



# Bromate in Ozone Treatment – a new avenue

EurO<sub>3</sub>zon

---

INTERNATIONAL OZONE ASSOCIATION  
INTERNATIONAL CONFERENCE TOULOUSE, EA3G 2022  
27<sup>TH</sup> NOVEMBER 2022

# Acknowledgement

---



- Roman Gyssels, EurO<sub>3</sub>zon ivzw
- Matthias Hoffmann, BWT Wassertechnik GmbH
- Jörg Mielcke, Xylem Services GmbH
- Bernhard Paolini, Veolia Water Solutions & Technologies
- Matthias Rothe, ProMinent GmbH
- Jaak Ryckeboer, EurO<sub>3</sub>zon ivzw
- Ines Simões, EurO<sub>3</sub>zon ivzw
- Harald Stapel, Xylem Services GmbH
- Arne Wieland, Xylem Services GmbH

Further acknowledgement to Dr. Nataliya Kitsera and Dr. Thomas Sendor (Ramboll Deutschland GmbH) for the expertise on toxicology provided in the analysis of bromate risk assessment.

# EurO<sub>3</sub>zon



- **EurO<sub>3</sub>zon is an international non-profit association dedicated to promoting the use of Ozone (O<sub>3</sub>) in Europe**, founded by the ozone equipment manufacturers BWT, ProMinent, Veolia (Ozonix) and Xylem (Wedeco) and several associated members.
- EurO<sub>3</sub>zon is also carrying out the approval and authorization of ozone under the Biocidal Products Regulation EC 528/2012 (BPR)
- To be very explicit and clear: **All these companies are and will remain to be competitors.** The only topic, covered by the cooperation, is the creation of the BPR & REACH dossiers. All data supplied by any party to build the dossier is confidential towards the others and handled by a third party.
- The rationale behind this cooperation is the enormous information that needs to be collected, evaluated and lastly the financial impact, which all cannot be managed by a single entity.
- **Note:** Bromate is in focus of this consortia, due to classification of by-products.

# Presentation Outline

---



## *Motivation*

- *The authors are anticipating that the WRF study 4708, 2021 is allowing new conclusions and promoting the review of current bromate health limits and recommend this work being included in future revision processes of health guidelines.*

Bromate regulation

Carcinogenicity assessment

Outlook to Future Regulation



# Bromate regulation

---

CURRENT SITUATION

# Oxidation by-products - Bromate

---

## Bromate formation & Mitigation

- Oxidation processes may cause bromate formation in presence of bromide in the water and depending on the applied ozone dose.
- The chemistry is well known and described (e.g., von Gunten); comprising reactions of bromide with ozone and OH-radicals.
- Mitigation is frequently used for limiting bromate formation by reducing bromide/bromate inlet concentration, lowering the ozone dose, and adding hydrogen peroxide or adjustment of pH, etc.

# Bromate carcinogenicity

---

## EU Classification under CLP Regulation – (EC) No 1272/2008

- Bromate has been classified in category 1B for carcinogenicity
- Presumed to have carcinogenic potential for humans
- Based on animal evidence

# Bromate regulation



## Guidelines Regulation Bromate Concentrations for Drinking Water

Guidelines / Regulator	Admissible concentration [µg/l]
EU Directive (EU)2020/2184 of the European Parliament	10
WHO's guideline value (2003, 2011)	10
Australian Drinking Water Guideline 6 (2017)	20
Guidelines for Canadian Drinking Water Quality (2018)	10
Drinking Water Quality Standards in Japan (2015)	10
Dutch Drinking Water Decree / Netherlands (2021)	1 5 (exception subsequent to disinfection)



# Bromate regulation



## Guidelines Regulation Bromate Concentrations for Waste Water

Guidelines / Regulator	Admissible concentration [µg/l]
Oekotoxzentrum Switzerland (2020)	50



# Bromate toxicity assessment

---

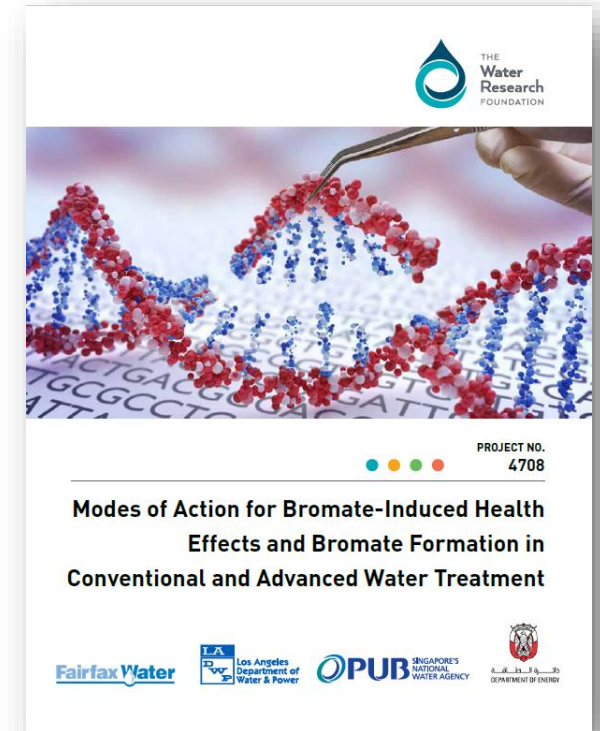
THE WATER RESEARCH FOUNDATION (WRF) REPORT (2021):  
INVESTIGATION OF THE MODE OF ACTION OF BROMATE INDUCED  
CARCINOGENESIS

# Recently published bromate research



## The Water Research Foundation (WRF) report (2021): investigation of the mode of action of bromate induced carcinogenesis:

- Bromate acts mainly via non-genotoxic mechanisms
- Human risk assessment should consider lesser sensitivity of humans compared to rats



# Recently published bromate research

---



**The Water Research Foundation (WRF) report (2021):**

## **Carcinogenicity**

Carcinogens are compounds that induce the incidence of tumor formation. Carcinogenic compounds can have a genotoxic or non-genotoxic mode of action.

