Pharmaceutical amoxicillin and water treatment: adsorption and UV photodecomposition.

A.C.S Reis and N. Ortiz

Center of Environmental Chemistry - CQMA
Institute for Energy and Nuclear Research - IPEN,
Av. Lineu Prestes, 2242, Cidade Universitária, CEP 05508-000,
São Paulo / SP - Brazil.
E-mail: nortizbr@gmail.com
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Abstract: The developed of water treatment process to adsorb and decompose the pharmaceutical antibiotic amoxicillin using iron oxide – limoline, quitosan and UV radiation. The removal percentage was 92% with adsorption rate in the range of 0.72 10^{-3} and 13.43 10^{-3} $mg.g^{-1}.min^{-1}$similar with those found in literature.

The UN-Water program draws special attention to climate change, water and biodiversity, water quality, water and gender, water and urbanization, sanitation, water scarcity, transboundary waters, water and urbanization and water and food production. In Brazil half of all natural disasters events are drought related and they cause half of the impacts in number of affected persons, the indicators of health and human well-being in the exposed regions are worse than the rest of the country (Sena et al, 2014). The lower water quality of many urban rivers and streams which cross cities are now a testimony of the lack of water quality management, the water environmental impact of the unplanned urban expansion. In winter, the dry season, the water reservoirs and the urban rivers located in metropolitan area of Sao Paulo show drastic reduction in water flow, and on the contrary in summer, the rainy season, the Pirajuçara and others urban streams are prone to show dramatic occurrences of flooding events (Ortiz, 2001). Some detention basins were built for water collection in raining season, those collected water, and after low cost adsorption treatment combined with Ultraviolet photodecomposition can be used as secondary water source.

The most important aspect and importance in the development of low cost water treatment is the growing scarcity of the fresh water in the world and those recurrent problems in water management of this important resource nowadays also feeling in the Brazilian southeast region.

The pharmaceutical compounds are known as the most difficult removable contaminants from urban contaminated water sources. There are about 118 pharmaceuticals compounds belonging to seventeen different therapeutic classes detected in raw urban wastewater and effluents from the conventional activated sludge system. The analytical results reveal the main composition by 23 analgesics and anti-inflammatories and 36 antibiotics.

The presence of antibiotics in polluted waters, as amoxicillin, represents a strong selective pressure imposed by such concentration on the dissemination of resistance genes and also others antibiotic resistance genes possible with more mobile genetic elements (Don, L. et al, 2010). The average mass load is 1 mg for 1000 inhabitant/day (Verlicchi et al, 2012). In Brazil as in other countries is also expected the increase of

pharmaceuticals consumption and discharge, especially antibiotics due the aging tendency of population.

The investigation was based on the measurements of the polluted urban river stream and the amoxicillin adsorption and UV-photodecomposition (Ortiz et al, 2012). The processes were studied with the determination of the adsorption rate (K_{ab}) from Langergren pseudo first order (equation I) and HO and collaborators (equation II) (HO and Mckay, 1999).

$$\text{Log } (q\text{-}qe) = \log qe - (K_{ab}\, t)/2{,}303 \qquad \text{I}$$

Where: q= amoxicillin adsorbed mass (mg g^{-1}), qe=amoxicillin adsorbed mass on equilibrium (mg g^{-1}), K_{ab} =adsorption rate (mg.g^{-1}.min^{-1}). The K_{ab} value was obtained using the qe measured for t=180 min, Figure 1.

$$t/q = 1/(K_2 qe^2) - (1/qe)t \qquad \text{II}$$

Where: K_2= is the adsorption/decomposition rate (mg.g^{-1}.min^{-1}). The K_2 value was obtained using the qe values measured for t=180 min.

$$h = K_2 qe^2 \qquad \text{III}$$

Where: h= is the initial adsorption/decomposition rate (mg.g^{-1}.min^{-1}) and qe measured at equilibrium time 180 min.

MATERIALS AND METHODS

A UV-photodegration chamber was built, using a GE UV lamp fixed on 10 cm distance from de magnetic stirring plat. A becker was used with 200 mL of synthetic amoxicillin solutions with 5.0 mg L^{-1}, it was diluted to perform each experiment, Figure 1. The 0.05 g of iron oxide (limonite) was weight and added with 0.01 g of quitosan to promote the amoxicillin adsorption, sedimentation and photodegradation. All aliquots of amoxicillin solutions were measured by UV-Vis- spectrophotometry Varian Cary E1, they are collected on different time mixture as: 0, 30, 60, 90, 180, 240, 300 min. The lower amoxicillin content was obtained at 180 min, corresponding with the equilibrium time. The experimental results were used to prepare Figure 2 and Table 1.

Figure 1: Experimental apparatus

Figure 2: Amoxicillin adsorption/ UVdecomposition.

Table 1: Kinetics parameters of adsorption and UV photodegradation processes

Amoxicillin Concentration (mg L^{-1})	Removal (%)	K_{ab} 10^{-3} (mg.g^{-1}.min^{-1})	K_2 10^{-3} (mg.g^{-1}.min^{-1})	h10^{-3} (mg.g^{-1}.min^{-1})
1.0	72	8.78	0.72	0.81
1.3	83	5.40	1.20	1.50
4.3	92	13.43	1.41	1.80

The K_{ab} K_2 and h results reveal only slight variations ranging between 0.72 10^{-3} and 13.43 10^{-3} mg.g^{-1}.min^{-1}. The removal percentage, adsorption and photodegradation rates were higher when the amoxicillin content increase, this effect is similar to those

reported in literature for pseudo- second order reactions with non-conventional adsorbents (Ortiz,2001).

CONCLUSIONS

The use of iron oxide –limonite combined with quitosan under UV radiation result on 92% of removal percentage of amoxicillin. The process promote the adsorption and decomposition of amoxicillin one of the most common antibiotics discharged with high frequency and low content in polluted water. Such pharmaceutic compound has been considered one of the most responsible for the microorganism's adaptation and increasing bacterial resistance. The study confirm the possible use of low cost combined process with allows the adsorption and decomposition of one of the most stable pharmaceuticals showing adsorption/decomposition rates similar with those reported in literature.

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