Ozone & GAC: Maximizing Synergistic Effects for Micropollutant Removal in Wastewater

British Water Micropollutant Conference 2024

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Ozone & GAC: Maxmizing Synergistic Effects for Micropollutant Removal in Wastewater

AGENDA

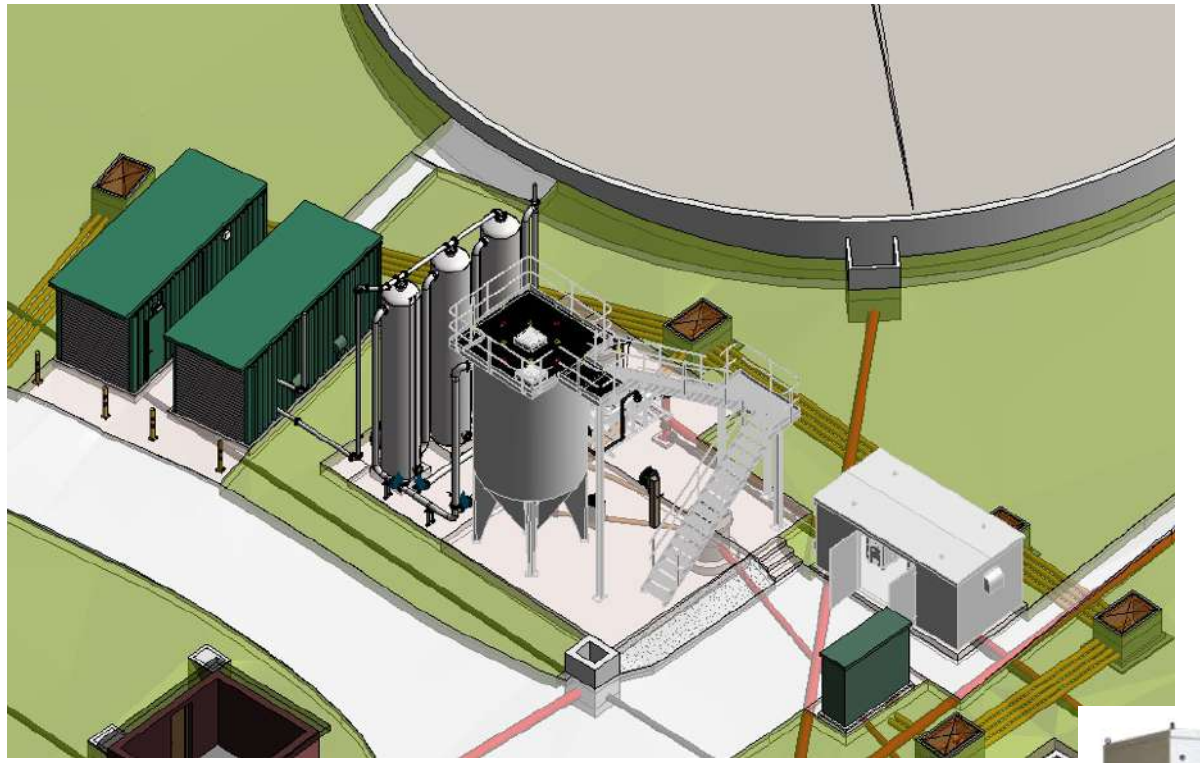
What we will cover today:

- Veolia / Ozonia / Curio Introduction
- Comparison of Ozone “versus” AC
- Example of the Combination
- Summary of the synergistic Effects
- Questions

Who are we?
Ozone Technology Support in the UK

VEOLIA	Global leader of ecological transformation providing solutions for energy, waste and water
Veolia Water Technologies & Solutions	Technology provider for water and process solutions for the ecological transformation
VEOLIA Ozonia®	The Veolia brand for disinfection & purification solutions using ozone and UV
curio®	Ozonia's partner in the UK with engineering, execution and service capabilities

