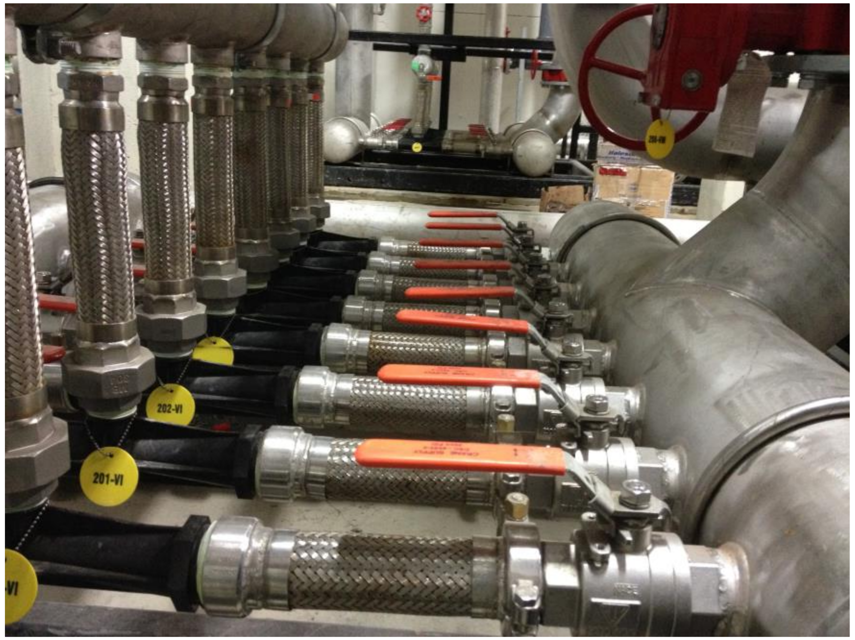
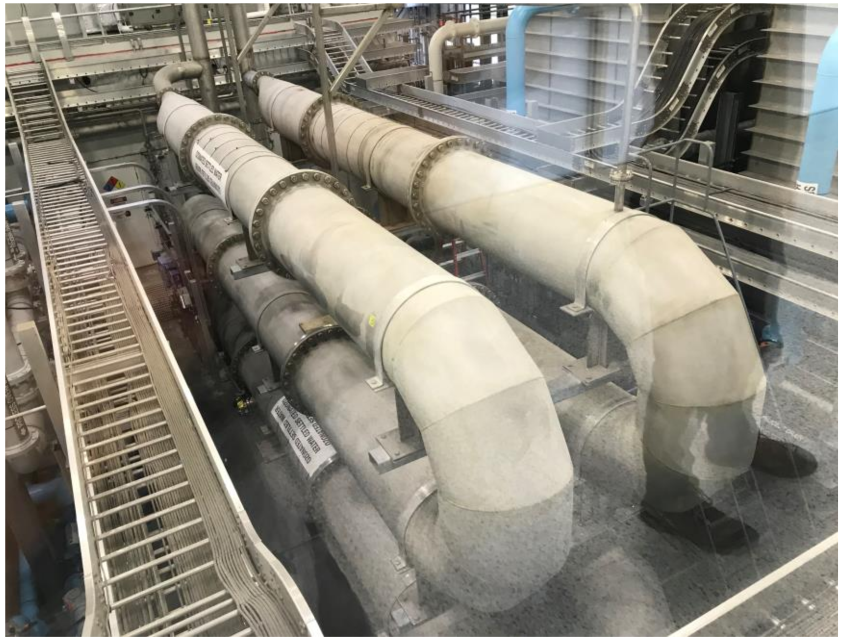
AM TEAM

Advanced Modelling for process optimisation

A novel engineering tool for ozonation - Unprecedented process insights





Info@AM-TEAM.com

LIVE WEBINAR – June 23rd, 2020 - slides

Today’s objectives

Today's webinar

- Context
  - AM-TEAM has developed a novel simulation model for ozonation. Already available today through services. The simulation tool will become available soon.
- Objectives
  - You get new, detailed process insights
  - You learn the basics of ozonation process simulation
  - You understand the practical application and potential of process simulation for process optimisation, design and monitoring
- Format
  - Hybrid model: presentation and live demos
  - Questions: 'Q&A' (not the chat)
  - Short questionnaire after webinar

Outline

- Intro
  - Personal introduction
  - Ozonation and simulation basics
- Virtual experimenting and virtual piloting
  - From batch to full-scale
  - Drinking water and wastewater

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Personal introduction

We help process technologists getting the processes they desire using very realistic computer simulations

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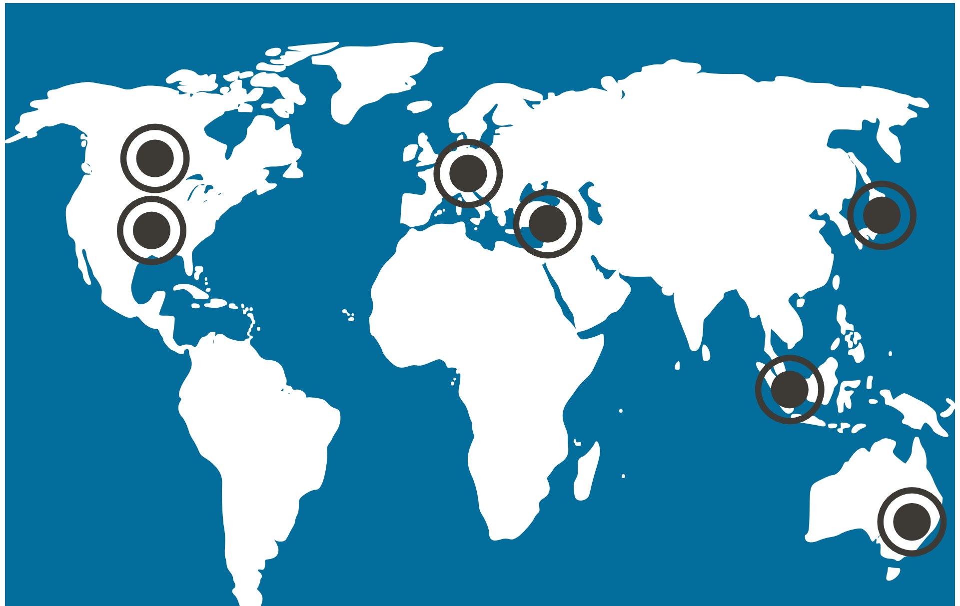
- Process simulation services for
  - Process optimisation (energy saving, performance increase, …)
  - Process design (optimal mixing, smaller footprint, CapEx saving, …)
  - Process scale-up (lower time to market, significant piloting cost saving, …)
- Highly specialised in CFD and kinetic modelling
- Global reach
- Our clients
  - Technology vendors
  - End users and utilities
  - Consulting & Engineering firms
- Exclusive focus on processes

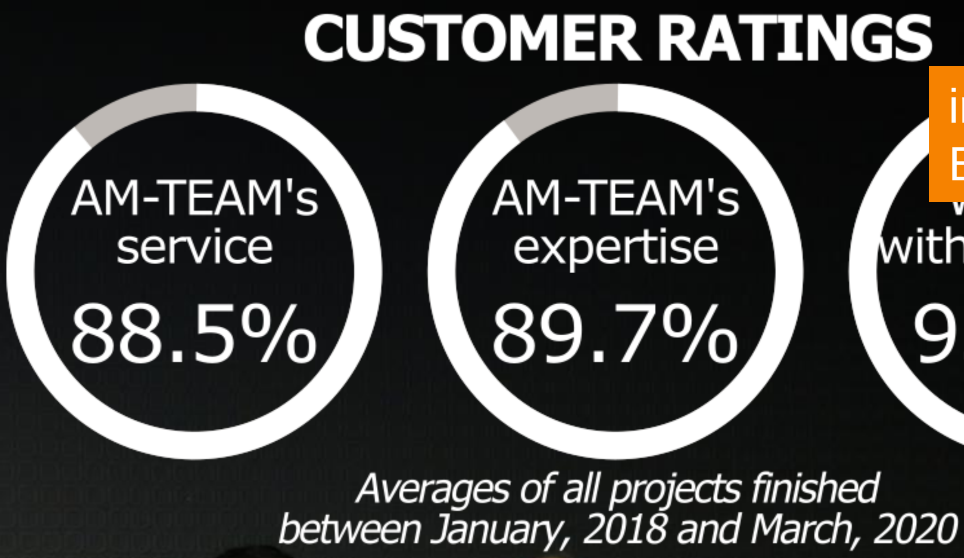
Extensive case studies and blogs:
AM-TEAM.com


Where we have ongoing projects

This is AM-TEAM

>100 projects finished

Orange: presenters



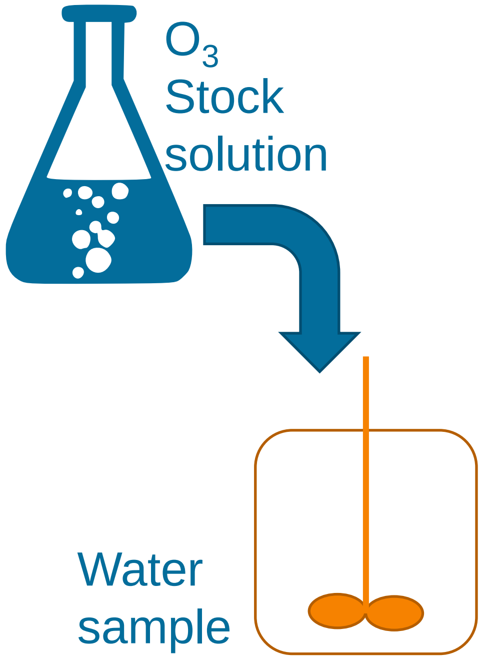
ir. Cilia De Wilde
Business Development Manager

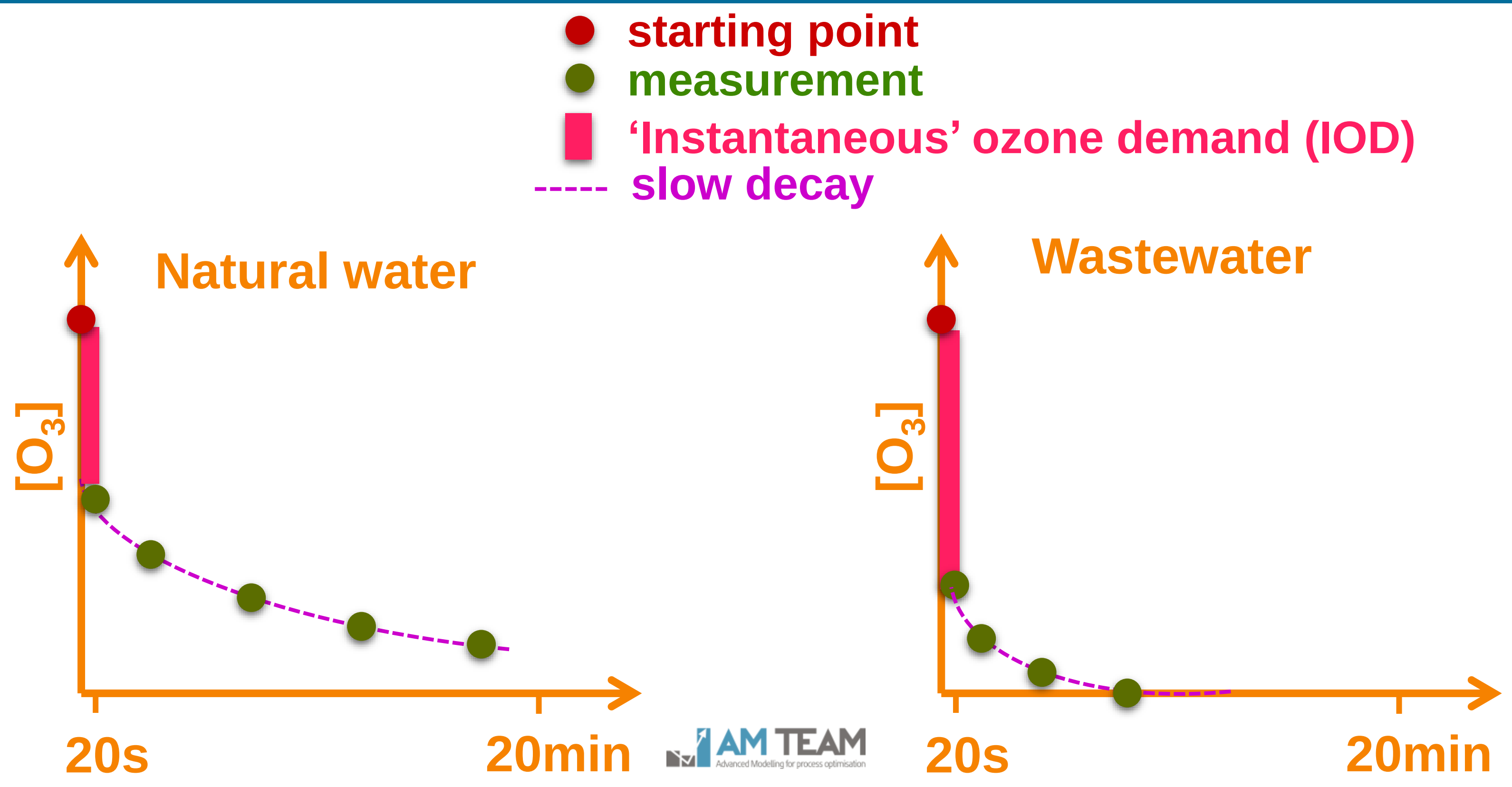
Dr. Wim Audenaert
CEO, co-founder

Dr. Giacomo Bellandi
Senior simulation expert

3 fundamental ozone facts

FACT #1
OZONE DECAY KNOWS **2 PHASES**





Ozonation inherently is an advanced oxidation process

FACT #2
TARGET POLLUTANTS ARE REMOVED BY **BOTH O_3 AND HO* RADICALS**

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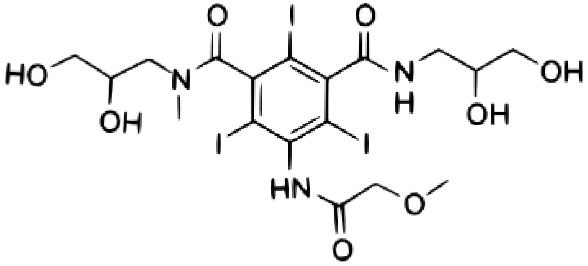

