Impact of oxidants on cyanobacteria cells and metabolites in water: development and validation of quantitative kinetic models

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Abstract

Cyanobacteria are an important microorganism group in drinking water reservoirs, as many of them may produce toxins and taste and odour (T&O) compounds. Oxidation is a common practice used in many drinking water reservoirs and/or water treatment plants (WTPs) for the control of cyanobacteria. In applying oxidation processes in reservoir and/or WTPs, cyanobacteria cells may be ruptured by the oxidants, causing release of toxins and/or T&O compounds into water and posing additional impact on the water quality of reservoirs and WTPs. Therefore, quantification of the impact of oxidants on cell integrity and degradation of the metabolites is essential for water utilities with oxidation processes. In this study, sequential reaction models were developed to simulate the concentration changes of applied oxidants (including hydroxyl radical), the kinetics of cell integrity of cyanobacteria, and the release and degradation of metabolites. The models were tested for three oxidants, including chlorine, hydrogen peroxide, and titanium dioxide, two cyanobacteria species, including *Microcystis aeruginosa* and *Anabaena circinallis*, and two metabolites, including microcystins and geosmin. The results show that Delayed Chick-Watson model and Hom model well simulate the kinetics of cell rupture for the studied systems. By combining the extracted parameters from the models for oxidant concentration and cell integrity, the developed models for metabolite degradation are able to predict the observed microcystins and geosmin concentrations in the water. The developed model may have the potential to be used to evaluate the applications of oxidants in the control of cyanobacteria in reservoirs and WTPs.

Keywords: Cyanobacteria; cyanotoxin; models; oxidant; taste and odour compound