Overview on full-scale ozonation plants in Germany and Switzerland

(and some words on activated carbon)

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„Ozonation on municipal wastewater treatment plants“

Head of process innovation

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Overview

- DWA and it´s working groups on advanced wastewater treatment
- Legal status in Germany/Switzerland
- Overview on ozone and activated carbon options
- Summary on ozonation demonstration in D/CH
- Full-scale ozonation plants

DWA working group on advanced wastewater treatment

Chairman: Prof. M. Barjenbruch (TU Berlin)

KA 8.1: Anthropogenic micropollutants in the water cycle

KA 8.2: Wastewater treatment with coagulation and precipitation

KA 8.3: Wastewater filtration

KA 8.5: Ozonation on municipal wastewater treatment plants

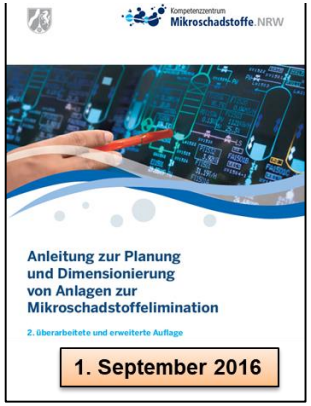
KA 8.6: Activated carbon application on municipal WWTPs

Collection and distribution of knowledge

In Germany, two centres of competence for micropollutants exist:

Kompetenzzentrum Mikroschadstoffe.NRW

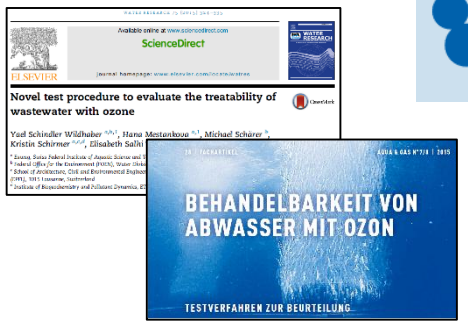
KOMS KOMPETENZZENTRUM SPURENSTOFFE-BW



Kom.NRW

In Switzerland, the VSA* operate the platform “micropoll”

VSA



*Verband Schweizer Abwasser- und Gewässerschutzfachleute

https://www.micropoll.ch/aktuell/

Legal background Germany

- In Germany there are currently no binding legal obligations, all WWTP upgrades are done voluntary
  (driving forces: public funds, water source protection, …)
- Ongoing MULTI-STAKEHOLDER DIALOGUE ON THE TRACE SUBSTANCE STRATEGY OF THE GERMAN FEDERAL GOVERNMENT
  - www.dialog-spurenstoffstrategie.de
  - Results expected end 2019/early 2020
  - Policy paper available in English:

  - https://www.bmu.de/fileadmin/Daten_BMU/Download_PDF/Binnengewaesser/spurenstoffstrategie_policy_paper_en_bf.pdf

Legal background Switzerland

- In Switzerland, legal frameworks exist along with a list of substances, which need to be eliminated at the whole WWTP by an average of 80% compared to raw sewage
- Selection of WWTPs for upgrade based on size (>80,000 PE, river or 24,000 PE, near lakes) or share of secondary effluent in the receiving river (> 10 %)