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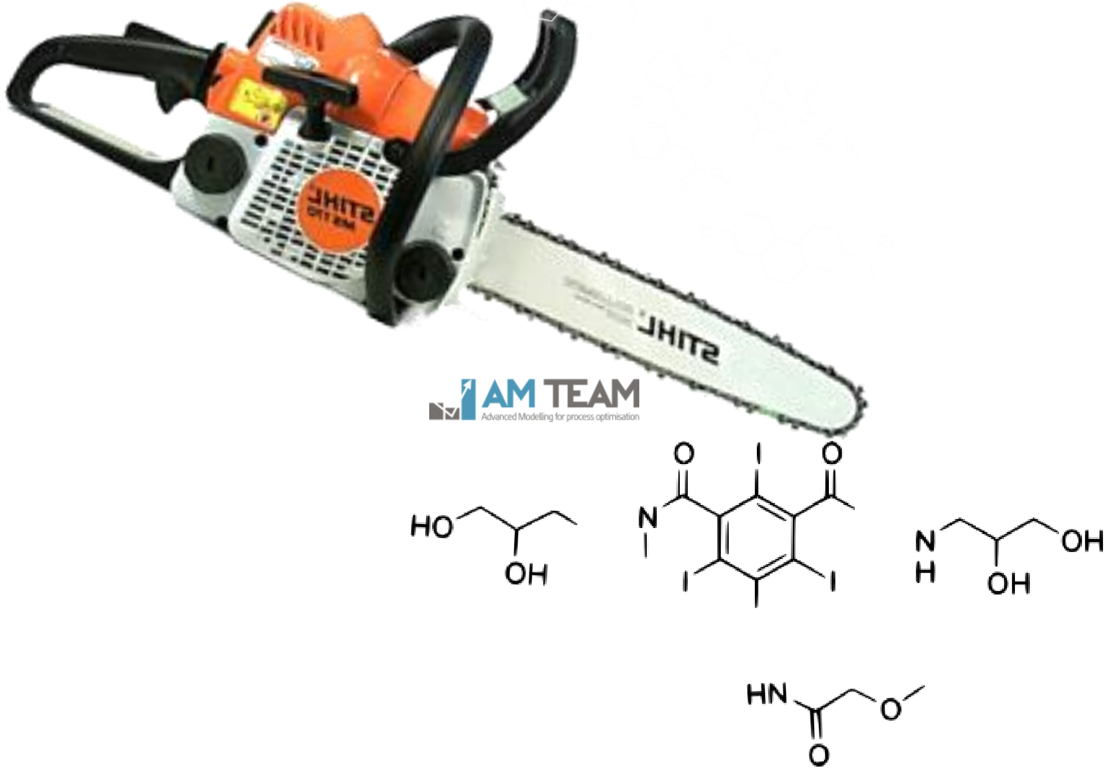
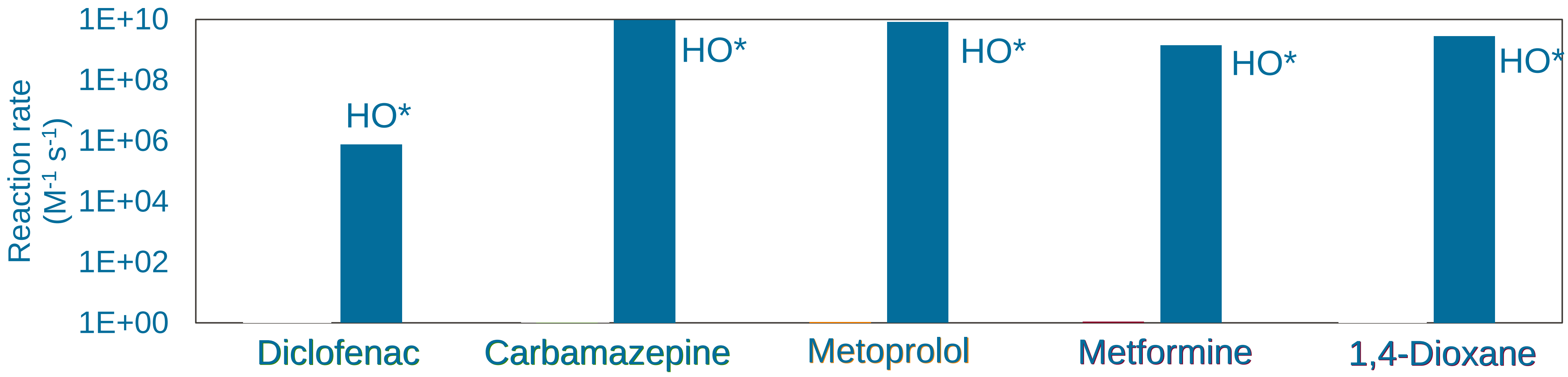
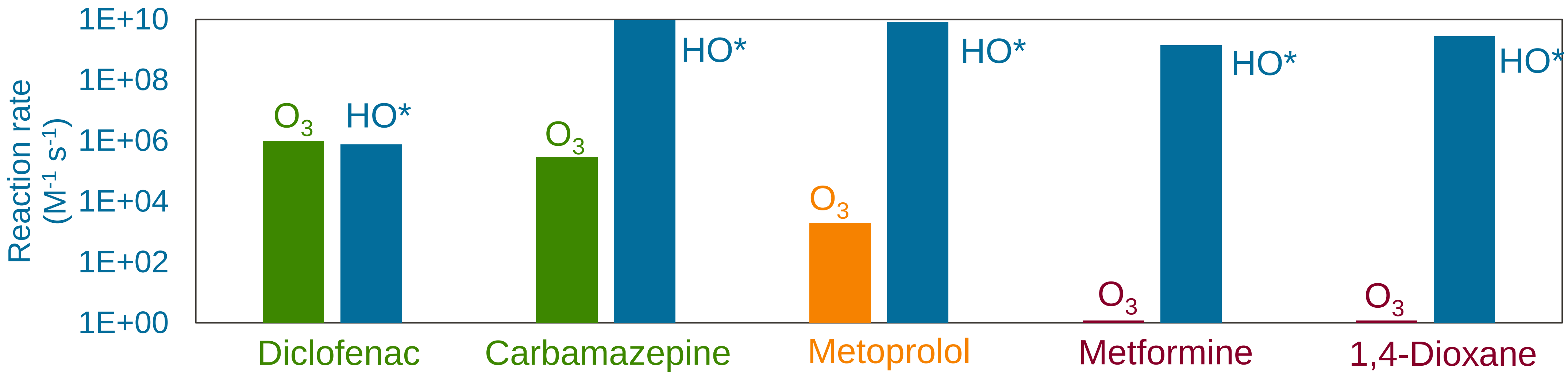


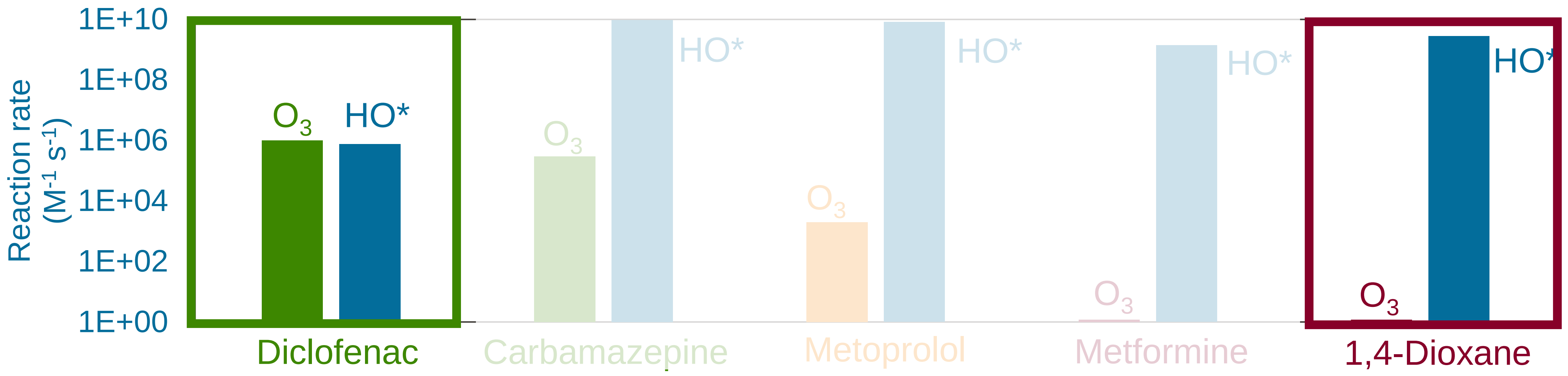
Target pollutants are removed by **both O_3 and HO***



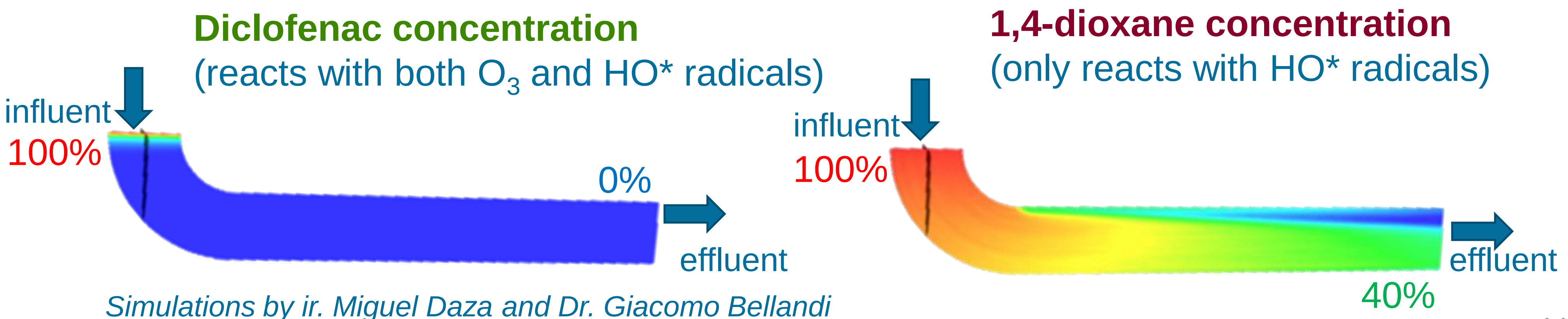
Target pollutants are removed by **both O_3 and HO***



Target pollutants are removed by **both O_3 and HO***



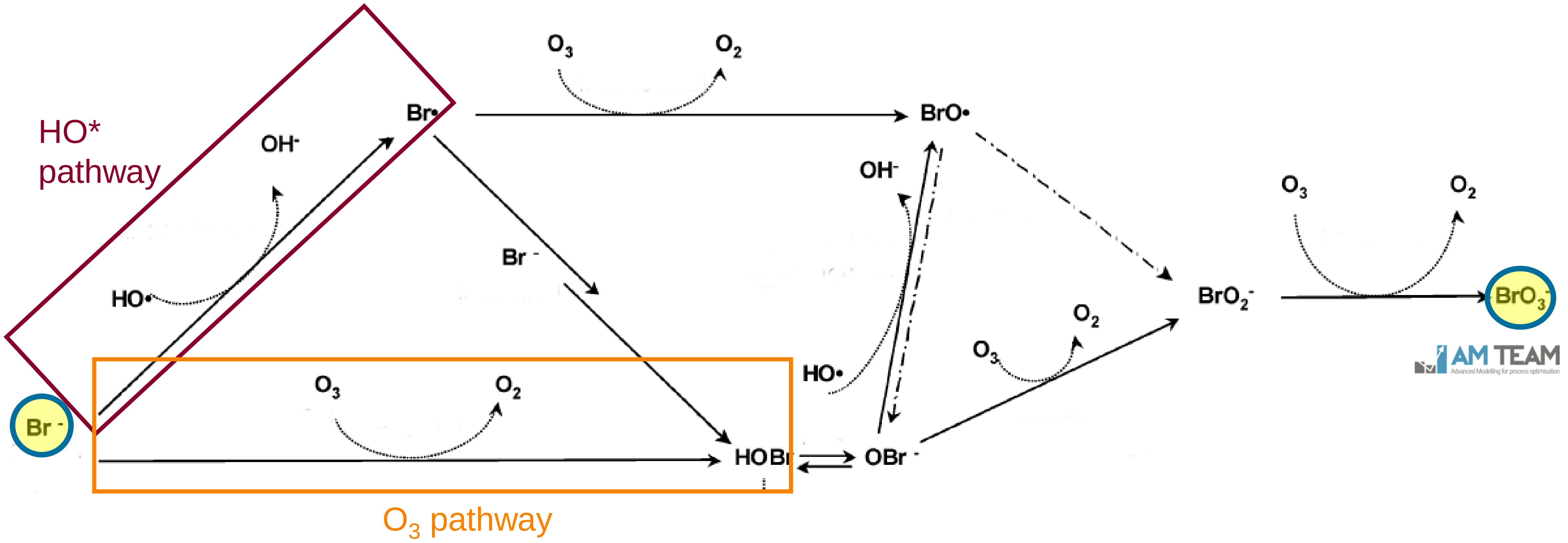
O_3 DOSED IN A SIMPLE BENDED PIPE – CFD-kinetic simulation including HO*



