Ultrasonic TiO_2 solar photodecomposition and biocarbon sorption processes to remove amoxicillin and cephalexin from binary systems.

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Abstract: The cephalexin (CEPH) and amoxicillin (AMOX) antibiotics are the most indicated in the medical prescriptions in Brazil, as the antibiotics used for public health assistance and also for veterinary medicine. Nowadays Brazil is a higher protein animal producer in the world. After the metabolization, the antibiotics discharge in the sewage system and manure composition on rural areas; act as secondary pollution sources for surface water resources. The integrated processes applying the ultrasonic source before the solar photodecomposition and biosorption showed the maximum removal percentage of 91.47% for AMOX and 90.62% for CEPH. Considering the binary systems with the 17:83 proportion percentages of AMOX and CEPH the removal percentage was 89.15% and 97.90% respectively. The use of low-frequency ultrasonic waves before the solar photodecomposition increased the TiO_2 surface area and effectiveness and enhanced the removal efficiency for both cephalexin and amoxicillin alone and in binary mixtures.

Keywords: ultrasonic waves, adsorption, titanium dioxide, solar/TiO_2, antibiotics, biocarbon, amoxicillin, and cephalexin.

Introduction

The antibiotics used in medicine started a new era for a better quality of life and public health. In spite of those results, the prescription of such pharmaceuticals formulations is mostly extensive for bacterial infections and treatment of humans and animals. The continuous release of an enormous amount of antibiotics to the environment for pharmaceuticals industries, hospitals, domestic sewage, and livestock excretion accelerate the adaptation and the bacteria resistance. The conventional water treatment methods remove only a

small portion of the antibiotics because of their non-biodegradable nature, and thus the remaining part of it runs off to surface water. The use of low-frequency ultrasound to increase the TiO_2 surface area followed by solar photodecomposition and biocarbon adsorption showed promising results as low cost, and well know treatment process and affordable material for the rural areas application.

Methods

The antibiotics standard solutions were prepared with amoxicillin and cephalexin, and diluted in different initial concentrations. The ultrasonic source application was in the time interval from 1 to 5 minutes followed by the suspension preparation using the TiO_2 anatase powder and antibiotics solutions. After that, the system was installed in a solar radiation chamber (solar lamp) with the collection of the suspension aliquots for every 20 minutes in a falcon tube with the biocarbon. The tubes were shaking and centrifuged at 1500 rpm for 15 minutes. The measurement of the supernatants was at UV – Visible Spectrophotometer.

Discussion and conclusions

The integrated process using ultrasound, solar photodecomposition/TiO2, and biosorption showed promising results for antibiotics alone systems and the binary mixture of CEPH and AMOX. The removal percentage increases accordingly with ultrasound time having 91.47% of amoxicillin and 90.62% of cephalexin as the best removal percentage using 5 minutes and 100 min in the solar chamber. All results indicate the ultrasonic application followed by TiO2/solar photodecomposition and biocarbon adsorption have better agreement with pseudo-second-order kinetics.

Acknowledgments

The National Council for Scientific and Technological Development (CNPq) by PIBIC program and São Paulo Research Foundation (Fapesp).