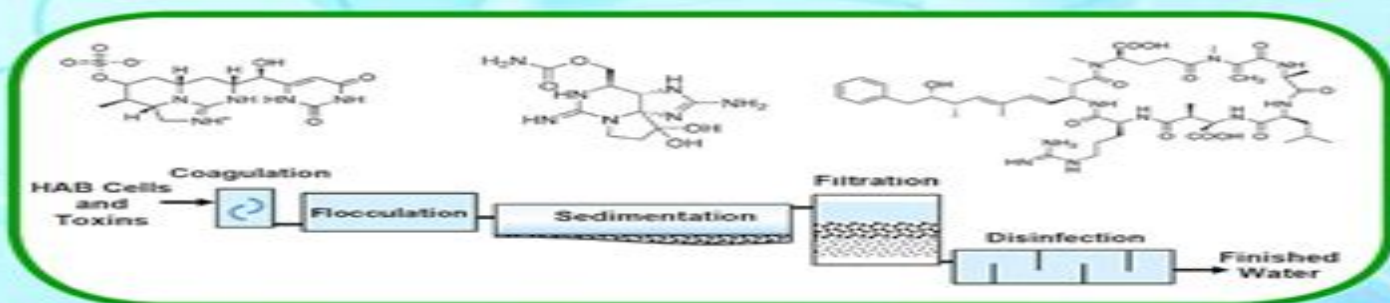
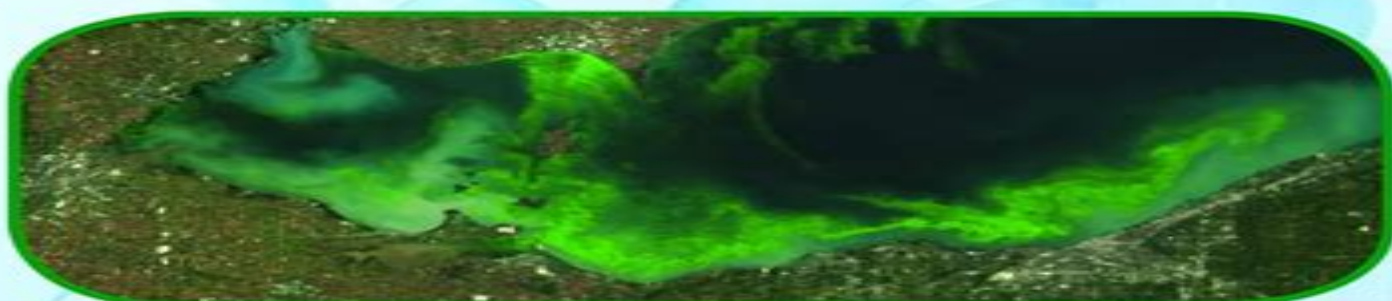


Harmful Algae Blooms in Drinking Water

Removal of Cyanobacterial Cells and Toxins



HAROLD W. WALKER



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Harmful Algae Blooms In Drinking Water Removal Of Cyanobacterial Cells And Toxins Advances In Water And Wastewater Transport And Treatment

Gayle Newcombe



Harmful Algae Blooms In Drinking Water Removal Of Cyanobacterial Cells And Toxins Advances In Water And Wastewater Transport And Treatment:

Harmful Algae Blooms in Drinking Water Harold W. Walker, 2014-12-18 Harmful algal blooms HABs occurring in freshwater and the associated toxins they produce are dangerous to animals and humans The increasing presence of HABs is a major challenge facing water managers and drinking water utilities across the world This book explores the current research on removal of HABs and toxins from drinking water and provides the necessary tools so that treatment plant operators engineers and water managers can understand the vulnerability of drinking water treatment plants to HABs and develop treatment processes to minimize their impact

Wastewater Treatment Amy J. Forsgren, 2018-10-08 Polycyclic Aromatic Hydrocarbons PAHs are a group of semi volatile organic compounds that are formed during the incomplete burning of gas coal oil wood garbage or other organic substances PAHs are a concern because a number of them have been identified as genotoxic and or carcinogenic They pose a threat to ecological systems and can cause health problems A significant source of PAHs is the effluent of wastewater treatment plants This book explores the occurrence and the treatability of PAHs in wastewater treatment

