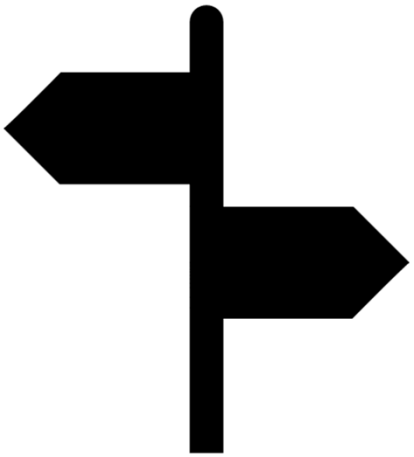
WWTP Houten HDSR 9 November 2023

Full scale implementation of ozone at WWTP Houten HDSR - Marlies Verhoeven

Hotspot analysis 2017



- 4 WWTPs HDSR on top of the list: Woerden, Nieuwegein, Utrecht en Houten
- WWTP Zeist – rebuilding the WWTP for extra removal of nitrogen for KRW purposes in 2027, also including removal of micropollutants (for KRW)
- Use the financial contribution of the Ministry Infrastructure & Water Management for removal of medicines in the period of 2019-2027

Start with WWTP Houten (2018)

- Limited experience in the Netherlands with technologies for removal of micropollutants/medicines on full scale WWTPs
- Learning while implementing on one of the smaller WWTPs of HDSR
- No extra demands for nitrogen of phospherus on this WWTP (at that time)
- The effluent of the WWTP is discharged on the Amsterdam Rijnkanaal (ARK) and influences the quality of a source for drinking water in the Lekkanaal

Design WWTP:

72.000 ie

RWA: 2850 m3/h

DWA: 580 m3/h

WWTP Houten – ARK – Lekkanaal – source for drinking water

Choice for ozone technology (2018)

- Multi criteria analysis:
- Energy use
- Operational flexibility
- Safety
- 70% removal
- Costs operational and investment
- Experience in the Netherlands
- Reducing biotoxicity of effluent
- Reliability
- CO2 footprint
- Bromate and other transformation products
- etcetera

Costs ozone installation

- Building costs ozone installation €3.360.000,-
- Operational costs:

Costs	€
Maintenance	€50.000,-
Electricity	€40.000,-
Staff	€10.000,-
Oxygen	€35.000,-
Rental oxygen storage tank	€7.800,-
Total operational costs	€142.800,-

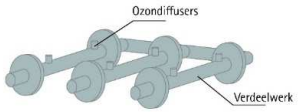
- Building time september 2021 to july 2022 – about 10 months
- Delay due to the custum prescription bromate on ARK from RWS
- Delay due to a Legionella contamination on the WWTP
- In operation since march 2023

The ozone installation at WWTP Houten

Legenda

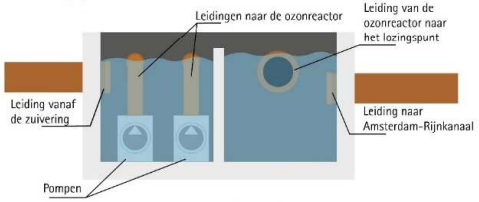
1. Zuurstoftank
2. Ozongenerator
3. Ozonreactor
4. Pompput

Ozonelementen



Via deze leidingen wordt de ozon aan het water toegevoegd. Op de leidingen zitten ozonelementen die de ozon door de ozonreactor verspreid.

De Pompput



De pompput pompt het gezuiverde water (effluent) vanuit de rioolwaterzuivering de ozoninstallatie in. Door de overstortdrempel stroomt het overtollige regenwater direct naar het lozingspunt.

HOOGHEEMRAADSCHAP DE STICHTSE RIJNLANDEN

Start ozone installation march 2023

- Start with 0,4 g ozone/g DOC
- Bromate must remain lower than 5 micrograms/liter in the effluent (custom prescription of RWS for discharge on ARK), surface water <1 micrograms/liter
- Online measurement DOC incoming and outgoing flow of the ozone reactor
- Measuring incoming flow (50 tot 870 m3/h = 1,5 x dry weather flow = 80% of total flow)
- Production and dosing of ozone based on flow and DOC
- Ozone is dosed with diffusers in three parts of the reactor, where the waterflow goes down
- Six parts in the reactor, 200 m3, remaining time in the reactor 20 min during dry weather conditions and 14 minutes during rain weather conditions
- Discharge on the ARK of total effluent (mixed with untreated effluent during rain weather condintions)

Measurements ozone WWTP Houten

- bromate effluent WWTP weekly
- micropollutants/medicines monthly over 3 days during dry weather conditions – day 1 and 2 influent of WWTP and day 2 en 3 effluent settling tanks and effluent WWTP
- DOC and bromide effluent weekly in the lab of Aquon
- online DOC ingoing and outgoing flow of the ozone reactor
- bio-assays planned in oktober 2023 – ER Calux, PAH Calux, Cytotox Calux, Microtox, P53 Calux with metabole S9, P53 Calux without metabole S9, PXR Calux

(First) results ozone WWTP Houten

Bromaat	<0,2 or <0,1 (change of detection limit), one measurement above detection limit 0,11	micrograms per liter	custom prescription RWS < 5 micrograms/l
Bromide	0,080 (average)	milligrams per liter	0,03 - 0,11 mg/l
Micropollutants removal (best 7 of 11 gidsstoffen – STOWA method 2021-15)	80 (average)	% removal WWTP+ozone	75 – 88% (6 measurements may to october 2023)
Bio assays	No results available		

Micropollutants / medicines (1)

Micropollutant	Average removal% WWTP+ozone	Average removal% biological proces	Average removal% ozone installation
Benzotriazool (11+EU)	66	33	44
Amilsulpride (EU)	59	14	43
Amoxicilline	<detection limit		
Azitromycine	72	46	50
Candesartan (EU)	58	20	48
Carbamazepine (11+EU)	75	18	69 ★
Ciprofloxacine	93 ★	92 ★	29
Citolopram (EU)	62	30	46
Clarythromycine (EU)	<detection limit		41
Clotrimazol	<detection limit		29

Micropollutants / medicines (2)

Micropollutant	Average removal% WWTP+ozone	Average removal% biological proces	Average removal% ozone installation
Diclofenac (11+EU)	86 ★	29	78 ★
Erytromycine	<detection limit		
Flicozanol	<detection limit		19
Furosemide	89 ★	42	78 ★
Gabapentine (11+EU)	90 ★	67 ★	46
Guanylureum	<detection limit		4
Hydrochloorthiazide (11+EU)	61	33	38
Iboprofen	99 ★	82 ★	88 ★
Ibesartan (11+EU)	60	22	48
Metformine	97 ★	39	21

Micropollutants / medicines (3)

Micropollutant	Average removal% WWTP+ozone	Average removal% biological proces	Average removal% ozone installation
Metropolol (11+EU)	52	36	16
Miconazol	<detection limit		58
Oxypurinol	42	23	23
Propranolol	89 ★	68 ★	70 ★
Som 4-5 methyl benzotriazool (11+EU)	47	13	37
Sotalol (11)	83 ★	44	71 ★
Sulfamethoxazol	93 ★	67 ★	65
Trimethroprim (11)	92 ★	79 ★	72 ★
Venlafaxine (11+EU)	60	25	43

Thank you for your attention!

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Ministry of Infrastructure and Water Management

Tackling Micropollutants in Wastewater
Results of the Dutch Innovation and Implementation Program

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