Adverse effects of erythromycin on the structure and chemistry of activated sludge

J.N. Louvet, C. Giammarino, O. Potier, M.N. Pons

Laboratoire des Sciences du Génie Chimique-CNRS, Nancy University, INPL, 1, rue Grandville, BP 20451, F-54001 Nancy Cedex, France

Erythromycin toxicity on activated sludge is expected to reduce pollution removal.

Abstract

This study examines the effects of erythromycin on activated sludge from two French urban wastewater treatment plants (WWTPs). Wastewater spiked with 10 mg/L erythromycin inhibited the specific evolution rate of chemical oxygen demand (COD) by 79% (standard deviation 34%) and the specific N–NH₄⁺ evolution rate by 41% (standard deviation 25%). A temporary increase in COD and tryptophan-like fluorescence, as well as a decrease in suspended solids, were observed in reactors with wastewater containing erythromycin. The destruction of activated sludge flocs was monitored by automated image analysis. The effect of erythromycin on nitrification was variable depending on the sludge origin. Erythromycin inhibited the specific nitrification rate in sludge from one WWTP, but increased the nitrification rate at the other facility.

1. Introduction

Due to anthropogenic wastewater discharge, antibiotics are detected in surface and ground water, including untreated drinking water sources (Focazio et al., 2008). This discharge can disturb aquatic ecosystems (Lee et al., 2008; Isidori et al., 2005) and may increase bacterial resistance in activated sludge and the environment (Baquero et al., 2008). However, Al-Ahmad et al. (2009) reported that antibiotics did not favor a multi-resistant bacterium added to activated sludge in a laboratory scale study. Moreover, Brain et al. (2005) have shown that tylosin, a macrolide antibiotic used in veterinary medicine, is non-toxic to freshwater macrophytes. Human antibiotics are discharged mainly in brown water, which is a mixture of urine, feces and water. Hospital effluents are mainly treated in urban wastewater treatment plants. However, hospitals are minor sources of the pharmaceuticals detected in aquatic environments when compared to non-point emissions from households. Nonetheless, the opportunity to treat hospital effluent should be taken into account (Schuster et al., 2008). Drug manufacturers already treat their concentrated wastewater in their own plants. Examples of antibiotic concentrations in wastewater and river water are presented in Table 1.

Runoff from livestock farms and antibiotic use in fish farming are two other untreated sources of contamination. For reviews of these topics, see Kümmerer (2001, 2009a,b).

Wastewater treatment plants (WWTPs) are expected to eliminate partially micropollutants such as antibiotics. However, WWTPs are constructed mainly with the purpose to remove nitrogen and chemical oxygen demand (COD) and not micropolllutants such as antibiotics that can be toxic to their biomass. This toxicity could reduce the chemical oxygen demand (COD) removal rate and the nitrification rate, which are key components of treatment in WWTPs. There is still a lack of data describing the effects of antibiotics on wastewater treatment processes, especially on the COD removal rate inhibition. Moreover, few studies examine the effects of antibiotics on floc morphologies. Halling-Sørensen (2001) reported that antibiotics, especially those with a broad spectrum of activity, were toxic to activated sludge. However, when the toxicological effects of tylosin were investigated, an increase in nitrification was reported.

Erythromycin is a bacteriostatic antibiotic macrolide widely used in human medicine (principally in ambulatory care), as well as by farmers to control bacterial diseases and promote animal growth. With regard to environmental contamination, erythromycin A was more frequently detected in 139 United States stream sites than 21 other veterinary and human antibiotics (Kolpin et al., 2002). Due to its widespread use and frequent environmental detection, this study uses batch toxicity tests to assess the effects of erythromycin on activated sludge.