AMSTERDAM INTERNATIONAL WATER WEEK

Abstract Title	**Designing a full-scale ozonation plant with computational fluid dynamics and the Amozone kinetic model for micropollutants removal and minimal bromate in tertiary treatment**
Topic	X Improving water quality O Resilient water systems O Circular solutions: Reuse, Recover and Recycle O Transitions in water, agro/food and energy
Challenges and Solutions	Waterschap De Dommel (The Netherlands) is in the process of realizing a full-scale ozone installation at the WWTP of Hapert for demonstration purposes on the removal of organic micropollutants (OMPs). The applicability and efficacy of ozonation is specific of the water matrix, which is dependent of the geography and the human activities contributing to that wastewater. In this view, the selection of a reactor design is of crucial importance to properly operate an ozone installation. For these reasons, the Amozone kinetic model was used to support already at the feasibility stage (virtual piloting), and now with the bouwteam as a decision support to help minimize design assumptions for this ozone installation.
Author(s), highlight corresponding author	1. Giacomo Bellandi1, AM-TEAM, Ghent, Belgium 2. Roberta Muoio, AM-TEAM, Ghent, Belgium 3. Ruud Schemen, Waterschap De Dommel, Boxtel, The Netherlands 4. Peter van Horne, Waterschap De Dommel, Boxtel, The Netherlands 5. Tiza Spit, Witteveen+Bos, Deventer, The Netherlands 6. Coen de Jong, Witteveen+Bos, Deventer, The Netherlands 7. Eric Buunk, Witteveen+Bos, Deventer, The Netherlands 8. Roel de Lepper, Nijhuis Water Technology B.V., Doetinchem, The Netherlands 9. Rob van der Vleugel, Nijhuis Water Technology B.V., Doetinchem, The

	Netherlands 10. Pieter Vlasschaert, AM-TEAM, Ghent, Belgium 11. Wim Audenaert, AM-TEAM, Ghent, Belgium
Abstract	The removal of organic micropollutants (OMPs) prior to discharge into the receiving water bodies is globally becoming of crucial importance. The Netherlands is currently investigating with water authorities the feasibility to remove at least 70% of 7 out of 11 guide OOMPs. For the applicability of ozonation, this needs to be achieved with minimal bromate (BrO_3^-) formation (<1µg/L yearly average). In this framework, the water authority De Dommel (WSDD), in close collaboration with the bouwteam (WSDD, AM-team and CLCWater (combination of ADS, Witteveen+Bos, Moekotte, Nijhuis en Pannekoek)), is in the process of realizing a full-scale ozone installation at the waste water treatment plant (WWTP) of Hapert. In order to optimize and in-silico test design changes, Computational Fluid Dynamics (CFD) was used integrated with the kinetic Amozone model. Several simulations were run to minimize assumptions on design criteria to assure optimal performances of the installation at different flow conditions. This work reports the main results comparing different designs and ozone injection strategies. For this water matrix, considering the reactor geometry, the ozone generator, and gas diffusers specifications, the co-current configuration performed the best for both maximum OMPs removal and minimal BrO_3^- formation. The combination of traditional design philosophies with the added CFD-Amozone framework offers new ways for novel treatment concept design. Injecting the ozone in different chambers via diffusers is a common dosing strategy that allows to minimize local ozone concentrations in the liquid and reduce bromate formation while providing sufficient oxidant exposure to remove OMPs. However, investigating the hydraulic behaviour of a reactor's design can reveal potential short-circuiting that increase the risk of BrO_3^- formation. After each injection chamber, organics are consumed further and ozone concentration in the liquid persist longer. In the last injection chamber, where organics oxidation has already advanced, ozone residuals are higher than the rest of the installation in all designs. Specific differences in baffles design and diffusers placement can result in more availability of ozone residuals, which increases the likelihood of BrO_3^- formation and should therefore be minimized. This was investigated with using

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<td>the combination with CFD and Amozone kinetic model.

For the same ozone dose on this specific water matrix, the counter-current design presented the highest residual concentrations in the last injection chamber (Figure 1, left). This was caused by an extended recirculation (dead-zone) present in the last injection chamber. The co-current design had lower local ozone concentrations and better ozone distribution (Figure 2, right).

The co-current design presented a higher benzotriazole and venlafaxine removal as a result of to the better hydrodynamics (Figure 2). This was also visible from ese results are in line with the water residence time simulation results (not shown). This proves that the better flow distribution in the co-current design helps avoiding shortcuts to the outlet and improving the OMPs exposure to the oxidants.</td>
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<td>Figures/diagrams/illustrations</td>
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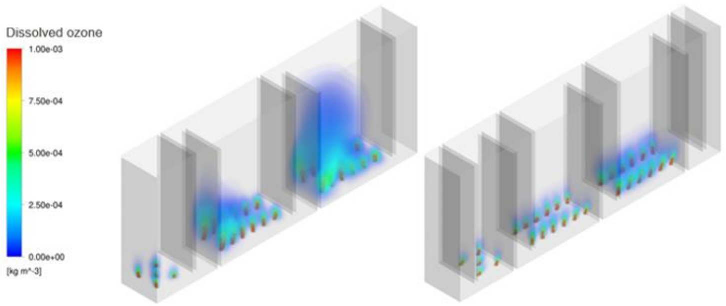

Figure 1. Volume rendering of dissolved ozone concentration, comparison of counter-current (left) and co-current (right) designs.

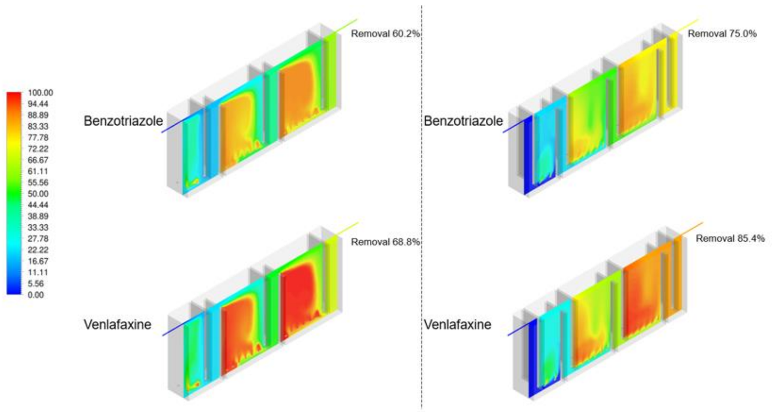

Figure 2. Relative OMPs removal for benzotriazole (top) and venlafaxine (bottom) to compare the counter-current (left) with the co-current (right) designs.

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