Advanced Nanomaterials for Wastewater Remediation Ravindra Kumar Gautam, Mahesh Chandra Chattopadhyaya, 2016-08-05 Contamination of aqueous environments by hazardous chemical compounds is the direct cause of the decline of safe clean water supply throughout the globe The use of unconventional water sources such as treated wastewater will be a new norm Emerging nanotechnological innovations have great potential for wastewater remediation processes Applications that use smart nanomaterials of inorganic and organic origin improve treatment efficiency and lower energy requirements This book describes the synthesis fabrication and application of advanced nanomaterials in water treatment processes their adsorption transformation into low toxic forms or degradation phenomena and the adsorption and separation of hazardous dyes organic pollutants heavy metals and metalloids from aqueous solutions It explains the use of different categories of nanomaterials for various pollutants and enhances understanding of nanotechnology based water remediation to make it less toxic and reusable

Membrane Bioreactor Processes Seong-Hoon Yoon, 2015-06-17 Grasp the Essential Principles of Membrane Bioreactor Processes Evolved from the conventional activated sludge CAS process membrane bioreactor MBR processes have become the next generation solution for municipal and industrial wastewater treatment and recycle Membrane Bioreactor Processes Principles and Applications explores nearly all the th

Cyanobacterial Harmful Algal Blooms: State of the Science and Research Needs H. Kenneth Hudnell, 2008-03-13 With the ever increasing incidence of harmful cyanobacterial algal blooms this monograph has added urgency and will be essential reading for all sorts of researchers from neuroscientists to cancer research specialists The volume contains the proceedings of the 2005 International Symposium on Cyanobacterial Harmful Algal Blooms and has been edited by H Kenneth Hudnell of the US Environmental Protection Agency It contains much of the most recent research into

the subject *Toxic Cyanobacteria in Water* Ingrid Chorus, Martin Welker, 2021-03-07 Cyanobacterial toxins are among the hazardous substances most widely found in water. They occur naturally but concentrations hazardous to human health are usually due to human activity. Therefore, to protect human health, managing lakes, reservoirs, and rivers to prevent cyanobacterial blooms is critical. This second edition of *Toxic Cyanobacteria in Water* presents the current state of knowledge on the occurrence of cyanobacteria and cyanotoxins as well as their impacts on health through water-related exposure pathways, chiefly drinking water and recreational activity. It provides scientific and technical background information to support hazard identification, assessment, and prioritisation of the risks posed by cyanotoxins and outlines approaches for their management at each step of the water use system. It sets out key practical considerations for developing management strategies, implementing efficient measures, and designing monitoring programmes. This enables stakeholders to evaluate whether there is a health risk from toxic cyanobacteria and to mitigate it with appropriate measures. This book is intended for those working on toxic cyanobacteria with a specific focus on public health protection. It intends to empower professionals from different disciplines to communicate and cooperate for sustainable management of toxic cyanobacteria, including public health workers, ecologists, academics, and catchment and waterbody managers. Ingrid Chorus headed the department for Drinking Water and Swimming Pool Hygiene at the German Environment Agency. Martin Welker is a limnologist and microbiologist currently with bioMérieux in Lyon, France.

Cyanobacterial Harmful Algal Blooms H. Kenneth Hudnell, 2016-04-01 Cyanobacteria are single-celled organisms that live in fresh, brackish, and marine water. They use sunlight to make their own food. In warm, nutrient-rich environments, microscopic cyanobacteria can grow quickly, creating blooms that spread across the water's surface and may become visible. Because of the color, texture, and location of these blooms, the common name for cyanobacteria is blue-green algae. However, cyanobacteria are related more closely to bacteria than to algae. Cyanobacteria are found worldwide, from Brazil to China, Australia to the United States. In warmer climates, these organisms can grow year-round. Scientists have called cyanobacteria the origin of plants and have credited cyanobacteria with providing nitrogen fertilizer for rice and beans. But blooms of cyanobacteria are not always helpful. When these blooms become harmful to the environment, animals, and humans, scientists call them cyanobacterial harmful algal blooms (CyanoHABs).

