Degradation of Microcystin-LR with Vacuum UV (VUV) advanced oxidation

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Abstract

Climate change and agricultural run-off are contributing to the accelerated growth of toxic cyanobacterial blooms in surface waters, compromising the safety of drinking water for communities around the world. This is particularly a challenge for small and rural communities that do not have the necessary infrastructure to treat their water for cyanobacterial toxins. Though some conventional treatments are effective in removing cyanobacterial cells, they are prone to cause cell lysis and the release of intracellular toxins, thus requiring additional chemical treatment, making it even more challenging for small communities to ensure the safety of their drinking water. In this research, we investigate the degradation of microcystin-LR (MC-LR), as a model cyanotoxin, using 254 nm and 185 nm UV. Vacuum UV (185 nm in this case) is of particular interest for being a chemical-free method of generating hydroxyl radicals for advanced oxidation. Kinetic studies show that hydroxyl radicals react with MCLR at rates nearly ten orders of magnitude greater than chlorine. MC-LR also absorbs 254 nm UV and has shown significant degradation by direct photolysis alone. Experimental work has primarily focused on the degradation kinetics of MC-LR in water, as well as the impedance caused by the presence of natural organic matter and other solutes (e.g., alkalinity) in varying concentrations. The research also includes treating natural bloom waters to understand the effect of 185 nm UV on cyanobacterial cell structure. If cell lysis occurs and the released intracellular toxins are effectively treated, then vacuum UV may be a single treatment strategy for microcystins, particularly suitable for small communities at risk of cyanobacterial blooms.