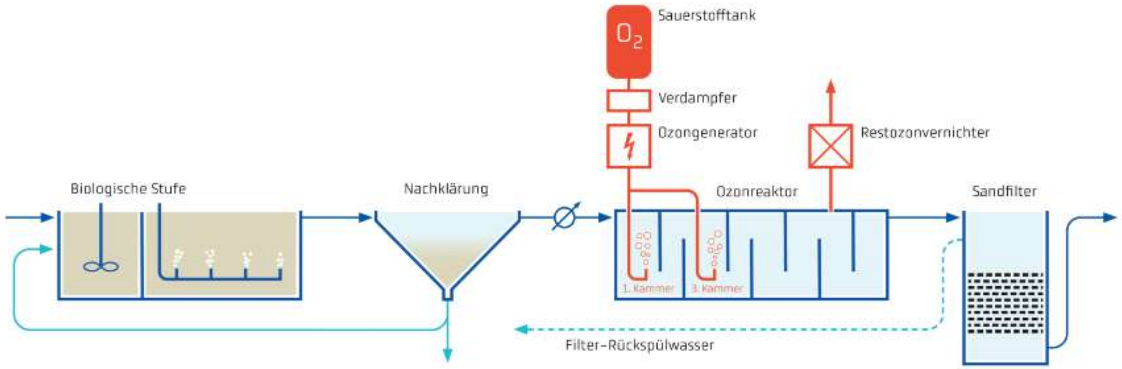
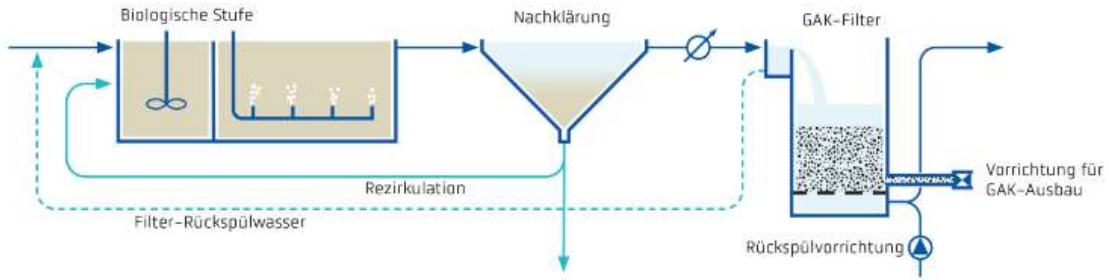
Veolia – Ozonia - Curio
First Micropollutant Removal Systems in the UK



Bathing Rivers Project	
Sites	Ludlow – 504 m³/h Itchen Bank – 414 m³/h Frankton – 70 m³/h
Micropollutant Removal Goal	80% reduction in - 1H-benzatriazole - Carbemazepine - Diclofenac - Ibuprofen - Propanolol
Curio Package	Containerized system with O3 system, process control, O3 dosing and O3 destruction

Ozonia CFS ozone generator inside

Comparison Ozone “versus” GAC
Process Overview

Ozone Treatment	GAC Treatment
Oxidative step	Adsorptive step
	
Requires - Ozone generation equipment (oxygen source and generator) - Ozone contact chamber - Downstream BAF	Requires - Multiple GAC filters - Access for removal/regeneration of GAC