Freshwater CyanoHABs can use up the oxygen and block the sunlight that other organisms need to live. They also can produce powerful toxins that affect the brain and liver of animals and humans. Because of concerns about CyanoHABs, which can grow in drinking water and recreational water, the U.S. Environmental Protection Agency (EPA) has added cyanobacteria to its Drinking Water Contaminant Candidate List. This list identifies organisms and toxins that EPA considers to be priorities for investigation. Reports of poisonings associated with CyanoHABs date back to the late 1800s. Anecdotal evidence and data from laboratory animal research suggest that cyanobacterial toxins can cause a range of adverse human health effects, yet few studies have explored the links between CyanoHABs and human health. Humans can be exposed to

cyanobacterial toxins by drinking water that contains the toxins swimming in water that contains high concentrations of cyanobacterial cells or breathing air that contains cyanobacterial cells or toxins while watering a lawn with contaminated water for example Health effects associated with exposure to high concentrations of cyanobacterial toxins include stomach and intestinal illness trouble breathing allergic responses skin irritation liver damage and neurotoxic reactions such as tingling fingers and toes Scientists are exploring the human health effects associated with long term exposure to low levels of cyanobacterial toxins Some studies have suggested that such exposure could be associated with chronic illnesses such as liver cancer and digestive system cancer This monograph contains the proceedings of the International Symposium on Cyanobacterial Harmful Algal Blooms held in Research Triangle Park NC September 6 10 2005 The symposium was held to help meet the mandates of the Harmful Algal Bloom and Hypoxia Research and Control Act as reauthorized and expanded in December 2004 The monograph will be presented to Congress by an interagency task force The monograph includes 1 A synopsis which proposes a National Research Plan for Cyanobacteria and their Toxins 2 Six workgroup reports that identify and prioritize research needs 3 Twenty five invited speaker papers that describe the state of the science 4 Forty poster abstracts that describe novel research

Evaluating the Effectiveness of Various Control and Water Treatment Processes on the Membrane Integrity and Toxin Fate of Cyanobacteria Jiajia Fan, 2013 Cyanobacterial blooms could reduce the available volume of source water for use as drinking sanitation and irrigation due to the associated toxins which could be severely harmful to humans and animals Generally the majority of cyanotoxins are intracellular in healthy populations but they could be released into the surrounding waters when the membranes are compromised by aging or chemical stress However conventional water treatment processes are not able to remove the dissolved toxins but only intracellular toxins in the intact cells Although various chemical compounds have trialled for cyanobacterial bloom control or cyanobacterial cells metabolites removal in water treatment processes the effect of these treatments on the membrane integrity and toxin fate of cyanobacterial cells have not been systematically studied and compared This study evaluated the effectiveness of copper sulphate CuSO_4 chlorine potassium permanganate KMnO_4 hydrogen peroxide H_2O_2 and ozone on the cell integrity densities toxin release and degradation of *Microcystis aeruginosa* cultured with ASM 1 medium All of these technologies can compromise the cell membrane of cyanobacteria to varying degrees Chlorine showed the strongest ability to impair the cell integrity with a majority 88% of the cells compromised within the first minute Ozone dose of 6 mg L⁻¹ also could induce 90% lysis of the cyanobacterial cells in 5 minutes and the cell lysis rate of KMnO_4 10 mg L⁻¹ was 0.829 h⁻¹ CuSO_4 and H_2O_2 could not only destroy the viability of cyanobacterial cells but also showed algistatic potential over the 7 day treatment All the chemicals expect CuSO_4 could remove the total toxins and chlorine was the most effective one with the fastest rate up to 2161 M s⁻¹ Although the intracellular toxins were liberated due to cell lysis there was no build up of dissolved toxins detected during chlorine and H_2O_2 exposure which may due to the faster toxin oxidation rates than release rates 1 and 3 mg

L 1 KMnO₄ degraded both the intracellular and extracellular toxins with the cyanobacterial cells remaining intact while ozone induced significant increase of dissolved toxins Wastewater reuse is important for irrigation however cyanobacterial blooms occurred frequently in the wastewater treatment systems with the ideal conditions for cyanobacterial growth Tertiary treated effluent water was applied to investigate the cell lysis and toxin kinetics based on culture medium study Similar impacts on the cyanobacterial cells were found using wastewater and medium but higher oxidant demand may be needed for wastewater treatment due to the higher concentrations of dissolved organic materials In addition the advantages and drawbacks of these chemicals on the downstream water quality were assessed to suggest the water authorities to choose the suitable option against cyanobacterial issues *Cyanobacterial (blue-green Algal) Toxins* Richard Scott Yoo,1995