Simulations by ir. Miguel Daza and Dr. Giacomo Bellandi

FACT #3

Bromate is formed by **both O_3 and HO* radicals**



Buffle, M., Galli, S., von Gunten, U. 2004. Enhanced bromate control during ozonation: the chlorine-ammonia process

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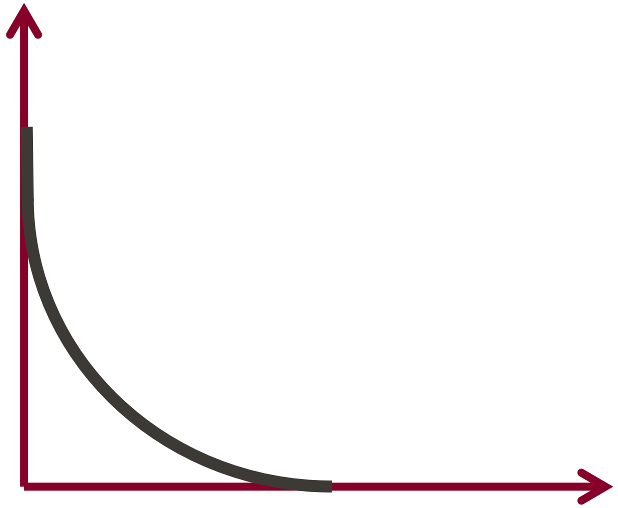
Batch demonstration

Conclusions

- In order to have a valuable simulation model, these facts have to be considered:
  - Ozone decay in 'real water' (Fact #1)
  - O_3 and HO* based target pollutant removal (Fact #2)
  - O_3 and HO* based BrO_3 formation (Fact #3)



O_3 **HO***

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What is a process simulation model?

What is a process simulation model?

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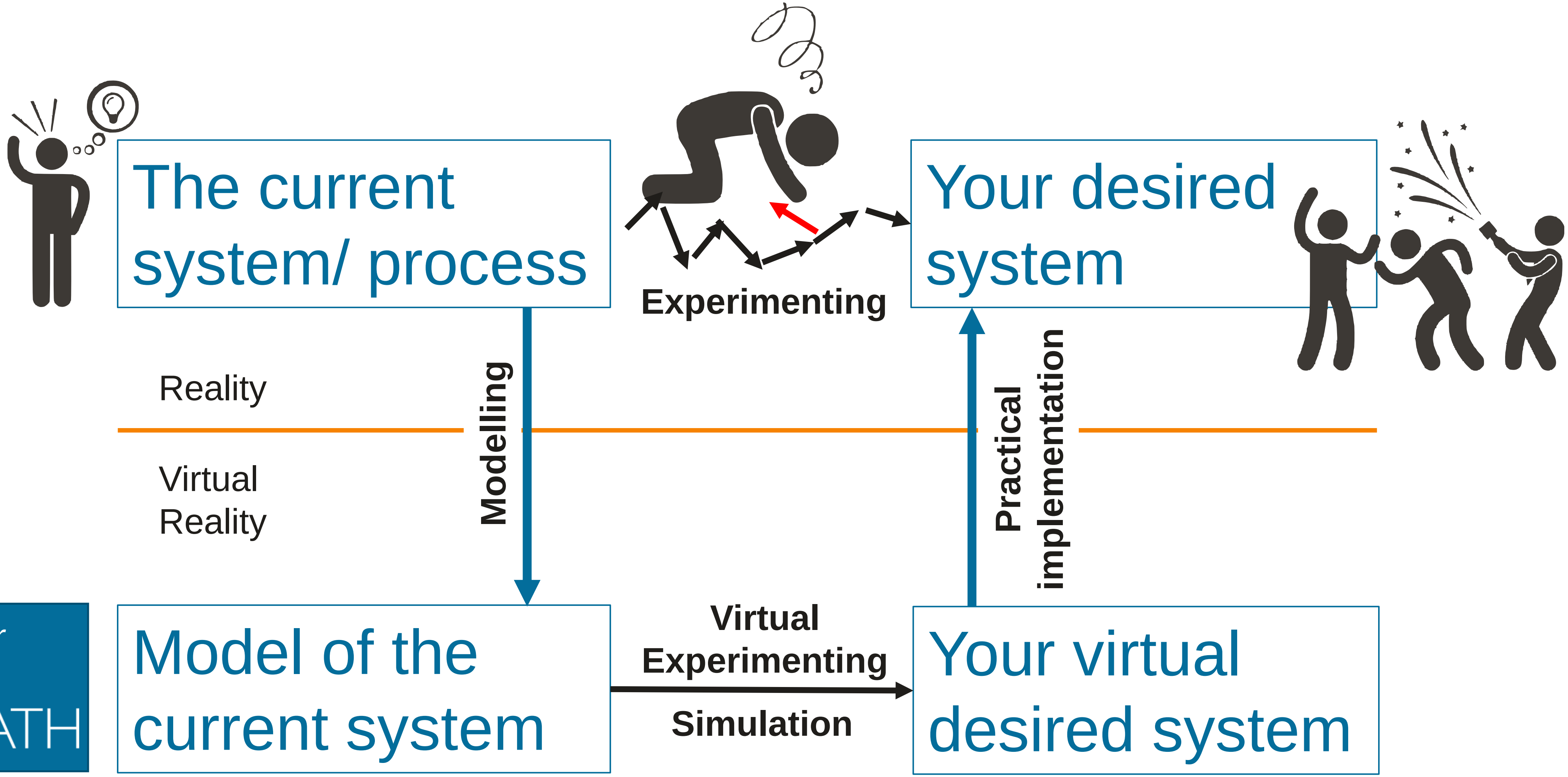

Credit for scheme: BIOMATH

A simulation model for ozonation

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Water matrix data
- DOC, COD, UV_{254}
- Conductivity
- Target pollutants
- Br^-
- Carbonates

Process model

$$\frac{dC_{1,4-dioxane}}{dt} = -\cdots$$

$$\frac{dC_{BrO_3}}{dt} = +\cdots$$

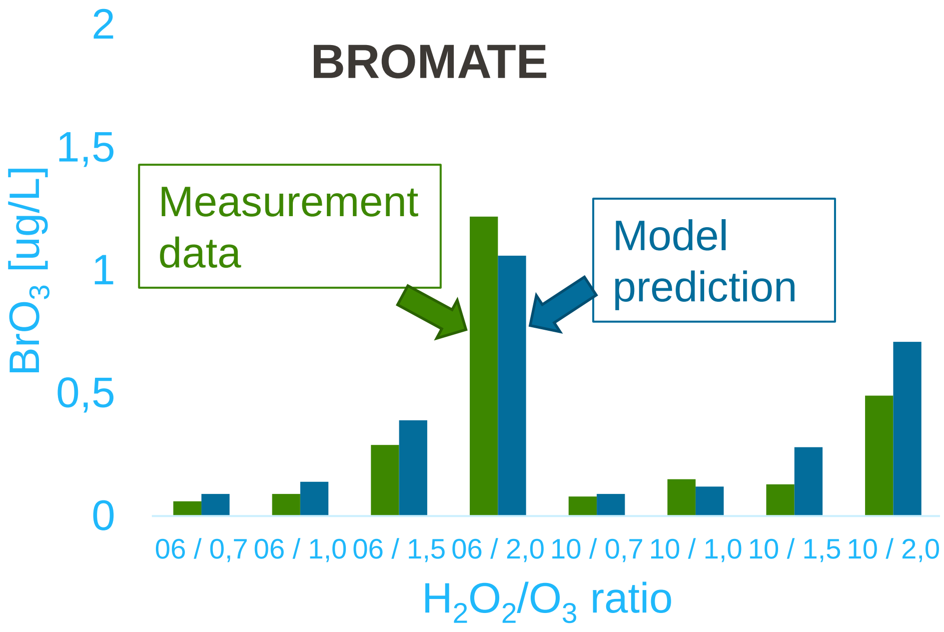
…

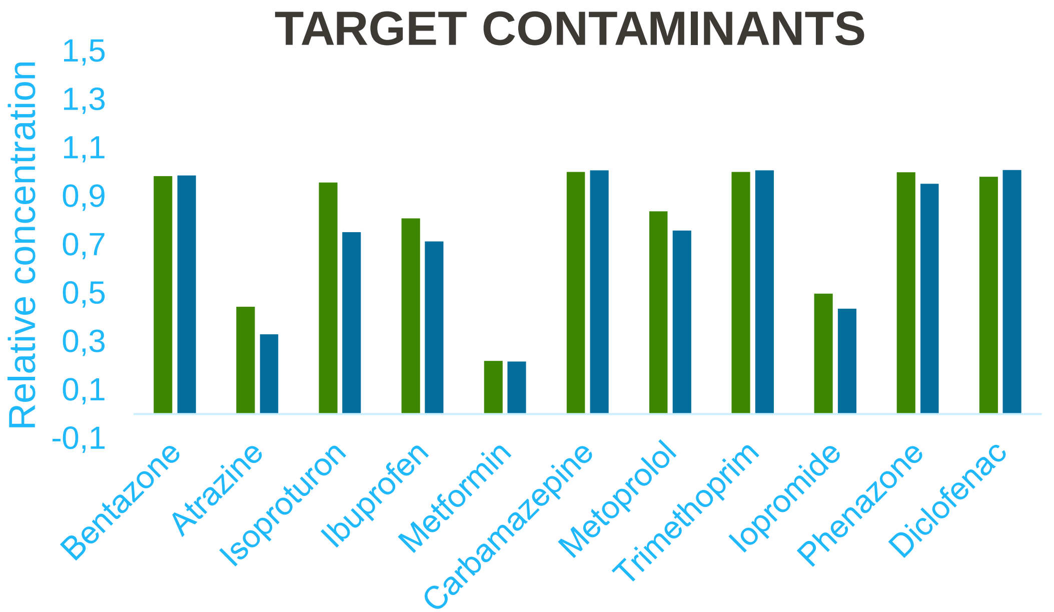
Prediction of
- Ozone decay
- Target pollutant removal
- Bromate
- Disinfection
- …

Process settings
- O_3 dose
- Chemical dose
- Volume and flow rates
- …

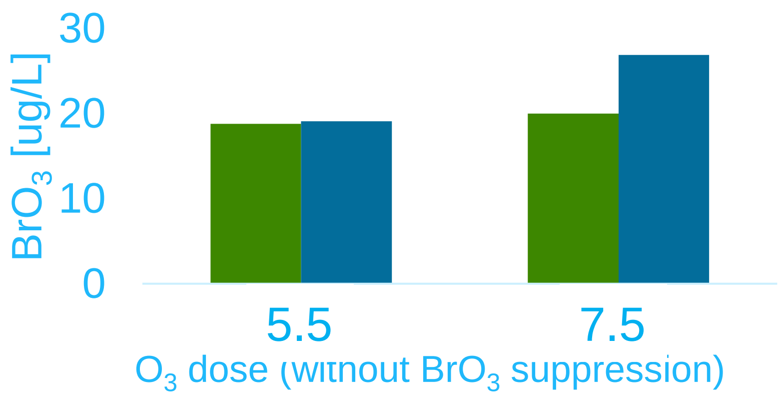
Prediction examples

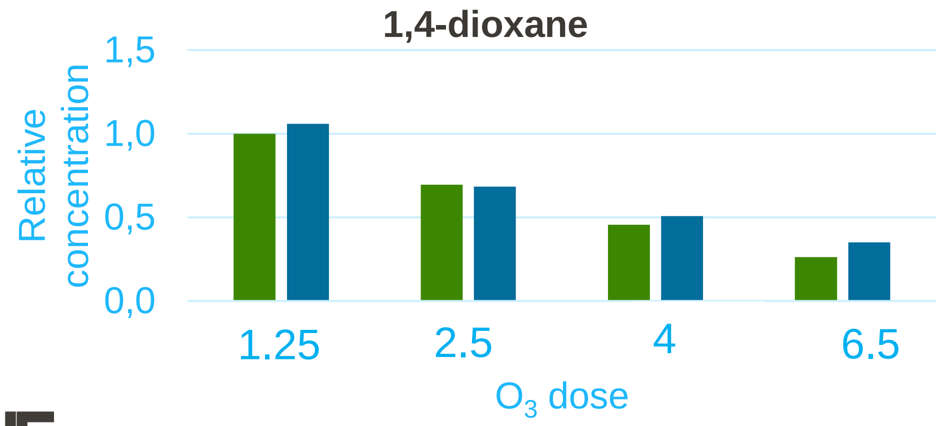
Surface water





Secondary effluent





AM OZONE
A product of AM TEAM

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What would be the practical value of a process simulation tool for O_3???