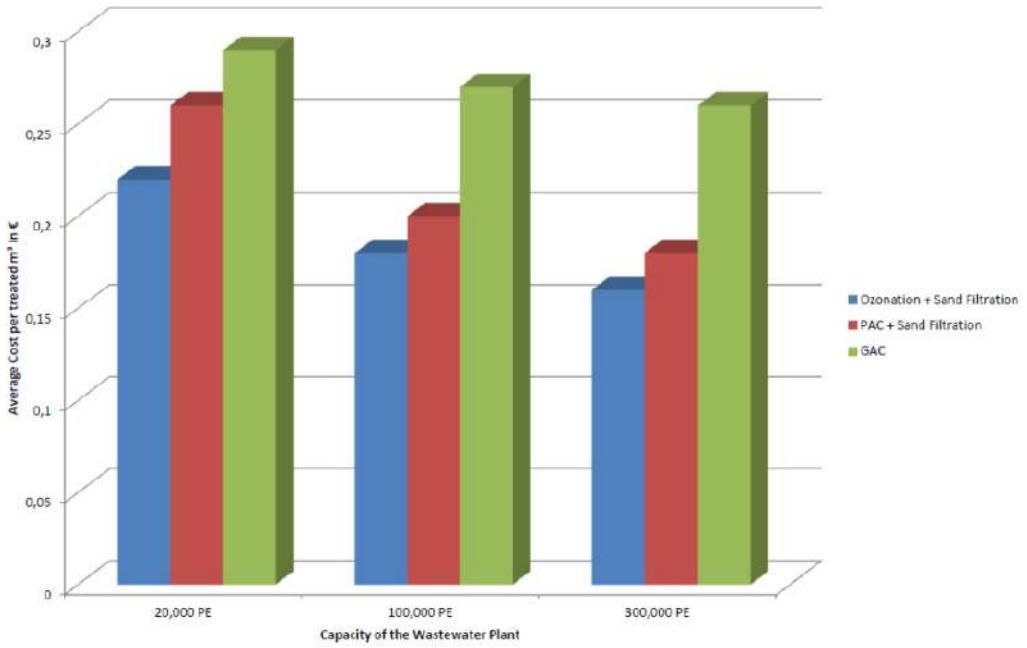
Source: https://micropoll.ch/verfahren/ozon/ozon-verfahrensfuehrung/

Comparison Ozone “versus” GAC
Process Details

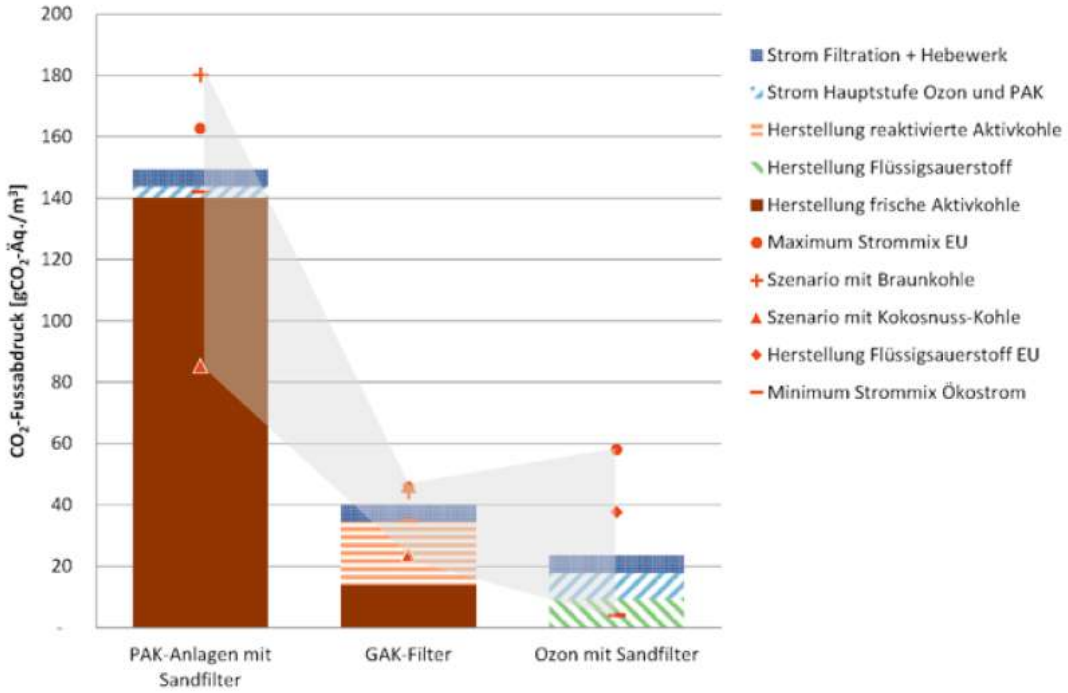
Ozone Treatment	GAC Treatment
Typical ozone dose ~ 0.5 g O3 / g DOC	Typical filter velocity 4-7 m/h @ 1.5-2.5 m filter height
Typical HRT ~ 10-15 min for peak flow	Typical Empty Bed Contact Time (EBCT) ~ 20 min for peak flow
OPEX: - Electrical power for O3 generation - Oxygen (LOX) or electrical power for oxygen generation (PSA)	OPEX: - Regeneration of GAC (after 20,000 – 30,000 bed voluminal)
Advantages: - Very effective against hydrophilic micropollutants - O3 dose adjustment possible	Advantage: - Very effective against hydrophobic micropollutants