Understanding the Impacts of Harmful Algal Blooms on Biologically-active Filtration for Drinking Water Treatment
Youchul Jeon,2020 Harmful algal blooms HABs dominated by toxic cyanobacteria have been increasingly detected in water bodies worldwide During such blooms cyanobacterial cells may produce and release undesirable algal metabolites such as cyanotoxins and taste and odor causing compounds which can severely impair water quality Among the cyanotoxins produced by different cyanobacteria the most prevalent in freshwater systems are microcystins MCs Microcystin LR MC LR one of the most toxic and frequently detected among microcystin congeners is a hepatotoxin that can be lethal In addition cyanobacterial cells release algal organic matter AOM containing a wide spectrum of components such as amino acids peptides proteins and polysaccharides These are known to serve as precursors for disinfection byproducts DBPs However much remains unknown about how HABs affect drinking water treatment processes especially a biologically active filtration BAF which is considered as a last barrier in a drinking water treatment plant DWTP and plays an important role in removing various natural organic matter and mediating the source water's ecological influence on tap water bacterial community Therefore the main research goal of this study is to investigate the impacts of HABs on a biological filtration system in a DWTP Specifically the first objective of this study aimed to examine the influence of severe HABs on microbial communities in a full scale BAF for drinking water treatment The obtained results showed that microbial diversity in BAF significantly decreases during severe HAB due to the predominance of bloom associated bacteria e.g. *Sphingopyxis* *Porphyrobacter* and *Sphingomonas* In addition severe HAB results in enhanced BAF community function utilizing fatty and amino acids and modularity suggesting a presence of biodegradable compounds from AOM Lastly the higher relative importance of stochastic processes was observed during the severe HAB than the mild HAB while stochastic processes were dominant BAF bacterial community assembly The second objective of this study was to assess the impact of AOM on the performance MC LR removal and biofilms of BAF Based on the component analysis excitation and emission matrix analysis results terrestrial humic like substances showed the highest removal among all the identified AOM components and were strongly correlated to MC LR removal In addition reduced empty bed contact time and deactivation of biofilms significantly decreased BAF performances

for both AOM and MC LR The active biofilm bacterial community structure and *mlrA* gene involved in microcystin degradation abundance demonstrated that bacterial biofilm composition responded to AOM and MC LR in which Rhodocyclaceae Saprospiraceae and Comamonadaceae were dominant The third objective of this study was to understand the effects of bioaugmentation on the removal of MC LR and bacterial community structure in BAF for drinking water treatment The non bioaugmented column showed less than 1 g L of MC LR in effluent after two weeks of operation In contrast no improved removal efficiency of MC LR was observed in the bioaugmented column and more than 1 g L of MC LR was continuously detected in effluent During the operation regular backwashing had no significant effect on the MC LR removal performance in both columns On the basis of *mlrA* gene abundance and 16S rRNA amplicon sequencing the decreasing pattern of *Sphingopyxis* sp IM 1 abundance was observed in every backwashing In addition indigenous bacterial groups e g the family Burkholderiaceae and *Methylothermobacter* were positively correlated with MC LR removal in the columns Phylogenetic molecular ecological networks showed that the bioaugmented column possessed more complex network and negative links than the control column indicating that bioaugmentation caused a negative influence on indigenous bacterial community