LIVE DEMO

Different categories of applications (apart from ‘process understanding’)

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VIRTUAL PILOTING

- TECHNOLOGY SELECTION
  - How suitable would O_3 be for a specific matrix?
  - What would be the specific removal of target pollutants at a certain O_3 dose?
  - Can bromate be suppressed, and what is impact on target pollutant removal?
  - Increase the value of real-life piloting efforts (eg complement data; learning)
- PROCESS DESIGN
  - What will be the O_3 residual throughout the train? (eg sensor location)
  - What is the optimal sizing in view of current and future water characteristics?
  - Selection of injection technology (FBD, SSI) – what’s happening?
  - Ozonation runs at Plant A. How would it perform at Plant B?
- PROCESS OPERATION
  - Real-time monitoring (i.e. ‘digital twin’)
  - New operational strategies (e.g. smart dosing; testing of control strategies)

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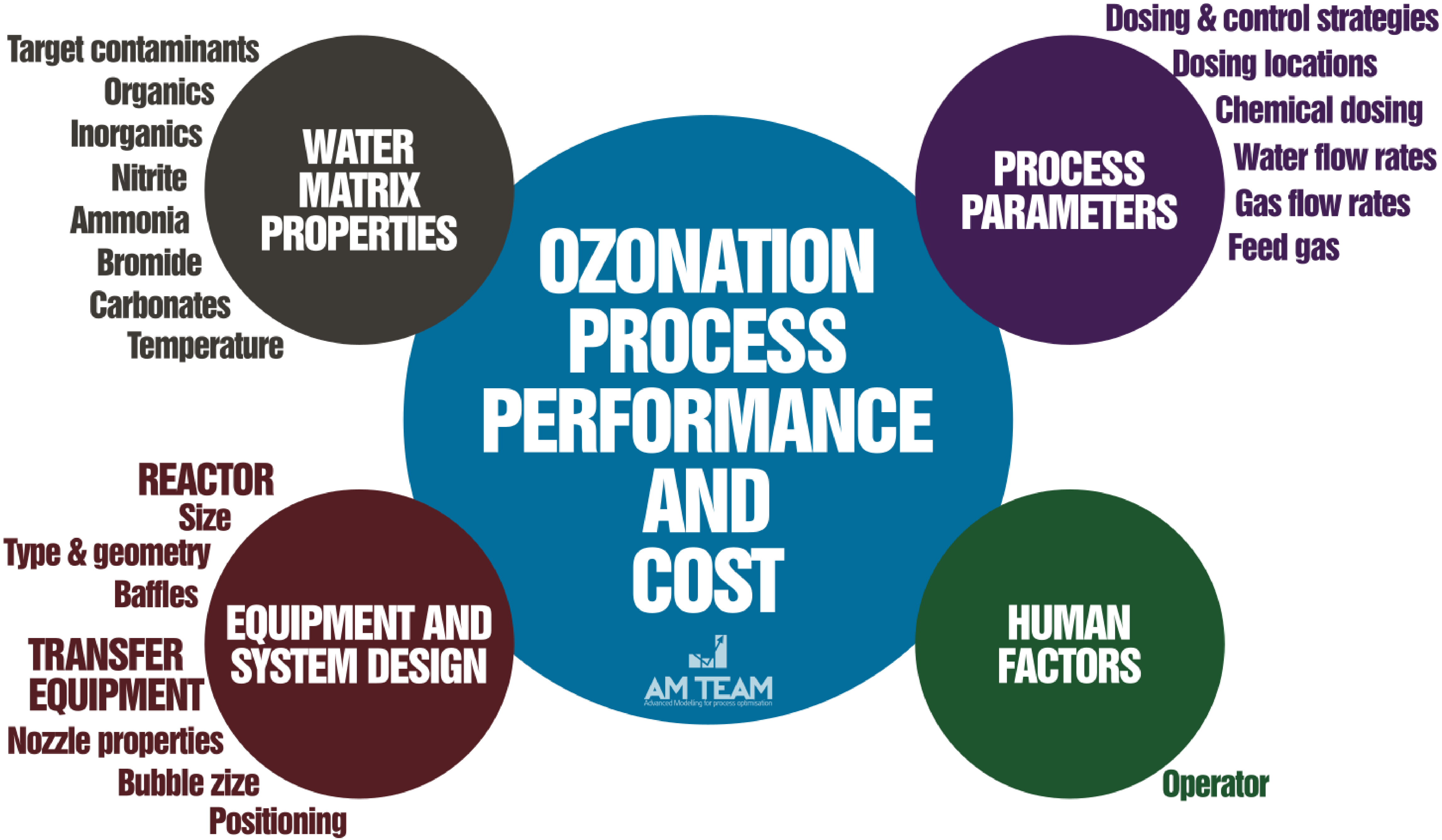
Conclusion


OZONATION PROCESS PERFORMANCE AND COST
WATER MATRIX PROPERTIES
Target contaminants
Organics
Inorganics
Nitrite
Ammonia
Bromide
Carbonates
Temperature
PROCESS PARAMETERS
Dosing & control strategies
Dosing locations
Chemical dosing
Water flow rates
Gas flow rates
Feed gas
EQUIPMENT AND SYSTEM DESIGN
REACTOR
Size
Type & geometry
Baffles
TRANSFER EQUIPMENT
Nozzle properties
Bubble zize
Positioning
HUMAN FACTORS
Operator
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Conclusion

- Status of model application
  - The model is currently being applied at plants in Europe and the US (wastewater effluent and drinking water ozonation)
  - Services and support available through AM-TEAM
    - (If you have a case: email info@am-team.com)
  - The simulation tool will become available soon
    - No in-house simulation expertise required
- We expect to remove significant practical, regulatory and financial barriers with regard to the application of ozonation
- Special acknowledgements: Dynamita (FR) and HRSD (US), Dunea (NL)

FULL WEBINAR RECORDING

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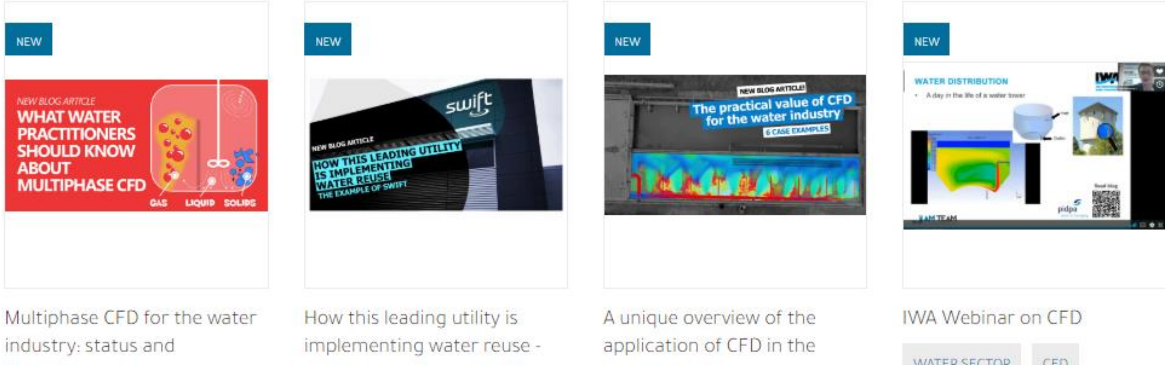
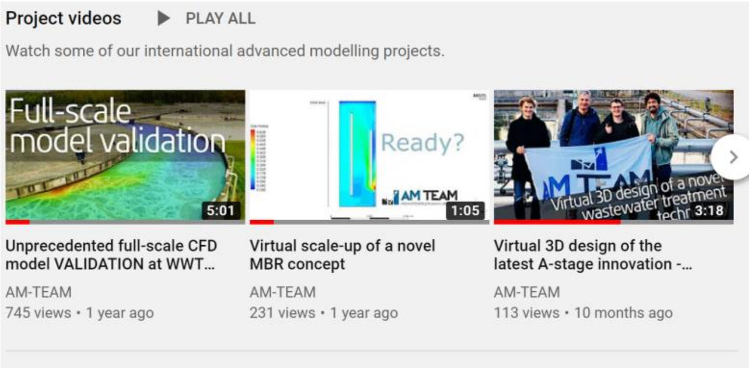
Our latest updates are posted on LinkedIn page (click to follow)

Thanks so much for your engagement. Follow us on social media.

AM TEAM *blog*



AM TV
Advanced Modelling Movies



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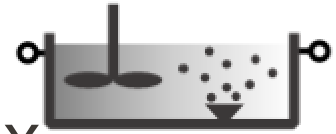
Our latest updates are posted on LinkedIn page (click to follow)

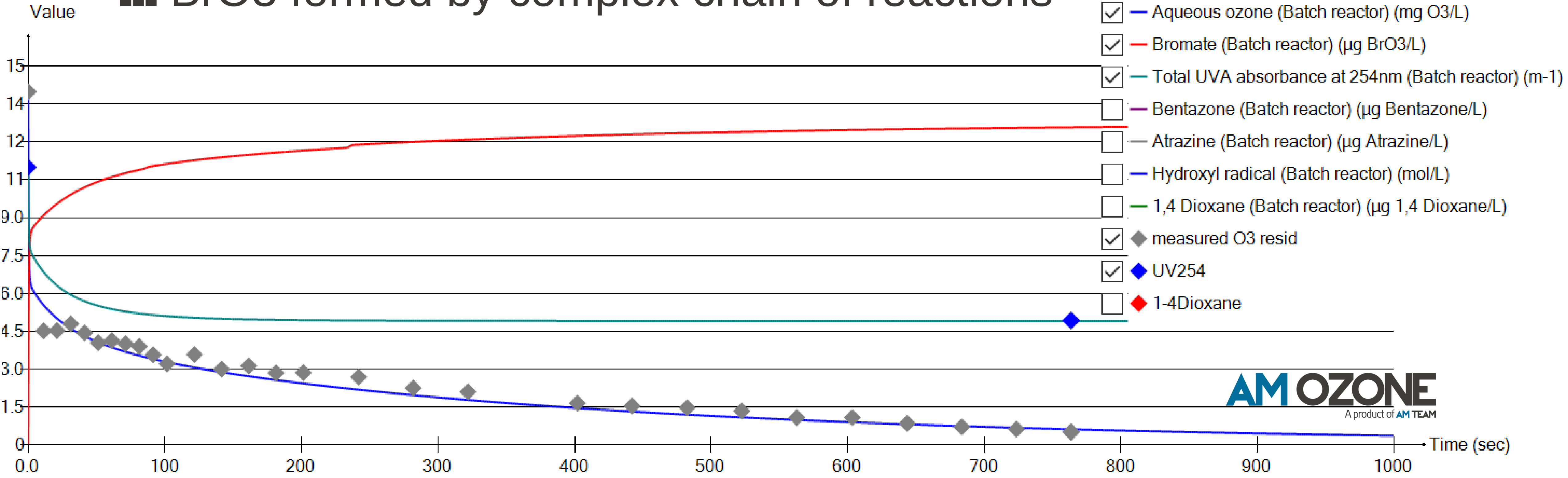
APPENDIX: live demo slides

Case 1 – batch reactor

Batch reactor

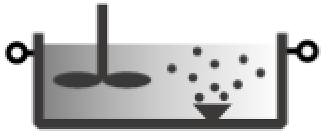


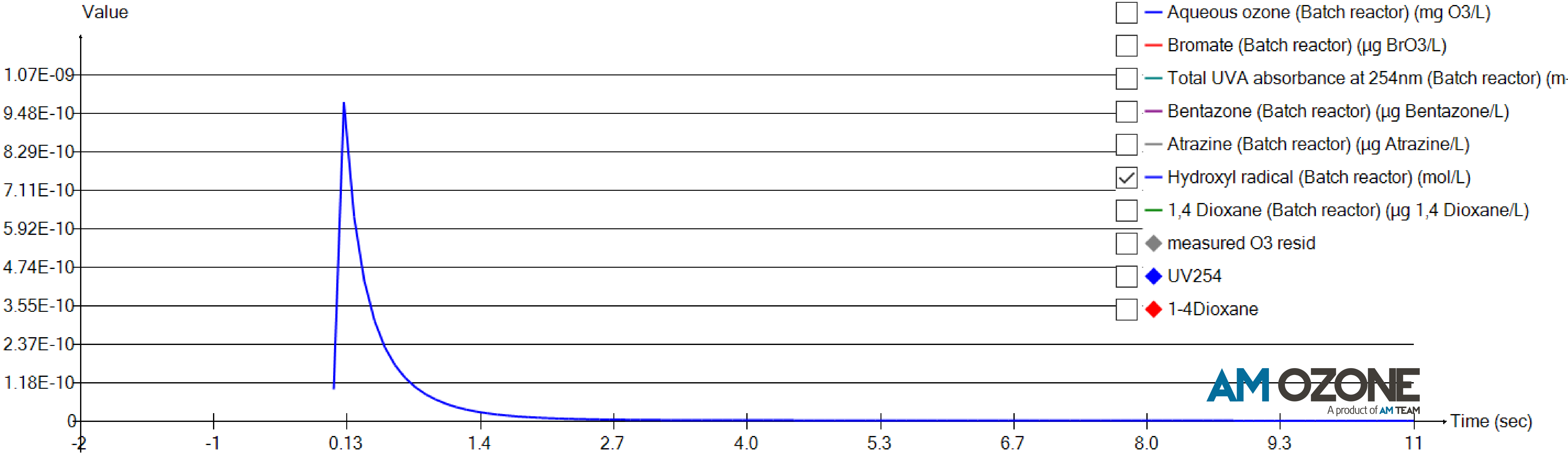
- Fitting real batch data
- O3 reacts with water matrix
- BrO3 formed by complex chain of reactions