Source: https://micropoll.ch/verfahren/ozon/ozon-verfahrensfuehrung/

Comparison Ozone “versus” GAC
TOTEX and Carbon Footprint

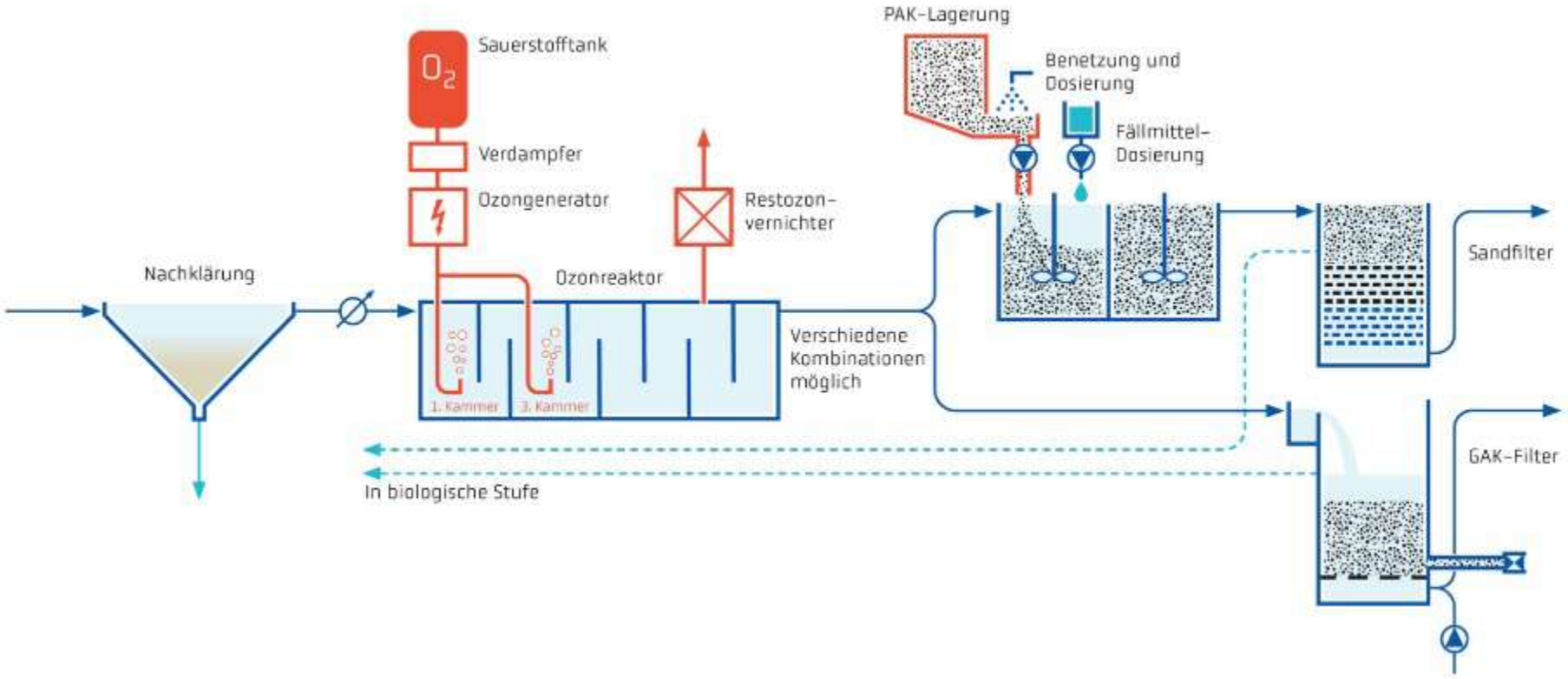


Mulder, M. et al. (2015) Costs of Removal of Micropollutants from Effluents of Municipal Wastewater Treatment Plants - General Cost Estimates for the Netherlands based on Implemented Full Scale Post Treatments of Effluents of Wastewater Treatment Plants in Germany and Switzerland.
STOWA and Waterboard the Dommel, The Netherlands