Harmful Algae, Algal Toxin, Taste and Odor Control and Mitigation in Public Water System Haiting Zhang,2018 Recent years harmful algal blooms occurrence has increased quickly in the surface water worldwide which has become a concern for drinking water plants due to the ability of toxic algae cyanobacteria to produce cyanotoxins including microcystins MCs mainly MC LR cylindrospermopsin CYN and taste and odor T O compounds Various types of chemicals are widely used in drinking water treatment plants as oxidants for treating source water challenged with harmful algal blooms In this study the release and degradation of intracellular MC LR due to oxidation of *Microcystis aeruginosa* M aeruginosa most common specie of cyanobacteria was examined kinetically Effect of water matrix and cell concentrations on the release and degradation of CYN as a result of chlorination of *Cylindrospermopsis raciborskii* C raciborskii was examined in two lake water serving as drinking water resources Furthermore removal efficiencies of free chlorine chlorine dioxide permanganate and peracetic acid PAA were compared for controlling M aeruginosa C raciborskii and related cyanotoxins i e MC LR and CYN At the same time the disinfection byproduct DBPs formation during oxidations of cyanobacteria and cyanotoxins were investigated Furthermore several T O events occurred in Missouri drinking water systems were studied and the major cause of the T O was 2 4 6 trichloroanisole 2 4 6 TCA a compound with extremely low taste threshold i e 0 3 ng L Thus the resource precursor s of 2 4 6 TCA and its formation and removal in drinking water treatment systems were investigated These results provided essential information for utilities to select suitable chemicals and dosages to control harmful algal bloom DBPs formation and T O issues Abstract page iv

Development of Monitoring and Treatment Technologies to Combat Harmful Algae Blooms Shardula Gawankar,2023 Lake Erie has been affected by harmful algal blooms for decades In 2014 this resulted in the plant having to shut down its intake after toxic cyanotoxins were found in source water Such occurrences

are becoming more common across the globe U S EPA has established regulations for microcystin the most common form of cyanotoxin Climate change is predicted to increase the occurrence of other types of cyanotoxins such as saxitoxins which are not regulated by the U S EPA Hence the removal and monitoring of cyanotoxins produced by harmful algae blooms in water is of utmost importance to protect public health The efficacy of oxidation varies greatly for each of the cyanotoxins due to their different chemical structures There is presently no oxidation process that a water treatment plant can implement that is proven to simultaneously remove all the cyanotoxins microcystin saxitoxin cylindrospermopsin and anatoxin from drinking water Thus water treatment plants that are currently designed to remove microcystins are not protected against all forms of cyanotoxins The investigation of the removal of these cyanotoxins using innovative treatment technologies requires a detection method that is sensitive and capable of detecting all the variants of cyanotoxins The detection of saxitoxin is particularly challenging as compared to other cyanotoxins due to its low molecular mass and highly polar nature Hydrophilic interaction liquid chromatography coupled with mass spectrometry HILIC MS has the ability to provide specific detection through mass differentiation which makes it an ideal tool for the quantitative analysis of saxitoxin and its variants Hence a method was developed to extract and detect saxitoxin from water using HILIC MS in conjunction with weak cation exchange solid phase extraction SPE to provide a sensitive and reliable quantification of saxitoxins However the application of LC MS for the detection of cyanotoxins in treatment studies is not cost effective as the cost of instrumentation is high its operation requires high skill and cyanotoxin standards have limited access and are expensive Hence a screening technique has been developed which uses methylene blue to identify the reaction kinetics of persulfate and peroxide oxidation in the presence of ferrous chloride and to optimize parameters which can be helpful in predicting the degradation of cyanotoxins under similar conditions Catalyst activated persulfate and peroxide oxidation produce sulfate and hydroxyl radicals which can degrade a wide range of recalcitrant chemicals and hence are preferred in water and wastewater treatment The screening technique was validated by investigating the degradation of microcystin LR The notable advantages of developing this screening technique are i reduced cost of analysis as methylene blue can be detected in real time by measuring its absorbance and ii can perform multiple trials in short time due to ease of analysis This screening technique was also applied to iron oxide coated ceramic membranes in combination with persulfate oxidation to understand the degradation kinetics