Case 1 – batch reactor

- HO* concentration
- predicted in real time

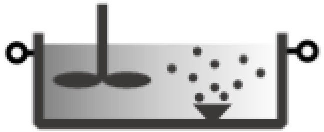


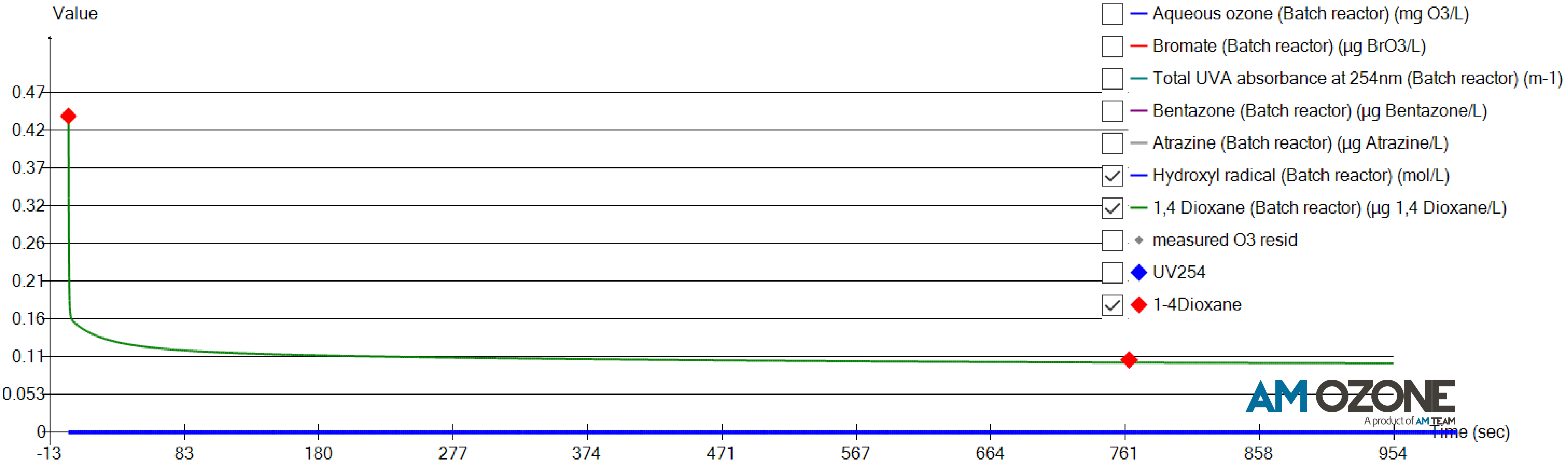


Case 1 – batch reactor

- 1,4 Dioxane

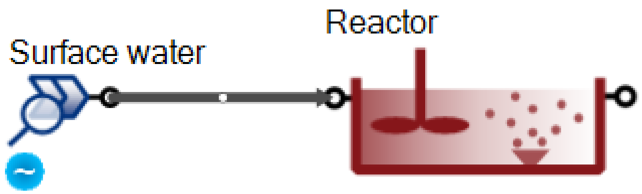
Batch reactor

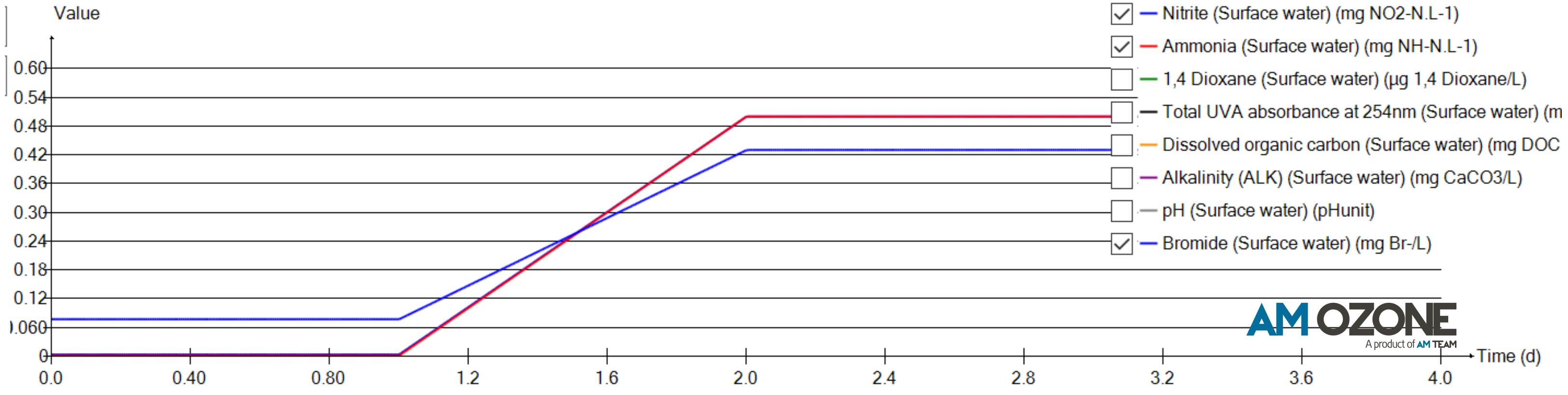


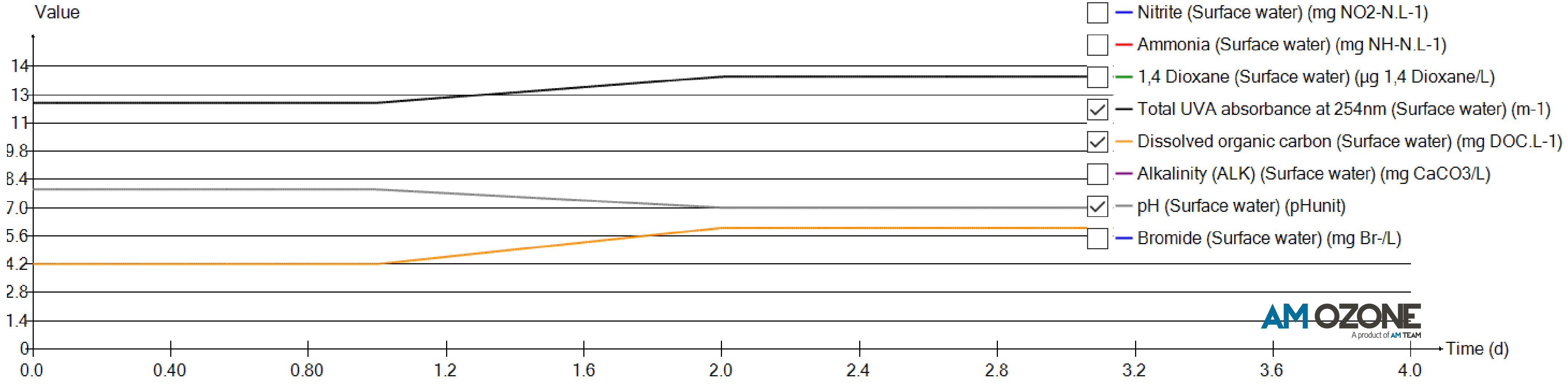


Case 2 – Dynamic influent

- What happens when influent water becomes more concentrated in time

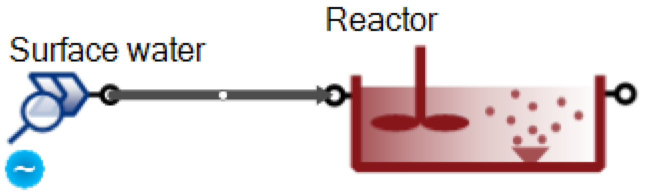


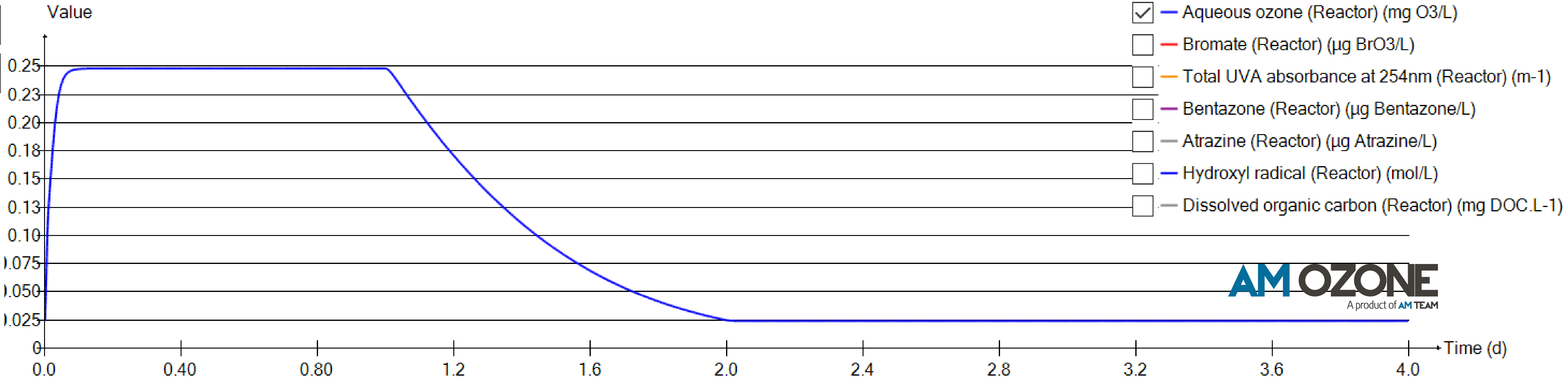




Case 2 – Dynamic influent

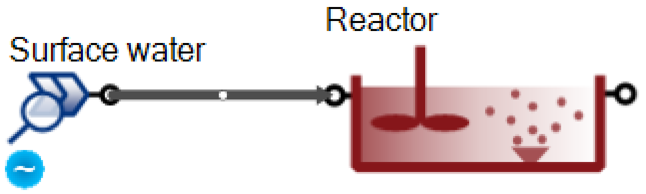
- With same gas flow rate, O3 gets depleted faster

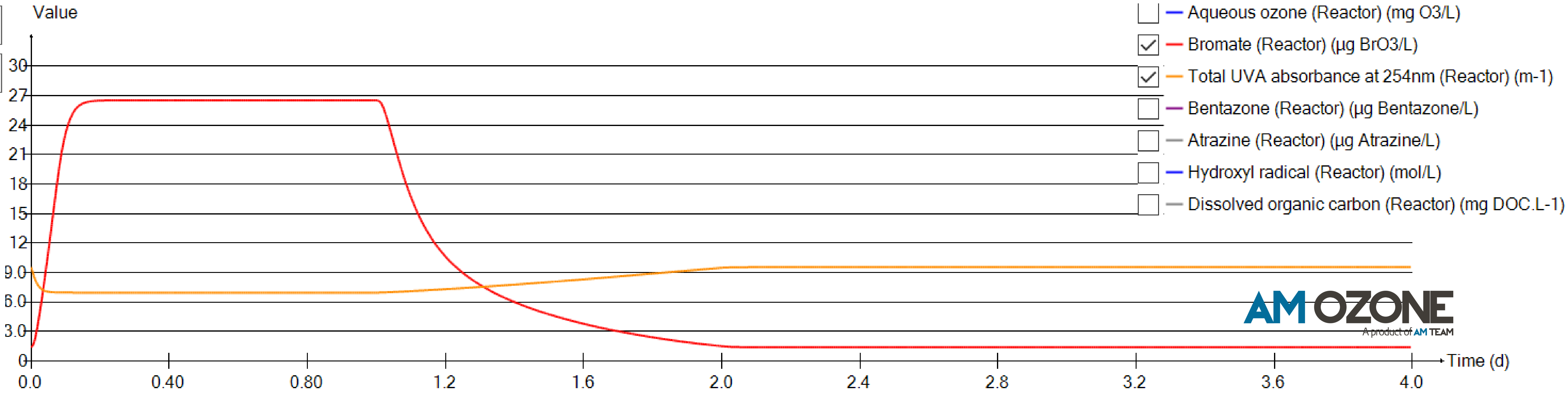




Case 2 – Dynamic influent

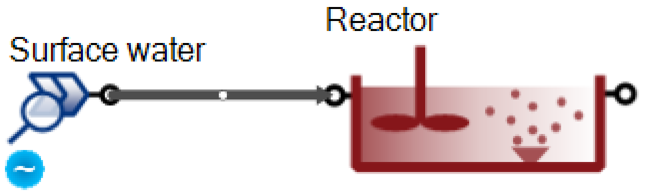
- At the same time BrO3 decreases (despite the increasing influent Br-!!) due to:
  - more scavenging of HO* from water matrix
  - less availability of O3

