Fate prediction and mass balances verification of pharmaceuticals compounds in Roldán-Balsicas WWTP (Murcia, Spain)

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Fate prediction and mass balances verification of pharmaceuticals compounds in Roldán-Balsicas WWTP (Murcia, Spain).

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Introduction

The available water resources are limited and the growing water consumption has increased pressure on natural resources. Therefore, wastewater represents an alternative option for use in urban areas, industry and, especially, agriculture. The current study was carried out in the wastewater treatment plant (WWTP) located in Roldán-Balsicas (Murcia, Spain), employing primary physicochemical treatment followed by biological treatment. Recent research has shown that some pharmaceuticals compounds are not completely removed in the WWTP, and may eventually be released to agricultural system with the reuse of wastewater-based resources (sludge and effluent). In this study, we used a simulation tool to predict the fate of three pharmaceuticals compounds (Diclofenac, ibuprofen and ketoprofen) in a municipal WWTP. Model predictions were verified with measurements from a monitoring campaign in the WWTP.

Objectives

The aims of this study were:

- Evaluate the biological degradation of the target compounds diclofenac (DCF), ibuprofen (IBP) and ketoprofen (KTF) in the secondary treatment of a conventional activated sludge WWTPs and estimate their sorption onto the sludge.

- Apply a simulation system to predict the fate of three pharmaceuticals compounds (DCF, IBP and KTP) in a municipal WWTP.

Experimental layout

The current study was carried out in the wastewater treatment plant (WWTP) located in Roldán-Balsicas (Murcia, Spain) (UTM) X: 679615.7525, Y:4185244.9214) (Fig. 1).

This WWTP manages 8910 population equivalents (PE) and is equipped for the elimination of carbon and nutrients. The primary treatment consists of a screen, an aerated bean extraction tank and a primary clarifier. The biologically treated wastewater from the conventional activated sludge is filtered through a layer of a continuously operating sand filter prior to being disinfected by ultraviolet radiation. Effluents are used for irrigation in agriculture.

Fig. 1. Roldán-Balsicas WWTP

Methodology

The sampling campaign was carried out in February 2016, and the samples were taken in the raw urban wastewater, anaerobic effluent, anoxic effluent, aerobic effluent and tertiary effluent [1].

The WWTP model Activity SimpleTreat [2] describes the fate (biodegradation, sorption) of ionizable pharmaceuticals based on the activity concept [3].

The physico-chemical input properties necessary in this model are the biodegradation rate, the molecular weight, the octanol-water partition coefficient, vapor pressure, solubility, the type of ionization, the acid dissociation constant of acids and bases (pKa,a and pKa,b) and the Henry constant of the neutral compound.

The model allows to predict the fraction of influent DCF, IBP and KTP biotransformed, sorbed to sewage sludge and discharged with wastewater effluent [4].

Measurements from a sampling campaign (raw WWTP influent and effluent from the activated sludge reactor) were used to verify model predictions. Measurements in the final effluent were not considered, since tertiary treatment removal is not described for in the model.

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Results and conclusions

The results suggested a high measured removal efficiency of DCF, IBP and KTP concentrations in the WWTP Roldán-balsicas (Table 1).

	Diclofenac	Ibuprofen	Ketoprofen
Measured removal efficiency (%)	76,52	98,68	55,55
Kbiol (1 h^{-1})	0,03	0,85	0,01
Kd (L $kg_{dwt\ -1}$)	110,00	30,00	40,00

Table 1. Measured removal efficiency, constant biodegration rates (Kbiol) and sorption equilibrium in the sludge (Kd) calculated in WWTP.

The model prediction confirm the same conclusion explained above.
Fig. 2. show the three treatment steps: primary settling, activated sludge reactor and secondary settling. Each treatment step is divided in a number of boxes (Air, water, suspended solids and settled sludge).