Meier Al.. et al. (2020) Klimafreundlich Gewässer schützen – CO2-Fussabdruck verkleinern bei der Elimination organischer Spurenstoffe auf Kläranlagen
Aqua & Gas nr. 2 2020, pages 26-35

Ozone plus GAC
Process Schematic

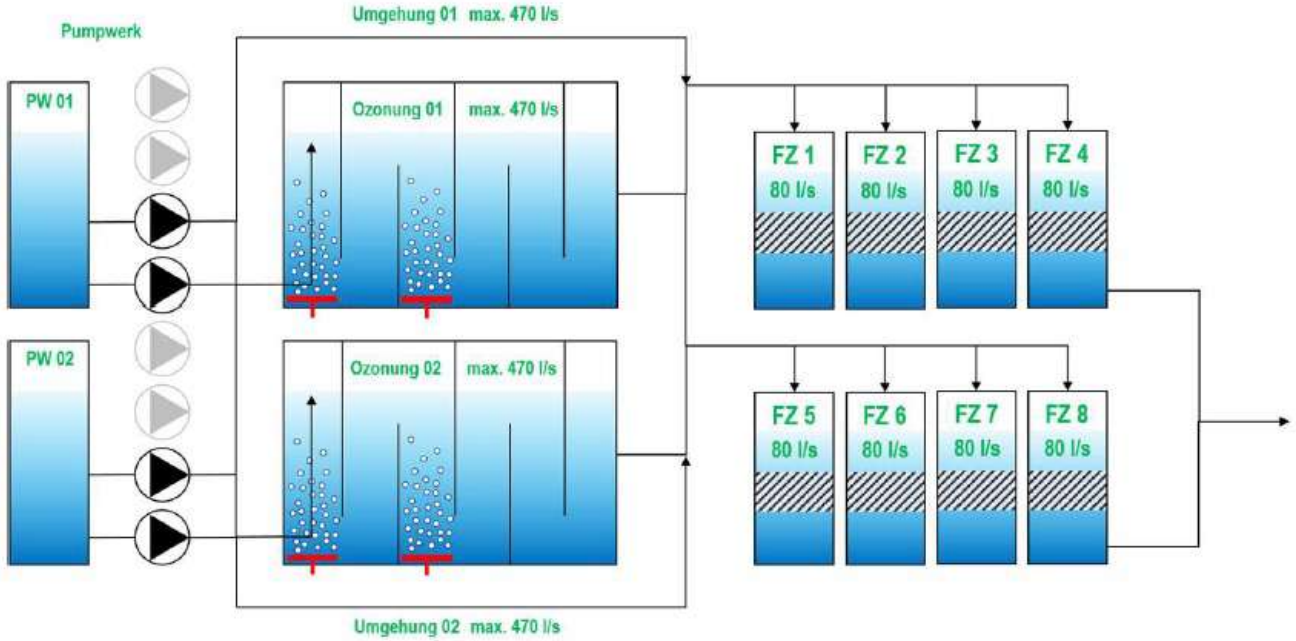


Source: https://micropoll.ch/verfahren/ozon/ozon-verfahrensfuehrung/

Ozone plus GAC
Example: ARA Altenrhein, Switzerland

Design Data	
Population equivalent	120,000
Flow Dry weather Max. flow	 221 l/s = 796 m³/h 1,000 l/s = 3,600 m³/h
Pre-treatment	Mechanical Biological Filtration
Treatment goal	80% removal of “Swiss” indicator substances for micropollutant
O3 + GAC operational	Since 2019

