

Article

Control of Bromate Formation in Desalinated Seawater Production and Transmission with Ammoniation

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Abstract: Bromate is a potentially carcinogenic disinfection by-product of potential concern in desalinated waters, where bromide derived from seawater can be converted to bromate by the oxidising species used for disinfection. Historically, it has been difficult to maintain complete adherence to national standards of no more than 10 ppb for bromate at all locations served with desalinated seawater by the Saline Water Conversion Corporation (SWCC) in the Kingdom of Saudi Arabia. In this full-scale study, the addition of 100–200 ppb of ammonia to the produced water of a Multi-Stage Flash Desalination plant effectively controlled the formation of bromate in the transmission system supplying inland centres in the Makkah Province of the Kingdom of Saudi Arabia (Arada, Taif) on a time scale sufficient for the distribution of water to the consumer, even when the bromide content of the produced water was artificially enhanced (up to 132 ppb) via the addition of seawater.

Keywords: ammonia; bromate; desalination; multi-stage flash; transmission



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1. Introduction

A significant public health concern in any system where potable water is stored or transported is the possibility of the formation of disinfection by-products. Disinfection is a necessity to avoid the bacterial contamination of drinking water, but the oxidising species used can generate a range of potentially toxic and carcinogenic species from trace components of the produced water [1–4]. When water contains bromide ions, these disinfection by-products can include the bromate ion as well as brominated organic species such as bromoacetic acid, bromoform, and bromodichloromethane [5,6]. Historically, bromate control has been an issue primarily in surface and ground water treatment with ozonation, and there is a considerable body of research literature addressing control measures for this problem [7–15].

Recent interest in bromate control in the Kingdom of Saudi Arabia in waters treated by chlorination rather than ozonation arises from a unique combination of two factors: (1) increasing use of seawater desalination by reverse osmosis (SWRO), rather than thermal methods, which leads to product water with a higher concentration of bromide; (2) transmission of the majority of produced water over lengthy pipelines (>100 km) at relatively high temperatures, as the formation of disinfection by-products increases with both temperature and time. While SWRO is a well-established technology in many parts of the world, outside of the Kingdom of Saudi Arabia it is used almost entirely to serve coastal centres, where it is consumed in close proximity to its point of production. These two factors have led to challenges in consistently meeting the 10 ppb maximum limit set by regulatory authorities in the Kingdom of Saudi Arabia [16,17].

Strategies To Control Bromate And Bromide

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Strategies To Control Bromate And Bromide:

Strategies to Control Bromate and Bromide Gary L. Amy, Mohamed S. Siddiqui, 1999 **Bromate Formation and Control During Ozonation of Low Bromide Waters** Thomas Gillogly, 2001 The primary purpose of this research was to evaluate the formation of bromate and the efficacy of control strategies for low to moderate *Water and Wastewater Treatment Technologies* Xuan-Thanh Bui, Chart Chiemchaisri, Takahiro Fujioka, Sunita Varjani, 2018-11-07 This book discusses major technological advances in the treatment and re use of wastewater Its focus is on both novel treatment strategies and the modifications and adaptations of conventional processes to optimize the treatment of a complex variety of pollutants including organic matter chemicals and micropollutants in different water resources as well as the integration of water treatment with bioelectricity production Written by leading researchers in the field it will be of interest to a wide range of researchers in both industry and academia *Bromide, Bromate, Brominated Disinfection By-products, Oh Brother!*, 1993

Disinfection By-Products in Drinking Water M Fielding, M Farrimond, 1999-01-01 This volume brings together contributors from water regulators and water suppliers in Europe and North America to discuss the main issues associated with reaching a cost effective balance between microbial and chemical risks Overviews of research are presented alongside illuminating case studies of the practical approaches taken by water companies and regulators on both sides of the Atlantic

Research plan for microbial pathogens and disinfection byproducts in drinking water , *Analysis and Formation of Disinfection Byproducts in Drinking Water* , 2021-04-01 Drinking water disinfection has markedly reduced diseases caused by waterborne pathogenic microorganisms However an unintended consequence of disinfection and or oxidation processes is the generation of disinfection byproducts DBPs which are formed from the reactions of disinfectants oxidants with water matrix components This volume of the Comprehensive Analytical Chemistry Handbook presents recent advances about the formation identification and quantification of inorganic and organic DBPs during oxidative processes The book begins with a first chapter reviewing the most recent non targeted screening approaches and workflows to characterize DBPs using low high and ultra high resolution mass spectrometry The second chapter discusses the analysis of inorganic chloramines in waters using on site and or in lab analytical methods The third chapter provides an overview of the current knowledge about the mechanisms of chlorine dioxide reactions and byproducts formation The fourth chapter presents some fundamental and practical aspects about ozonation processes in water treatment and provides an overview about ozone reaction mechanisms and byproducts formation The fifth chapter focuses on the reactivity of halide ions particularly bromide and iodide with common oxidants and the role they play in determining the speciation of DBPs in treated waters The chapter also presents strategies to mitigate the formation of DBPs during oxidation processes Finally the last chapter tackles the topic of DBPs formation during potable water reuse It discusses the formation of DBPs of major concern in both membrane based and non membrane based potable water reuse treatment schemes Researchers water treatment specialists and regulators will find in

this book a valuable and compact resource on several key topics regarding the formation identification quantification and mitigation of DBPs Identification and quantification of known and unknown DBPs Formation of DBPs during different disinfection oxidation processes DBPs of concern in new technologies and or new applications of existing technologies in water treatment **Fiscal Year 1999 EPA R&D Budget Authorization** United States. Congress. House. Committee on Science. Subcommittee on Energy and Environment,1998 *Fiscal Year 2001 Budget Authorization Request* United States. Congress. House. Committee on Science. Subcommittee on Energy and Environment,2001 *Improvement of the Ozonation Process Through the Use of Static Mixers* C. Mysore,J. Leperc,Daniel W. Smith,S. Craik,G. Finch,R. Lake,P. Agutter,C. de Traversay,D. Wolbert,Gary Amy,2004-01-01 Among the known disinfectants ozone has been demonstrated to be very effective in inactivating protozoans Current and proposed regulations impose additional treatment requirements for *Cryptosporidium parvum* These regulatory trends tend to place more stringent performance demands on disinfection systems and have therefore increased the need for improvements in the design The static mixer offers one alternative method for improving the efficiency of the dissolution of ozone and optimizing its use in the disinfection process The overall objective of this research was to quantify the potential benefits of ozone application through the use of static mixers in terms of increased transfer efficiency disinfection capacity and enhanced chemical reactions at laboratory pilot and full scale systems Specific goals were to identify and quantify the effect of several water quality parameters and environmental engineered factors on the disinfection capacity of the ozone static mixer system and assess bromate formation under optimum conditions for microbial inactivation Originally published by AwwaRF for its subscribers in 2003 This publication can also be purchased and downloaded via Pay Per View on Water Intelligence Online click on the Pay Per View icon below

The Top Books of the Year Strategies To Control Bromate And Bromide The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous compelling novels captivating the hearts of readers worldwide. Lets delve into the realm of top-selling books, exploring the fascinating narratives that have charmed audiences this year. Strategies To Control Bromate And Bromide : Colleen Hoover's "It Ends with Us" This poignant tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover skillfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can triumph. Uncover the Best : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids captivating storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Strategies To Control Bromate And Bromide : Delia Owens "Where the Crawdads Sing" This captivating coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens spins a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These bestselling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of captivating stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is an exceptional and thrilling novel that will keep you guessing until the very end. The novel is a cautionary tale about the dangers of obsession and the power of evil.

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