical Engineering Journal 211–212 (2012) 302–309

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

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

Selective removal of acidic pharmaceuticals from contaminated lake water using multi-templates molecularly imprinted polymer

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HIGHLIGHTS

- ▶ A novel multi-templates MIP was prepared using acidic pharmaceuticals mix as the template.
- ▶ The MIP had better selectivity and higher adsorption efficiency for templates.
- ▶ The MIP is an effective method for selective removal of the five pharmaceuticals from real water.

ARTICLE INFO

Article history:
Received 30 June 2012
Received in revised form 24 September 2012
Accepted 26 September 2012
Available online 3 October 2012

Keywords:
Acidic pharmaceuticals
Selective removal
Multi-templates molecularly imprinted polymer
Water treatment

ABSTRACT

A novel multi-templates molecularly imprinted polymer (MIP), using acidic pharmaceuticals mixture (ibuprofen (IBP), naproxen (NPX), ketoprofen (KEP), diclofenac (DFC), and clofibric acid (CA)) as the template, was prepared for the removal of acidic pharmaceuticals from contaminated water. The sorption behaviors of the MIP including sorption kinetics, isotherms, effect of pH and ionic strength were investigated in detail. The MIP exhibited excellent selectivity affinity toward five acidic pharmaceuticals with higher binding capacity in water compared to non-imprinted polymer (NIP). The pseudo-second-order model well described the adsorption of acidic pharmaceuticals on the MIP. The feasibility of applying MIP for removing acidic pharmaceuticals from contaminated environmental water was demonstrated by comparing the adsorption capacity of acidic pharmaceuticals in spiked lake water to that in deionized water. In addition, the MIP could be used at least fifteenth cycles without obvious loss in adsorption capacity.

1. Introduction

The presence of pharmaceutically active compounds in the aquatic environment has drawn significant attention during the past decade, because of their potential in altering the normal endocrine function and physiological status of animals and humans [1–4]. Among these compounds, acidic pharmaceuticals are often studied due to their high consumption (e.g. non-steroidal anti-inflammatory drugs) or persistence (e.g. clofibric acid) [5–7]. These acidic pharmaceuticals are partially eliminated in wastewater treatment plants due to their persistency against the biodegradation processes, and their water-solubility promotes their release into the surface water and lake water, in which they have been already detected worldwide [7]. Actually, effluents from WWTPs are relevant point sources for pharmaceuticals in the aquatic environment. Although adverse health effects caused by the consumption of acidic pharmaceuticals at very low concentrations are not clear at present, diclofenac (DFC), a widely used analgesic and antipyretic activities, has been reported to be the cause of vulture population decline in South Asia [8]. Ibuprofen (IBP) and naproxen (NPX) have been also found to have toxic effects on different species of bacteria and algae [9,10].

Numerous investigations have demonstrated that biodegradation of acidic pharmaceuticals in sewage treatment plants (STPs) was limited [11]. For example, Only 5% of CA could be eliminated in short-term tests with biofilm reactor [12]. Zorita et al. reported 55% of CA removal in a conventional WWTP in Sweden and could be improved to 61% in tertiary treatment process with a sand filter [13]. Recent studies show that advanced oxidation processes (AOPs) are potential treatment processes that might improve the removal efficiency of acidic pharmaceuticals [14,15]. However, CA was poorly degraded by AOPs such as ozonolysis [16,17], H_2O_2/UV, and TiO_2/UV [15]. Also, implementation of these techniques would increase the cost of wastewater treatment. Adsorbents based on activated carbon are commonly used in advanced wastewater treatment for the removal of organic contaminants

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http://dx.doi.org/10.1016/j.cej.2012.09.090