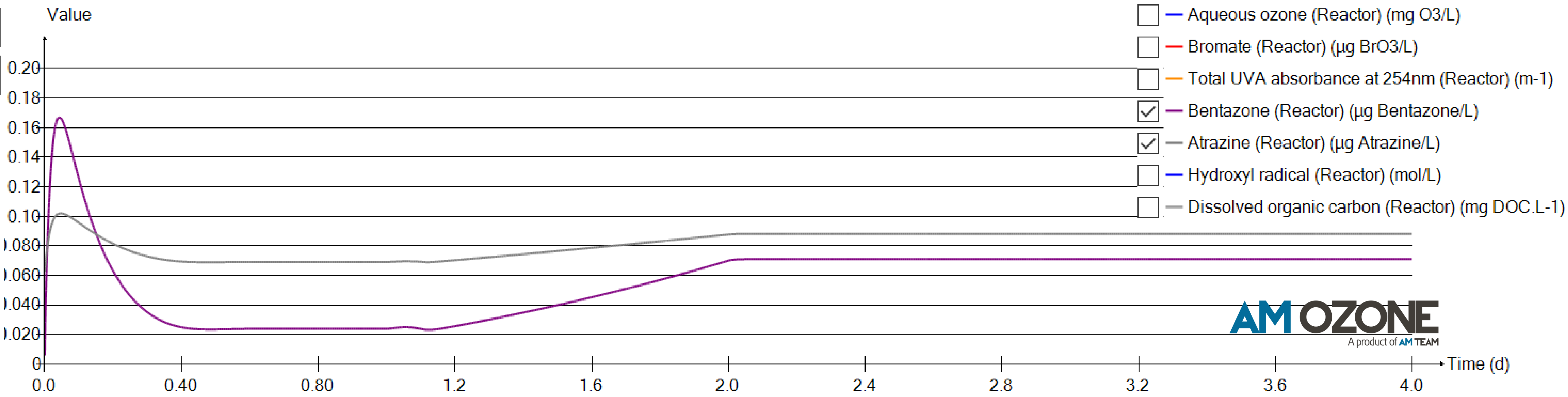




Case 2 – Dynamic influent

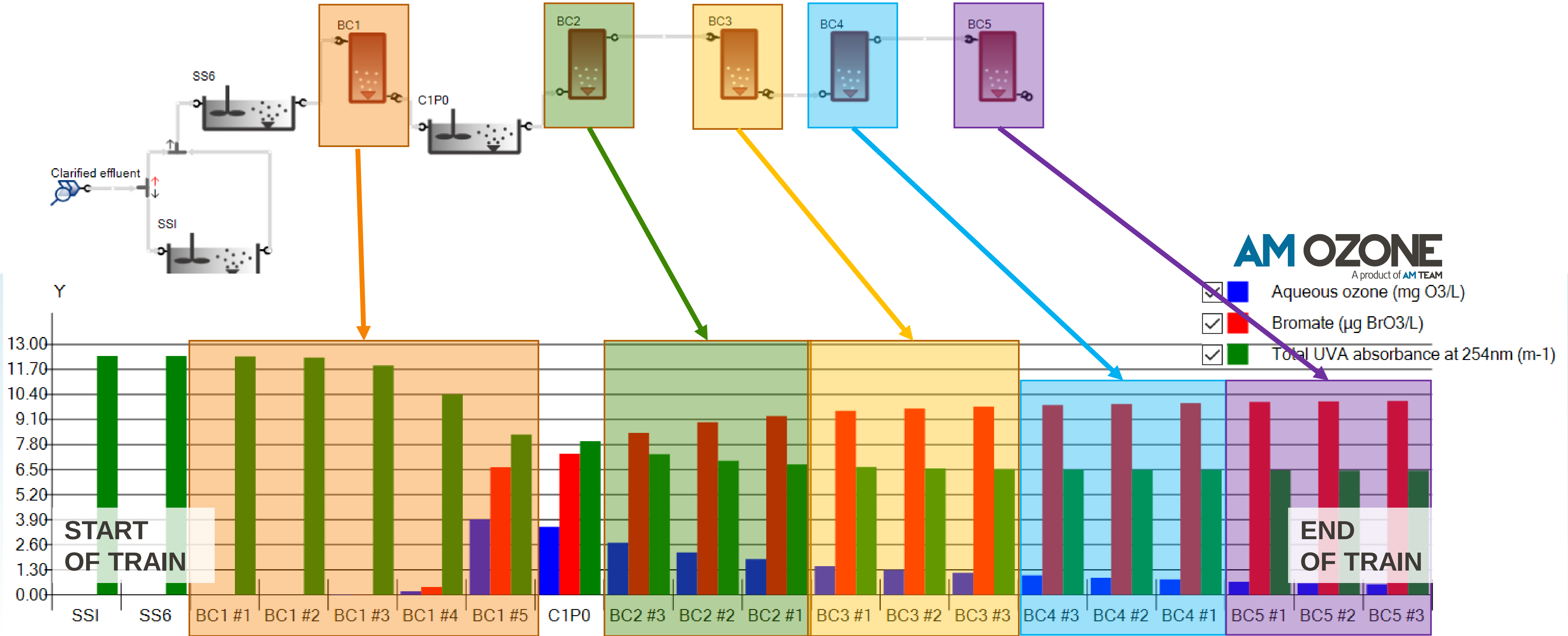
- Predicting HO* concentration we can also predict an unlimited number of micropollutants





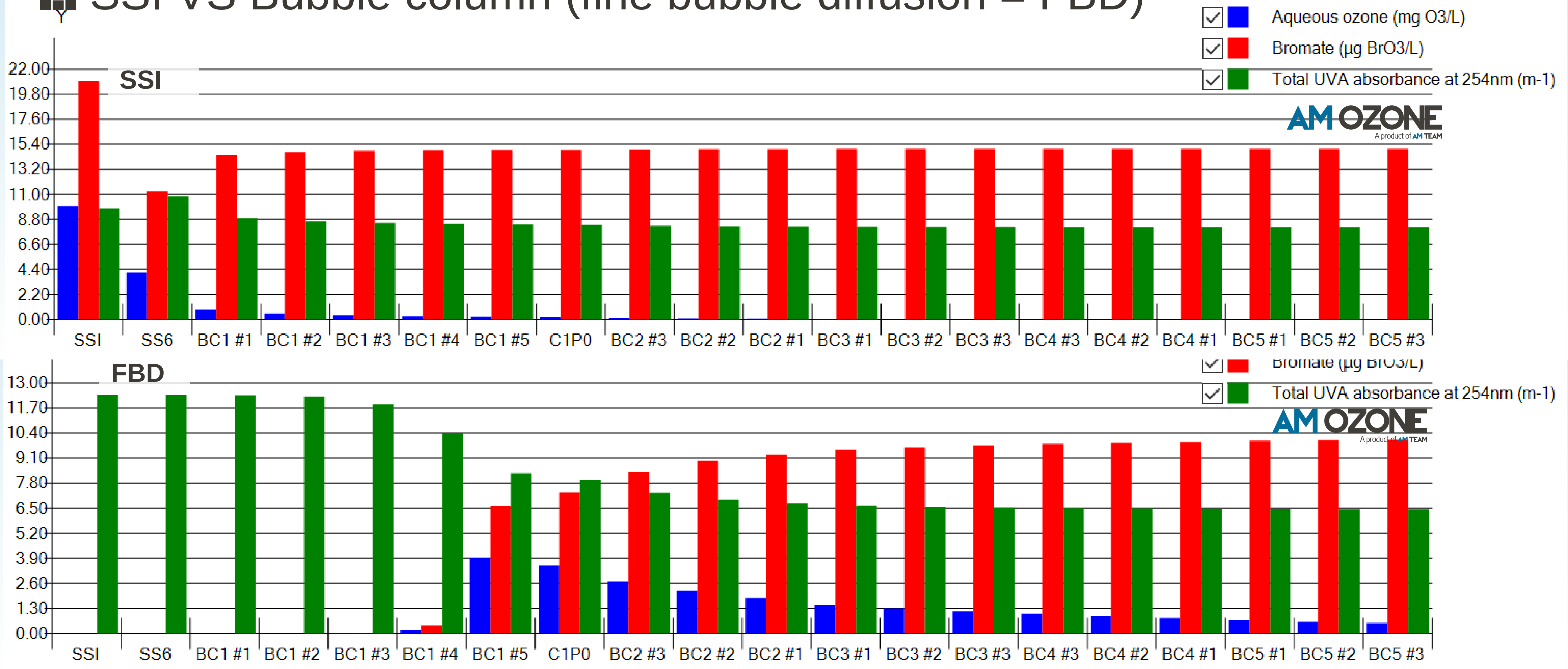
Case 3 – Full scale plant (SSI VS bubble column)

Bubble column treatment train profile



Case 3 – Full scale plant (SSI VS bubble column)

SSI VS Bubble column (fine bubble diffusion = FBD)



Case 3 – Full scale plant (SSI VS bubble column)

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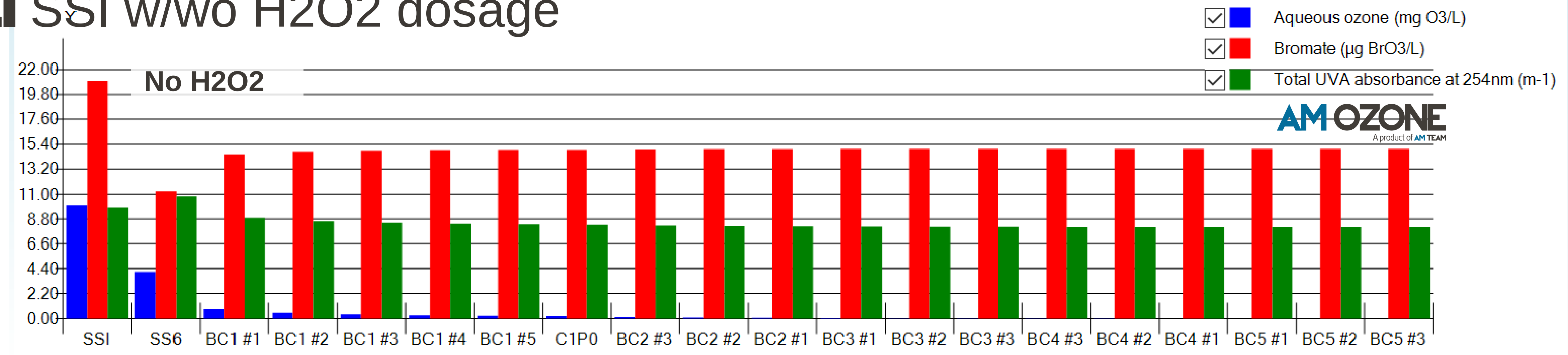
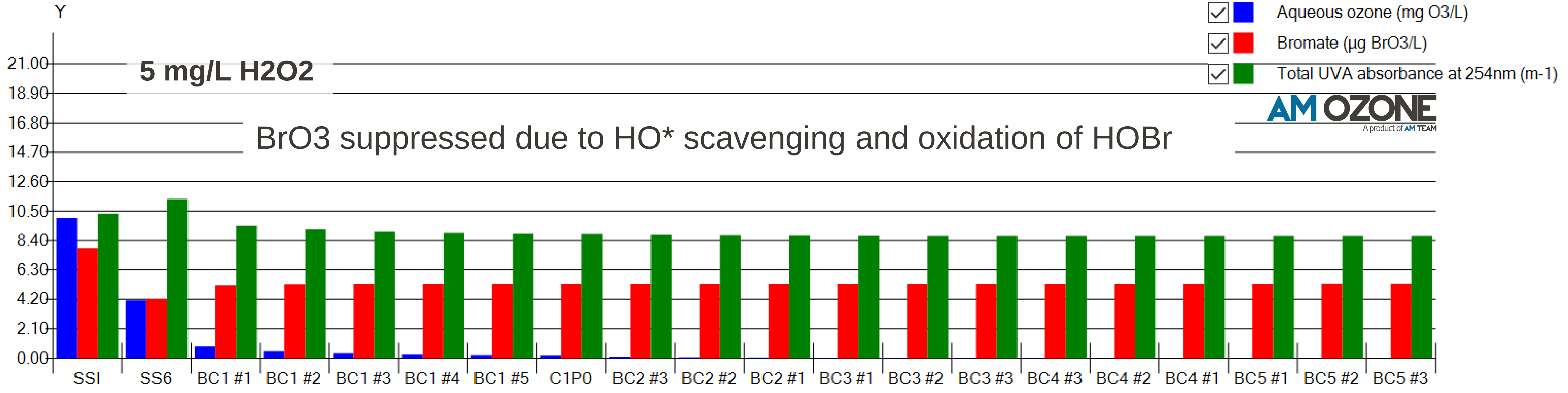
SSI w/wo H_2O_2 dosage





Case 3 – Full scale plant (SSI VS bubble column)

