Kinetics and management of cyanotoxin removal and cyanobacterial lysing in water treatment

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Abstract

In light of the common occurrence of hazardous algal blooms (HAB) in many countries, water utilities internationally are faced with the challenge of providing safe water that meets increasingly stringent health guidelines. Cyanotoxins enter treatment plants in intracellular and extracellular forms. Ideally, the intracellular toxins are removed via physical removal (e.g., flocculation/settling/filtration) without being released into the water phase as extracellular toxins. Oxidation of cyanobacterial cells, however, have been shown to cause cells to lyse and release toxins through damage to the cell membrane causing increased permeability or outright cell rupture. Prediction of oxidation impacts on cyanotoxin concentrations and removal within a water treatment plant, therefore, requires modeling impacts of oxidants on the bacterial cell as well as the toxin itself. In this presentation, the overall removal of cyanobacteria and cyanotoxins via oxidative as well as physicochemical treatments will presented (including co-authors' various studies on cell lysing and extracellular toxins). Specific focus on the modeling of the effects of chemical oxidation (e.g., free chlorine, permanganate, ozone, monochloramine, chlorine dioxide) on the lysing and release of toxins from cells, and the subsequent removal of extracellular toxins will be presented using CyanoTOX as the framework (the AWWA computation tool developed by the co-authors of this paper). Case studies will be presented to demonstrate the applicability of the tool in both developing guidelines, testing capabilities, and responding to HAB events. In addition, to oxidation and sorptive treatment approaches, guidance on overall treatment concepts will be discussed.