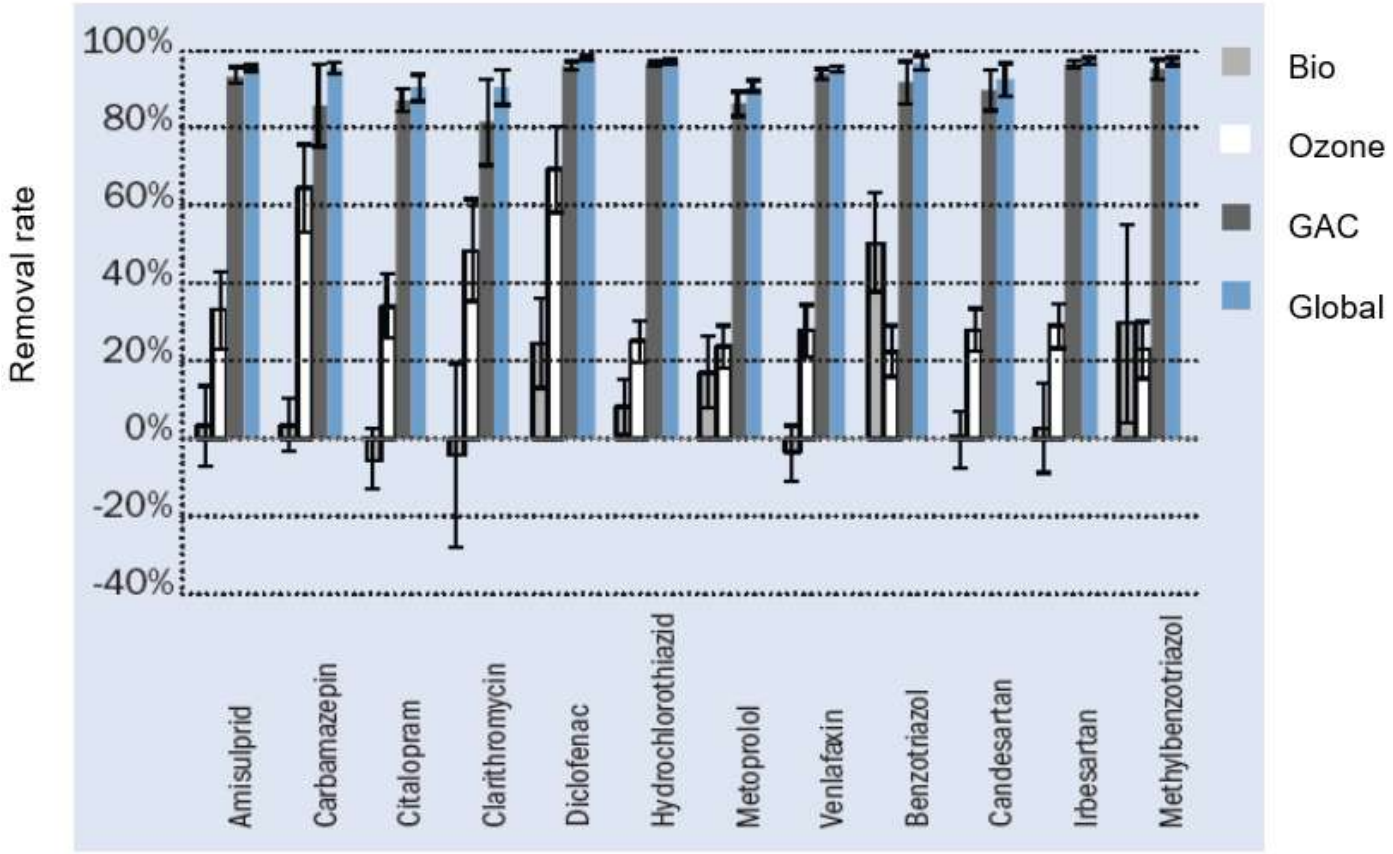
ARA Altenrhein
Detailed Process Information



Design Data	
Max. flow for O3	470 l/s = 1,692 m³/h
Max. O3 dose rate	3.0 g O3 / m³
Spec. O3 dose rate	Initially 0.3 g O3 / g DOC Now 0.1 g O3 / d DOC
Max. O3 capacity	5.6 kg/h
HRT @ Qmax	15 min (1 reactor)
Ozone reactor	2 x 365 m³ @ 6 m depth
GAC filters	8 (7 duty, 1 stand-by)
Max. filter velocity	5.85 m/h
GAC height	1.5 m (47 m² per filter)
EBCT	15 – 40 min

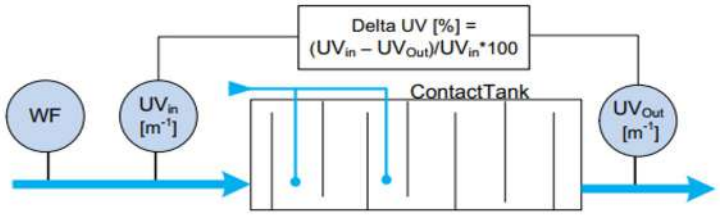
ARA Altenrhein
Results

Average Removal Rates in 2020: 95%!