Cyanobacterial Toxins of Drinking Water Supplies Ian Robert Falconer, 2004-12-20 The contamination of both drinking and recreational water supplies by cyanobacteria is increasingly a cause for concern worldwide While contamination causes livestock deaths with relative frequency acute poisoning is rare in humans However there is growing apprehension over the possible role of cylindrospermopsins and microcystins in gastrointestinal and liver cancer *Cyanobacterial Toxins of Drinking Water Supplies* provides an articulate account of the biology chemistry toxicology and human health implications of cylindrospermopsins and microcystins and their occurrence in water supplies It discusses effective methods of prevention

mitigation and remediation of cyanobacterial blooms in reservoirs The book presents novel and traditional approaches to water treatment for the elimination of these toxins Written by a renowned expert who plays an instrumental role in revising the World Health Organization s drinking water guidelines for cyanotoxins the book uses the field s most relevant findings and current examples to support a practical approach for assessing the potential risks and costs from toxic cyanobacterial blooms in water supplies Cyanobacterial Toxins of Drinking Water Supplies provides a lucid analysis of present and emerging issues in the ecology safety and treatment of drinking water for in environmental agencies researchers and policymakers It is an authoritative resource for professionals in drinking and recreational water management water supply utilities analytical laboratories and public health offices

Removal of Cyanobacterial Toxins in Ten Midwestern Drinking Water Plants Elke Bettina Boyd,2002

Cyanotoxins in Drinking Water Harold Walker,2025-03-06 Provides students with a holistic systems based perspective of Harmful Algal Blooms or HABs and HAB toxins while explaining details on occurrence health effects and treatment processes for the removal of HAB cells and toxins from drinking water It s also useful for professionals interested in HABs and HAB toxins in drinking water

Removal of Algal Toxins from Drinking Water Using Ozone and GAC Gayle Newcombe,2002 Toxic cyanobacteria blue green algae have now been reported in 27 countries and are found on all continents including Antarctica Drinking water authorities world wide are faced with the challenge of treating contaminated water or the possibility of a toxic bloom occurring sometime in the future This tailored collaboration project was to provide the international drinking water industry with information to facilitate the confident application of viable treatment techniques for cyanotoxins Assessment included toxicity of the ozonated solutions assessment of the protein phosphate inhibition assay technique and the possibility of seeding an activated carbon filter with select bacteria for removal of microcystin LR This report offers valuable guidance to the water supplier to aid in deciding upon the most appropriate treatment options for a range of dissolved blue green algal toxins

Cyanobacterial Toxins of Drinking Water Supplies Ian Robert Falconer,2004-12-20 The contamination of both drinking and recreational water supplies by cyanobacteria is increasingly a cause for concern worldwide While contamination causes livestock deaths with relative frequency acute poisoning is rare in humans However there is growing apprehension over the possible role of cylindrospermopsins and microcystins in gastrointestinal and liver cancer Cyanobacterial Toxins of Drinking Water Supplies provides an articulate account of the biology chemistry toxicology and human health implications of cylindrospermopsins and microcystins and their occurrence in water supplies It discusses effective methods of prevention mitigation and remediation of cyanobacterial blooms in reservoirs The book presents novel and traditional approaches to water treatment for the elimination of these toxins Written by a renowned expert who plays an instrumental role in revising the World Health Organization s drinking water guidelines for cyanotoxins the book uses the field s most relevant findings and current examples to support a practical approach for assessing the potential risks and costs from toxic cyanobacterial blooms in water supplies Cyanobacterial

Toxins of Drinking Water Supplies provides a lucid analysis of present and emerging issues in the ecology safety and treatment of drinking water for in environmental agencies researchers and policymakers It is an authoritative resource for professionals in drinking and recreational water management water supply utilities analytical laboratories and public health offices

Toxic Blue-green Algae Great Britain. National Rivers Authority,1990 In September 1989 dogs and sheep died at Rutland Water following the ingestion of a scum of toxic blue green algae The NRA therefore undertook the first major national appraisal of blue green algae throughout England and Wales Their report describes the results of the 1989 survey and looks at how events were managed Recommendations are made for future management monitoring research and development It also reviews blue green algal toxins the factors which affect blue green algal bloom production and approaches to controlling algal populations

Removal of Intact Cyanobacterial Cells by Water Treatment Christopher Wing Kueng Chow,1997

Blue-green Algae CRC Cooperative Research Centre for Water Quality and Treatment (CRCWQT),2002

Decoding **Harmful Algae Blooms In Drinking Water Removal Of Cyanobacterial Cells And Toxins Advances In Water And Wastewater Transport And Treatment**: Revealing the Captivating Potential of Verbal Expression

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