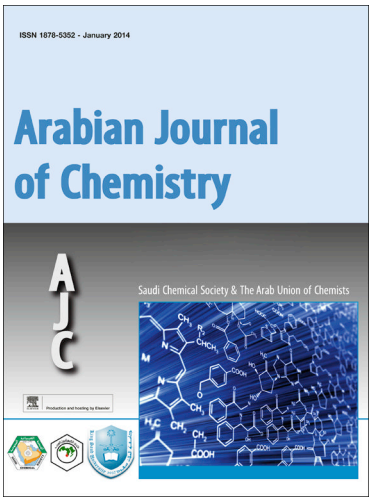

Original article

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Kinetics and Thermodynamics of NPX Adsorption by γ-FeOOH in Aqueous Media

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Abstract

Naproxen (NPX) is a common PPCPs in wastewater treatment plants which is influenced by the coexistence on its photodegradation. Most research on reasons for NPX photodegradation has focused on the soluble substances in water mainly, and the adsorption effect of solid particles is less. The effects of initial concentration, temperature, and pH on the adsorption of NPX on γ-FeOOH were studied. It was found that the equilibrium time of γ-FeOOH adsorbed NPX was 240 min. The increase of initial concentration and temperature were favorable for the adsorption. The optimal adsorption pH was 7.0, and the adsorption capacity attained 28.05 $mg•g^{-1}$. It was learned, through model fitting, that the adsorption reaction was in accordance with the Laggenren quasi-second-order kinetic model; the internal diffusion process was the control step, where the adsorption was close to the Langmuir isothermal adsorption model. The thermodynamic calculation showed that $\Delta G < 0$, $\Delta H > 0$, $\Delta S > 0$, which inferred that the adsorption was a spontaneous, endothermic, and entropy increasing process, which is the common action of chemical bond forces and static electricity.

KEYWORDS: γ-FeOOH; NPX; adsorption; adsorption capacity; kinetics; thermodynamics

1. Introduction

Naproxen (NPX) is a non-steroidal anti-inflammatory analgesic, which is a commonly used non-prescription drug with anti-inflammatory, antipyretic, and analgesic effects. The physicochemical parameters and chemical formulas of NPX are shown in Table S1. As a typical drug and personal care product (PPCP), the core elements and metabolites of NPX through the human body, or via the excretion of animals, enters urban sewage treatment systems through the course of its use. In sewage treatment plant effluents, the NPX detection concentration is typically 0.1 ~ 2.6 $\mu g \cdot L^{-1}$ (Boyd et al., 2005; Brillas and Sires, 2015). In aquatic environments, however, cumulative $ng \cdot L^{-1}$ levels have been observed. Medical studies have revealed that the long-term intake of trace levels of NPX may induce heart disease, stroke, and toxic effects in the lung (Dominguez et al., 2011; Fent et al., 2006; Hasan et al., 2012; Isodori et al., 2005).

γ-iron hydroxide (γ-FeOOH), also known as iron yellow, is one of the primary components of rust, that is surface rich and widely distributed in water, soil, and rock. γ-FeOOH imparts several effects at surfaces and interfaces and has small size and quantum size effects (Nurmi et al., 2005). It may effectively adsorb organic matter in water and have an improved flocculation effect. Under certain light and oxygen conditions, it can initiate