2021: 91% removal
2022: 88% removal

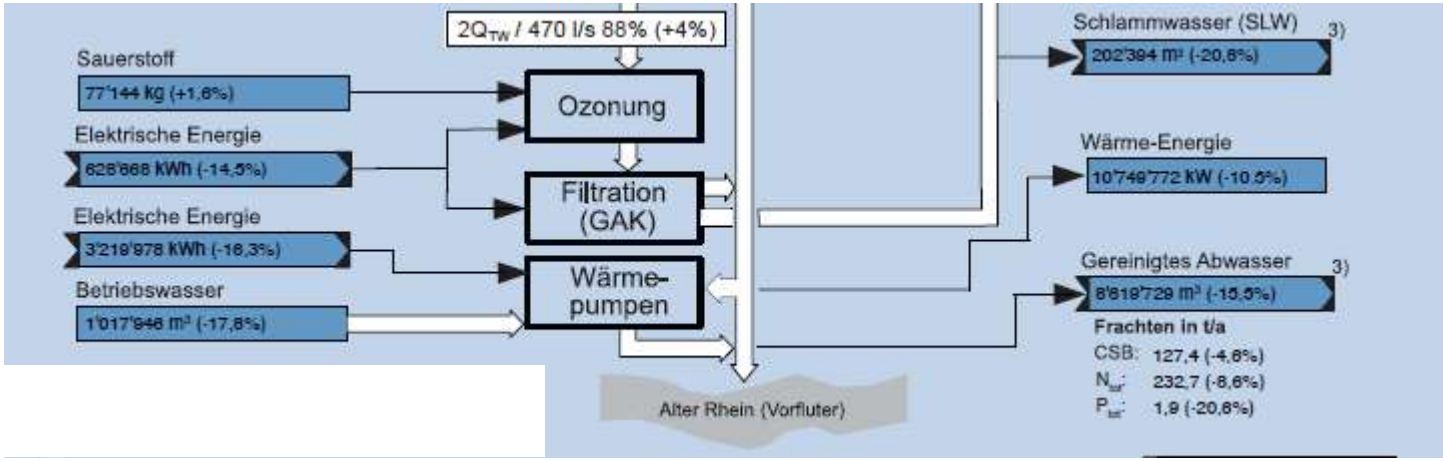
Process optimization due to Delta UV control:



=> O3 dose ~ 0.1 g O3 / g DOC

ARA Altenrhein
Costs & Benefits

Costs 2022:



Electrical consumption: 0.073 kWh/m³
LOX consumption: 0.009 kg/m³

for 88% micropollutant removal

Big Benefit:

Extension of GAC lifetime!

Initially expected lifetime ~3 years
Now > 6 years!

Ozone & GAC
Conclusions

1. Ozone and GAC are often seen as “either or”
2. Due to different reactions, they each address different micropollutants species better than the other
3. A combination O3+GAC leads to a much more resilient process
4. A combination of O3+GAC allows a reduction in O3 dose (savings in CAPEX and OPEX)
5. A combination of O3+GAC allows for an extension of GAC life (savings in OPEX)

=> A logical choice for a longterm vision of micropollutant removal

Ozonia* Plant of the Month

Ara Neugut, Switzerland

First Swiss wastewater plant with a micropollutant removal step selects Ozonia ozone!

Overview

Plant Capacity:	150,000 population equivalents
Flow Rates:	90-660 l/s (2-15 MGD)
Production Capacity:	11 kg O_3/h total (~580 ppd)
Treatment Goal:	micropollutant removal
Scope of Supply:	2 Ozonia CFV-5 Generators
	2 Ozone destruct units IK-40

Performance

The ozone amount is controlled by a ΔUVA measurement. The ozone concentration is on average 6%. Subject to water and diffusor quality, the specific ozone dose is ~0.38 to 0.42 g O_3/g DOC Neugut removes 82% ± 2% of the specified micropollutants constant basis.

