

Chlorination in a wastewater treatment plant: acute toxicity effects of the effluent and of the recipient water body

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Received: 4 June 2010 / Accepted: 26 April 2011 / Published online: 3 June 2011
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Abstract This study investigates the impact of wastewater treatment plant (WWTP) effluent on the toxicity of the recipient water body and the effectiveness of the disinfection treatment applied (sodium hypochloride) to assure the compliance of both microbiological and toxicological emission limits. No toxicity was found in the majority of samples collected from the recipient river, upstream and downstream of the WWTP, using three different toxicity tests (*Vibrio fischeri*, *Daphnia magna*, and *Pseudokirchneriella subcapitata*). Only three samples presented toxic unit (TU) values with *V. fischeri*, and one presented TU with *P. subcapitata*. The influent toxicity ranged from slightly toxic to toxic (TU = 0.68–4.47) with *V. fischeri*, while only three samples presented TU values with the other tests. No toxicity was found in the absence of chlorination, while the mean toxicity was 3.42 ± 4.12 TU with chlorination in the effluent. Although

no toxicity or very slight toxicity was found in the receiving water, its residual toxicity was higher than the US EPA Quality Standard in two samples. *Escherichia coli* concentration had a lower mean value in the chlorinated effluent: $13,993 \pm 12,037$ CFU/100 mL vs. $62,857 \pm 80,526$ CFU/100 mL for the not chlorinated effluent. This difference was shown to be significant ($p < 0.05$). *E. coli* in ten chlorinated samples was higher than the limit established by European and Italian Legislation. The mean highest trihalomethanes (THMs) value was found in the influent samples (2.79 ± 1.40 µg/L), while the mean highest disinfection by-products (DBPs) was found in the effluent samples (1.85 ± 2.25 µg/L). Significant correlations were found between toxicity, sodium hypochlorite, THMs, DBPs, *E. coli*, and residual chlorine. In conclusion, this study highlighted that the disinfection of wastewater effluents with sodium hypochlorite determines the increase of the toxicity, and sometimes is not enough to control the *E. coli* contamination.

Keywords Wastewater · Chlorination · Toxicity · Trihalomethanes · *Escherichia coli*

Introduction

Industrial wastewater, effluent of sewage treatment plants, and runoff from agriculture are major

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