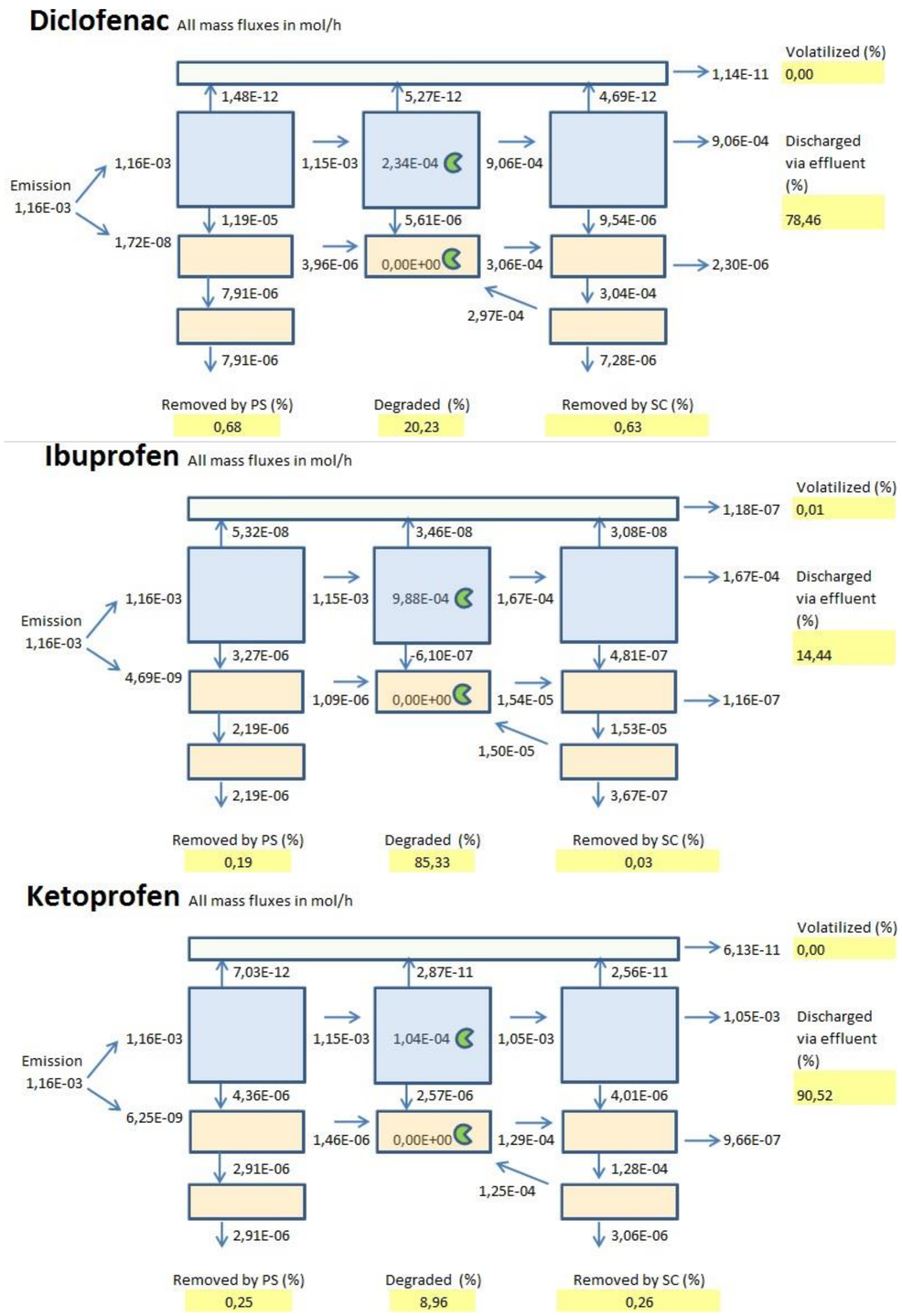

Fig. 2. Diagram with the predicted removal efficiency

The results of this study indicated that the concentration of pharmaceuticals in the effluent showed a trend in the order: DCF > KTP > IBP.

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