*Trademark of Veolia; may be registered in one or more countries.

Ozonia* Plant of the Month

ARA Morgental, Switzerland

Since January 2022, the combined wastewater flows of ARA Hofen and ARA Morgental are treated with ozone followed by a filtration step in order to remove > 80% of the micropollutants regulated by the Swiss discharge requirements.

Overview

Wastewater flow rate:	max. 900 l/s (20.6 MGD)
Ozone capacity:	30.3 kg ozone per hour total liquid oxygen
Ozone generator:	two Ozonia M-20 generators
Treatment goal:	micropollutant removal

Performance

The equipment is sized to provide a max 15.9 mg/l of ozone at a max dry weather flow rate of 533 l/s. The variable dose rate is controlled by Delta UV – difference in UV absorption pre and post the ozone step – in a broad

Equipment and instrumentation to implement the use of Delta UV ozone dosage control

The treated effluent is discharged directly into Lake Constance

Logo and aerial view with the kind permission of ARA Morgental

© by Eliquo Stulz

Ozonia ozone generators M12

Source: https://um.baden-wuerttemberg.de/de/presse-service/presse/pressemitteilung/pid/spatenstich-fuer-neue-reinigungsstufe-der-klaeranlage-in-tuebingen

Ozone destruct units DTCV-200

MANY THANKS!

For more solutions, please visit:

https://www.watertechnologies.com/lp-ozonia-featured-plants

Ozonia* Plant of the Month

Nykvarnsverket WWTP, LinkÖping (Sweden)

Following a pilot study in 2014, Tekniska verken i Linkoeping AB implemented the ozone system for micropollutant removal in 2017. The ozone contact chamber with a radial diffusor is located after the activated sludge process and prior to MBBR reactors for nitrification & denitrification.

Overview

Plant capacity:	3,000 m³/h (19.1 MGD)
Ozone capacity:	max. 20 kg ozone per hour total (1,060 ppd)
Ozone generator:	Ozonia CFV30

Performance

A variety of tests were conducted to determine the best performance at lowest operating costs (details can be found at CWPharma website). To obtain average 80% reduction of selected micropollutants, a required specific ozone dose of 0.55 mg ozone/mg DOC, N corr was determined. The OPEX of the treated water is ~ 0.013 €/m³.

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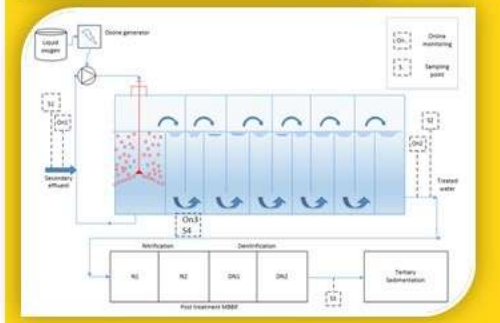

Source: "Retrofitting ozonation into existing plants" by Robert Sehlén, 2019

Tuebingen Sewage Treatment Plant, Germany

The federal state of Baden-Wuerttemberg is actively supporting the installation of a 4th wastewater treatment step to remove micropollutants. In 2021, the largest ozone installation in the state for this application was successfully commissioned. For the treatment plant at Tuebingen, Eliquo Stulz combined the Ozonia ozone system with downstream sand filtration ensuring that the river Neckar receives an effluent with drastically reduced traces of medicines, hormones, and other chemicals.

Overview

Flow rate:	max. 2,880 m³/h (18.3 MGD)
Ozone capacity:	20 kg ozone per hour total
Ozone generator:	two Ozonia generators (2 x M12)
Treatment goal:	micropollutant removal, disinfection

Performance

Ozone is produced from liquid oxygen (LOX) at a concentration of 9.5% by weight. Dome diffusors are used to bring the ozone in contact with the effluent water at an adjustable dose between 0.7 – 7.0 g/m³. Any residual ozone in the off-gas from the contact chambers is safely converted back into oxygen with two ozone destructors type DTCV-200.

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