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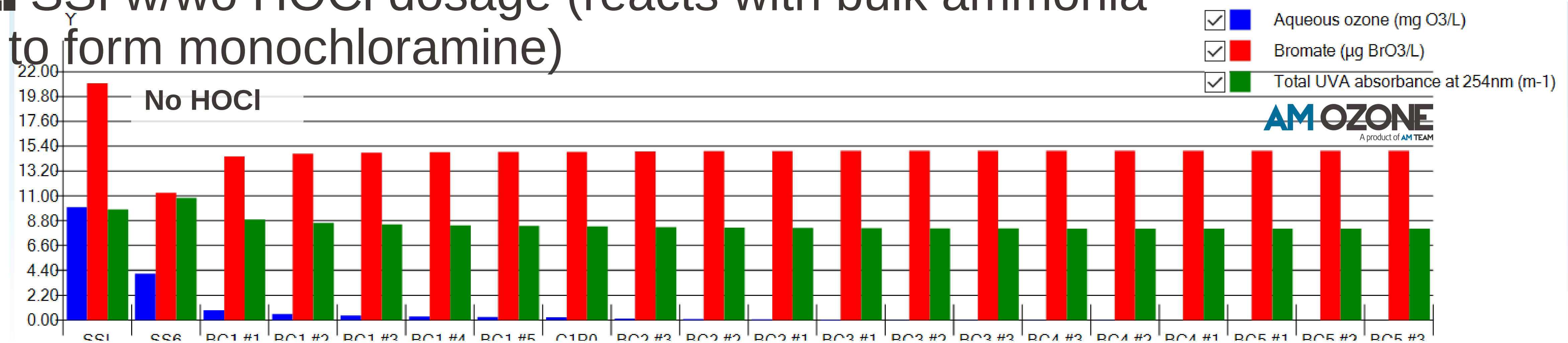
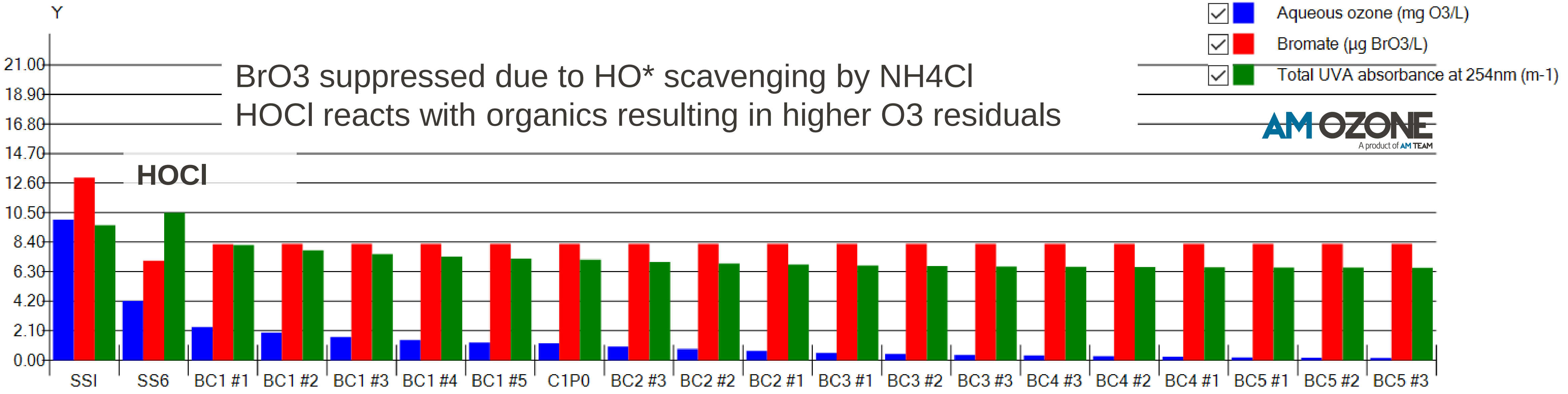
- SSI w/wo HOCl dosage (reacts with bulk ammonia to form monochloramine)





BrO3 suppressed due to HO* scavenging by NH4Cl

HOCl reacts with organics resulting in higher O3 residuals

Case 3 – Full scale plant (SSI VS bubble column)

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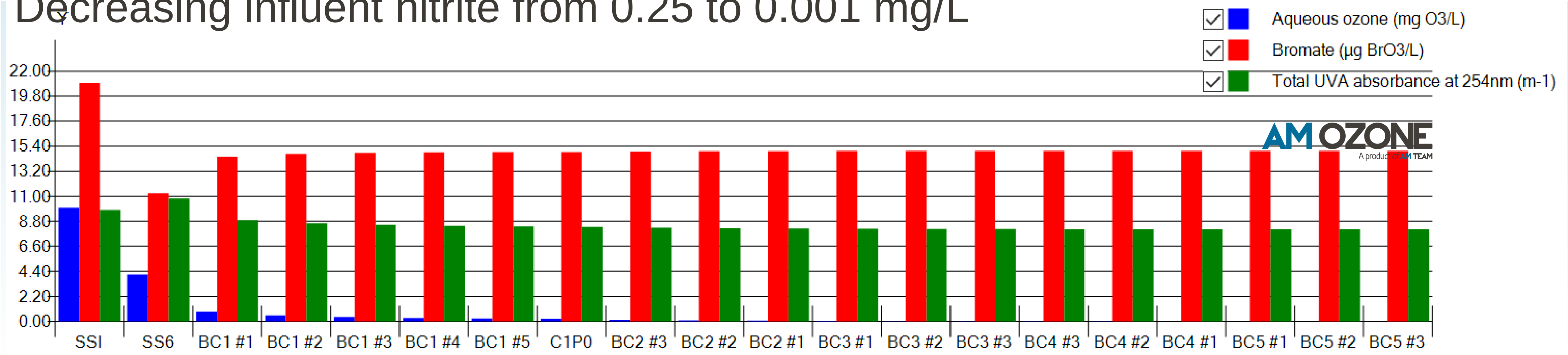
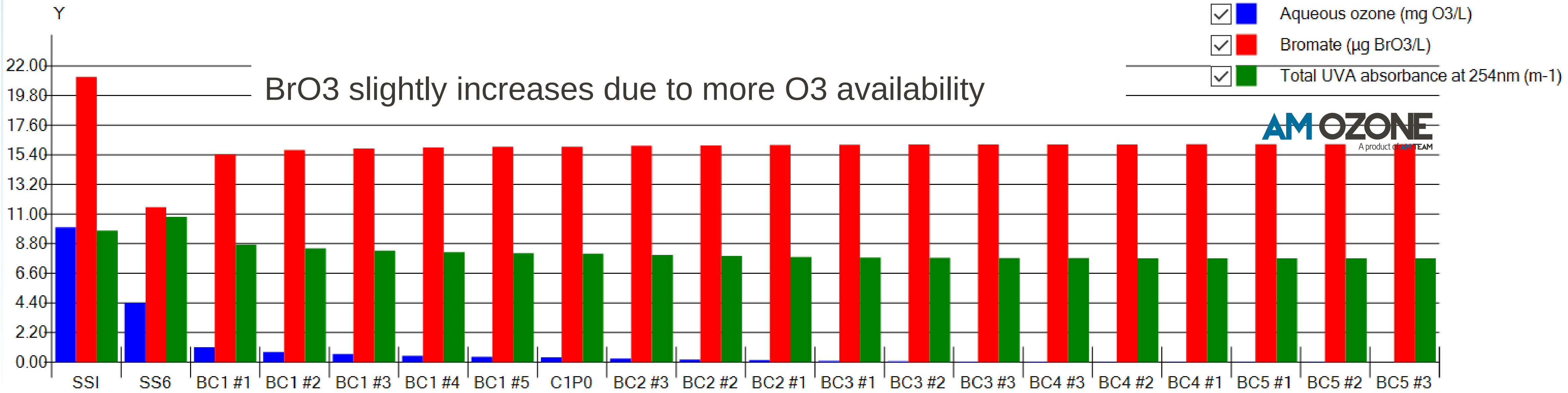
- Decreasing influent nitrite from 0.25 to 0.001 mg/L

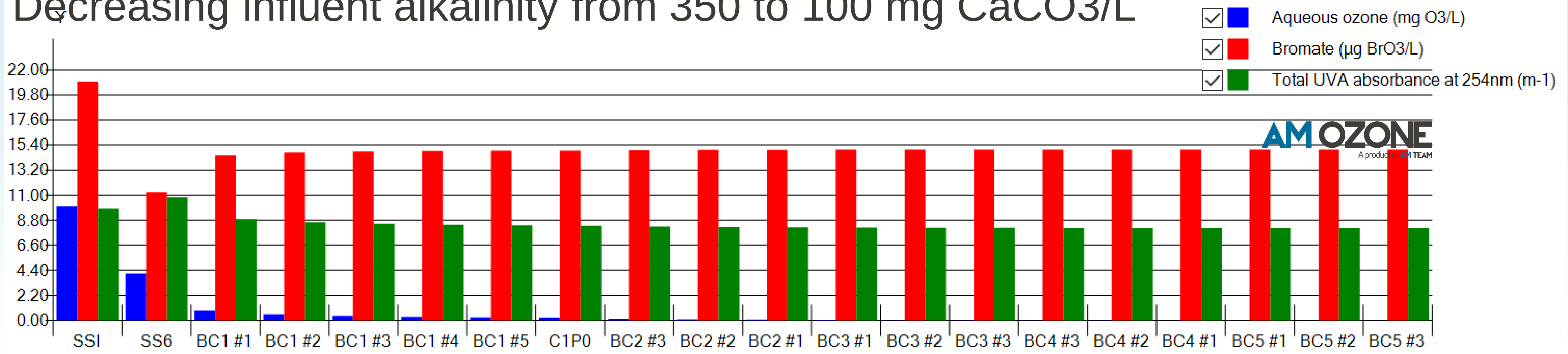


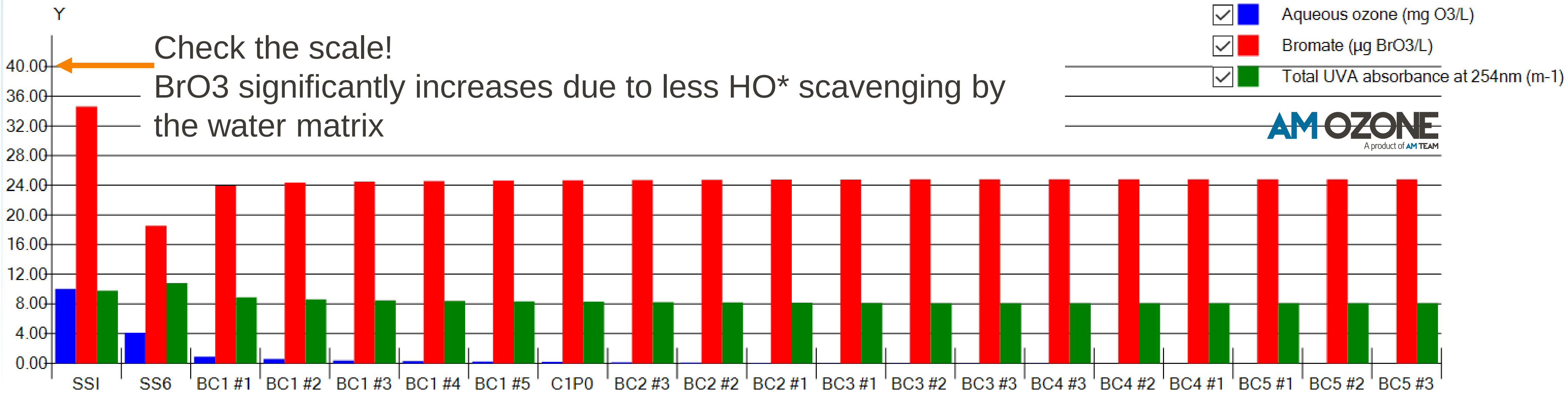
BrO3 slightly increases due to more O3 availability



Case 3 – Full scale plant (SSI VS bubble column)

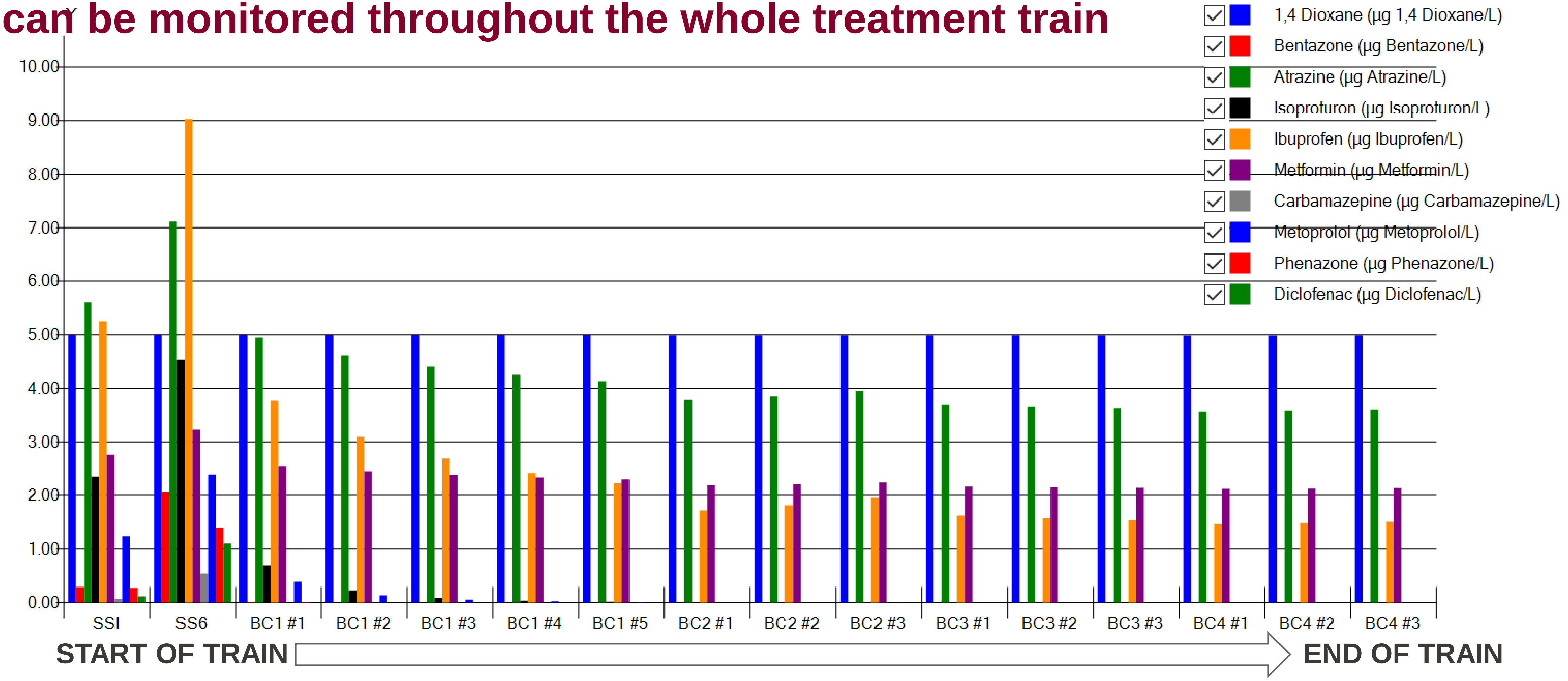
- Decreasing influent alkalinity from 350 to 100 mg CaCO3/L