# Recently published bromate research



The Water Research Foundation (WRF) report (2021):

## Genotoxic

Genotoxic compounds are compounds that cause mutations in the DNA. Mutations are defined as permanent changes in the DNA.

The genotoxic mode of action **requires and results in linear extrapolation of the doses to zero dose** (i.e., there is no threshold dose for producing cancer), that require a maximum contaminant level goal of zero.

# Recently published bromate research

---



**The Water Research Foundation (WRF) report (2021):**

## **Non-genotoxic**

If the cancer arises from a non-genotoxic effect, that effect is **establishing a non-zero maximum contaminant level goal (MCLG)** to arrive at a safe dose.

# Recently published bromate research



## 1. Bromate acts mainly via non genotoxic mechanisms:

- WRF study employed molecular toxicology studies and results are supporting that bromate acts primarily through **non-genotoxic mechanisms**
- Report does not question the carcinogenicity, but rather raises the question on how the risk limits should be calculated, considering the non-genotoxic mode of action
- Calculation: use non-zero Maximum Contaminant Level Goal (MCLG) rather than low dose linear extrapolation
- The bodily functions convert 90% of bromate to bromide upon ingestion: bromide would play some role in the carcinogenicity of bromate, but not sufficient to cause cancer on its own

Source: WRF, 2021

# Recently published bromate research

---



## **2. Human risk assessment should consider lesser sensitivity of humans compared to rats**

- Lesser sensitivity of Human TSH to minor decreases in serum thyroid hormones

Source: WRF, 2021





# Cases of more Stringent Bromate Limits

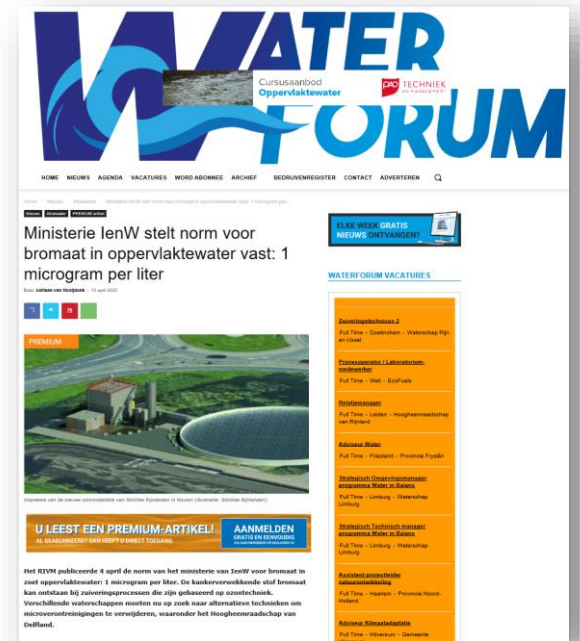
---

RIVM – NATIONAL INSTITUTE FOR PUBLIC HEALTH AND THE  
ENVIRONMENT MINISTRY OF HEALTH, WELFARE AND SPORT  
(NETHERLANDS)

# Current situation in the Netherlands



- **The Ministry of Infrastructure and Water Management's new standard for bromate in fresh surface water (April 4<sup>th</sup>, 2022 ):**
- RIVM\* report proposes more stringent limit of 1 µg/l for bromate in surface waters at drinking water intake points
- Dutch Drinking Water Regulation - limit for bromate in drinking water 1 µg/l (in case of disinfection max. concentration of 5 µg/l @90 percentile value, with 10 µg/l as max.)



<https://www.waterforum.net/ministerie-ienw-stelt-norm-voor-bromaat-in-oppervlaktewater-vast-1-microgram-per-liter/>

\*) National Institute for Public Health and the Environment Ministry of Health, Welfare and Sport



# Future Bromate Limits ?

---

ARE TOXICITY ASSESSMENTS GOING TO BE REVIEWED

# What is the outlook now?

---

- New Bromate limit proposal is considering its complete elimination
- Present bromate limits based on experimental studies performed 20 or more years ago
- Bromate limits were derived through linear extrapolation and a maximum contaminant level goal of zero, considering it as **genotoxic carcinogen**
- However, new insights: **non-genotoxic mechanism** → new risk assessment calculation necessary

# The case for water treatment?

---

**If, Bromate health limits are continuously being derived by linear extrapolation and a maximum contaminant level goal of zero:**

## **Possible developments:**

- Limiting the selection of available treatment technologies based on their strength.
- Process design challenges in cases of elevated Bromate levels at inlet.
- Surface water is becoming more and more relevant for drinking water production
- Bromate risk assessment standards by WHO and EU are going to diverge
- Technical details are unclear (e.g., definition “water intake point”, analytic method, capacities, ...)
- Further explanations on consequences are necessary

# Outlook

---



- Current risk assessment and limits are assuming, bromate as genotoxic substance.
- There is doubt about the mode of action as outlined by the WRF report. Providing evidence for a **non-genotoxic effect** that supports the **current level of 10 µg/L** as adapted by WHO and EU as a **safe level**.
- In order to affect revision processes of future Bromate health guideline or regulatory review processes, the consideration for the integration of the WRF study is strongly recommended.

# End



BPR Dossier

**Thank you  
for  
your attention**

[www.EurO3zon.org](http://www.EurO3zon.org) / [info@EurO3zon.org](mailto:info@EurO3zon.org)  
EurO<sub>3</sub>zon ivzw/aisbl/inpa, Eilandstraat 4 , 1981 Hofstade, Belgium