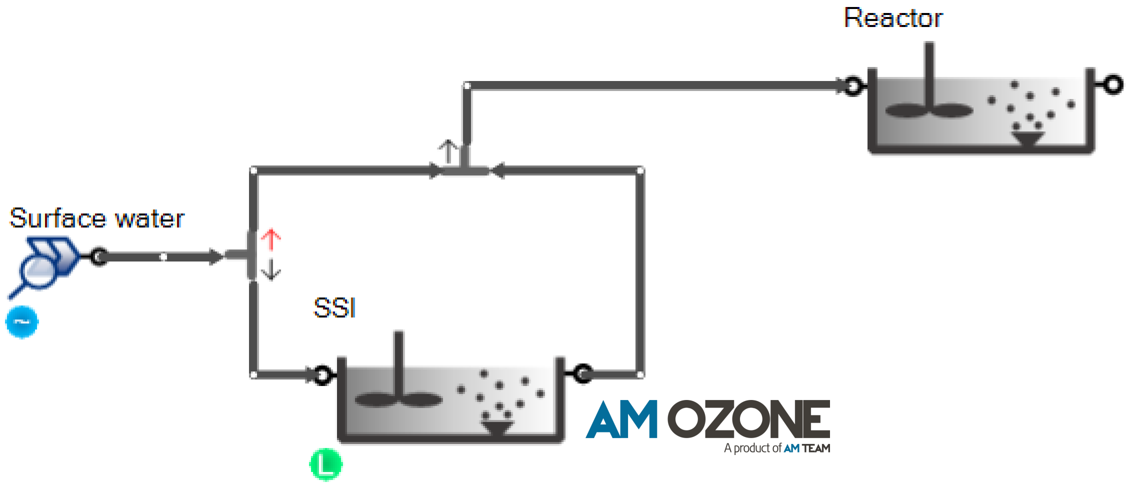
Case 3 – Full scale plant (SSI VS bubble column)

- **An unlimited amount of target pollutants can be monitored throughout the whole treatment train**



Case 4 – Full scale drinking water treatment plant in EU

- SSI configuration
- Available data (for 270 days!!)
  - Influent UVA254 sensor data
  - Effluent UVA254 sensor data



Case 4 – Full scale drinking water treatment plant in EU

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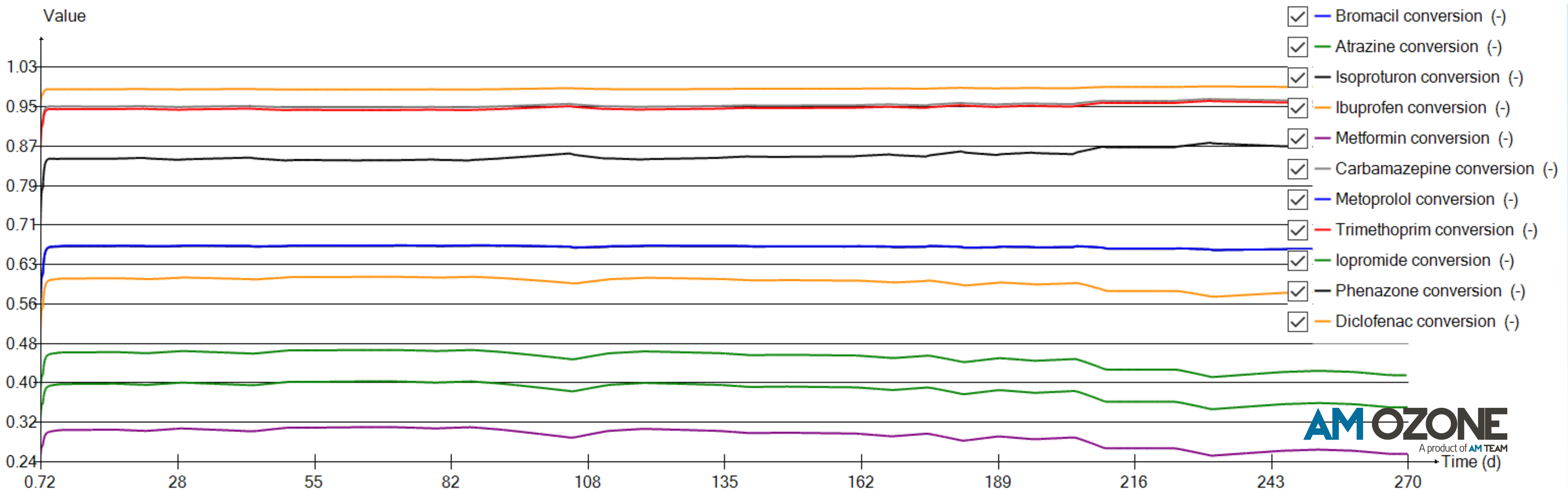
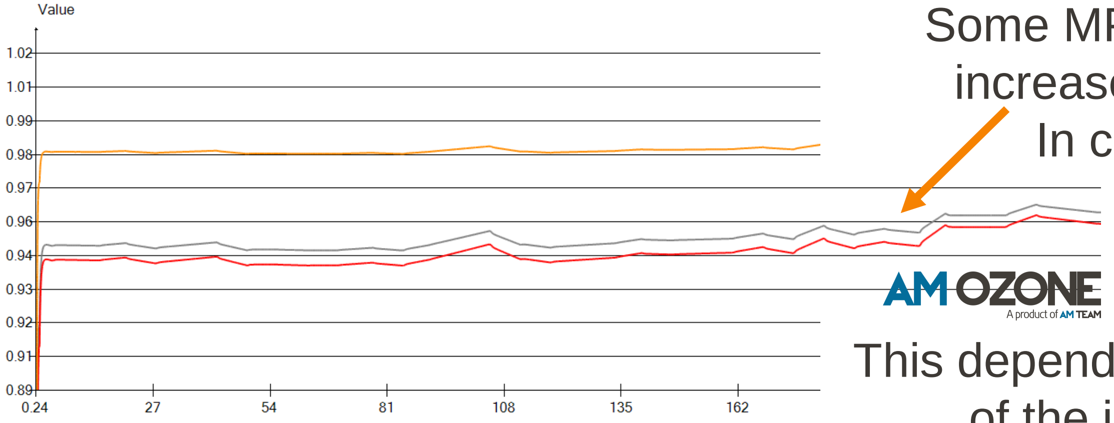
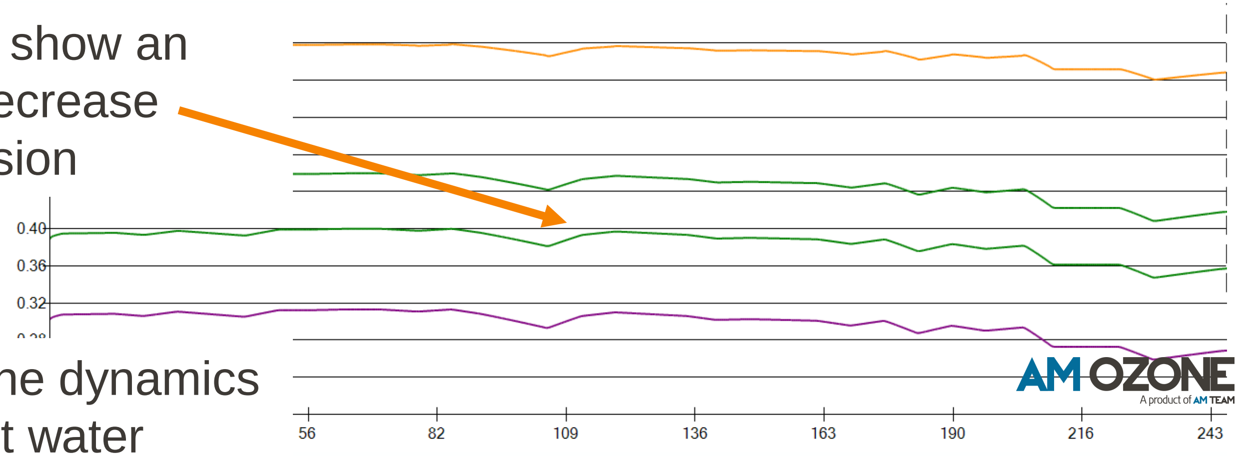
- Based on the influent water matrix is possible to predict HO* concentration and therefore MPs removal





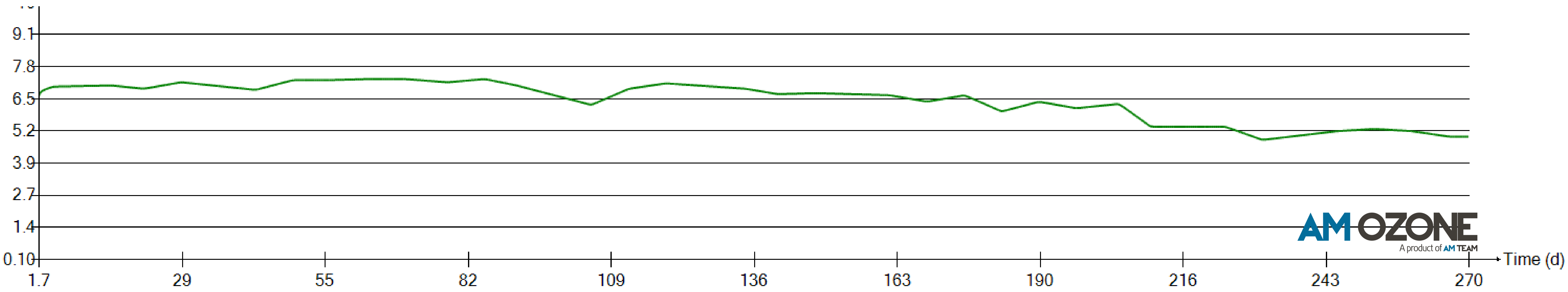
Some MPs will show an increase or decrease In conversion



This depends on the dynamics of the influent water

Case 4 – Full scale drinking water treatment plant in EU

- Nonetheless, BrO3 formation for the whole period of 270days



Case 4 – Full scale drinking water treatment plant in EU

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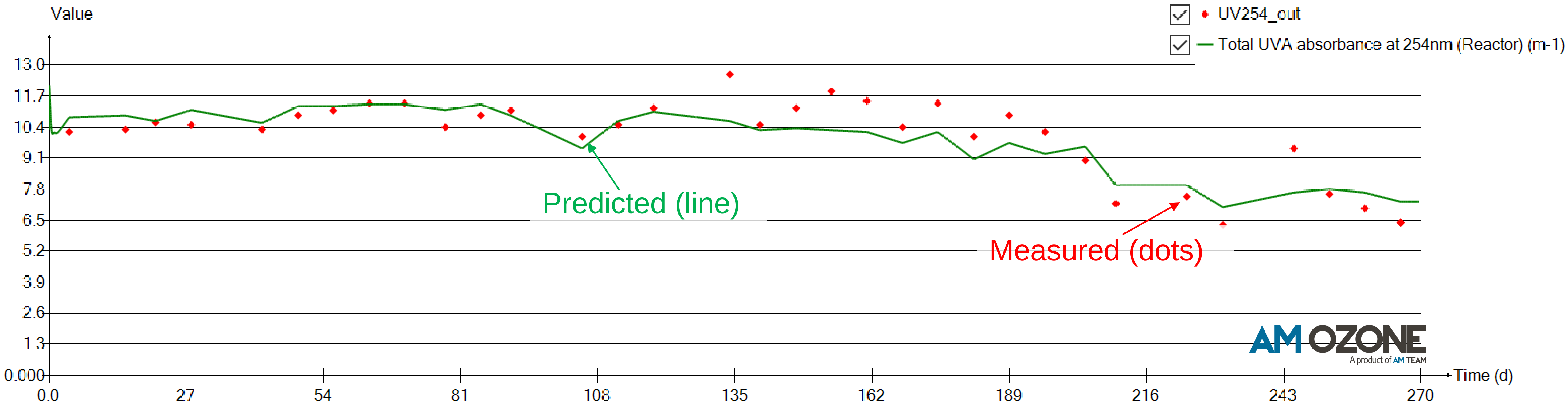
Advanced Modelling for process optimisation

- Effluent UVA254 sensor data and modelled data for all 270 days



Using a single parameter set calibrated on a plant in US treating secondary effluent