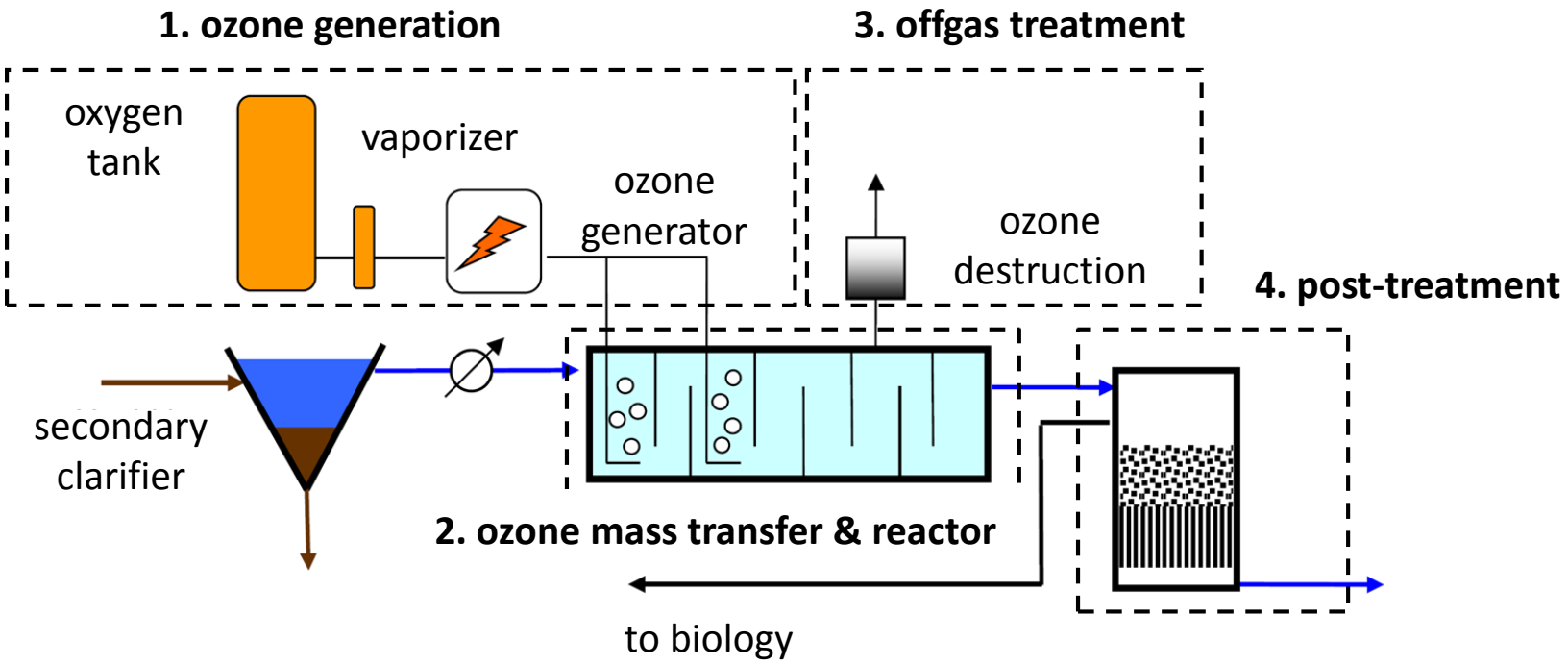
Kategorie	Name	k_{O3} [M^{-1} s^{-1}]	k_{OH} [10^9 M^{-1} s^{-1}]
1	Amisulprid		
1	Carbamazepin	$3x10^5$	8,8
1	Citalopram		
1	Clarithromycin	$4x10^4$ (pH7) $9.6x10^5$ (pH8.5)	~5
1	Diclofenac	$3x10^6$	7,5
1	Hydrochlorothiazid		
1	Metoprolol	2000 (pH7) $5.1x10^4$ (pH8.5)	7,3
1	Venlafaxin	8500 (pH7) $1.5x10^5$ (pH8.5)	~10

Kategorie	Name	k_{O3} [M^{-1} s^{-1}]	k_{OH} [10^9 M^{-1} s^{-1}]
2	Benzotriazol	240 (pH7) 2300 (pH8.5)	7,6
2	Candesartan		
2	Irbesartan		
2	4-Methylbenzotriazol 5-Methylbenzotriazol	780 (pH7) $1.1x10^4$ (pH8.5)	8,6

Short version of rules:

- minimum of 6 substances
- C_0 at WWTP influent > 10*LOQ
- 2 : 1 selection rule
- calculate average

Schematic overview of ozonation stage at municipal WWTPs



Session/WG 1: Planning and design of ozonation plants
Session/WG 2: Operation and control of ozonation plants
Session/WG 3: Ozonation post-treatment

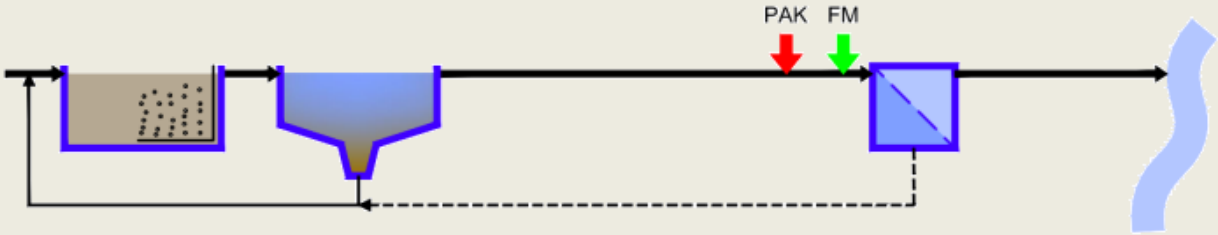
Figure based on:
Abegglen, C. und H. Siegrist, Mikroverunreinigungen aus kommunalem Abwasser. Verfahren zur weitergehenden Elimination auf Kläranlagen. 2012, Bundesamt für Umwelt (BAFU): Bern.

Processes with powdered activated carbon

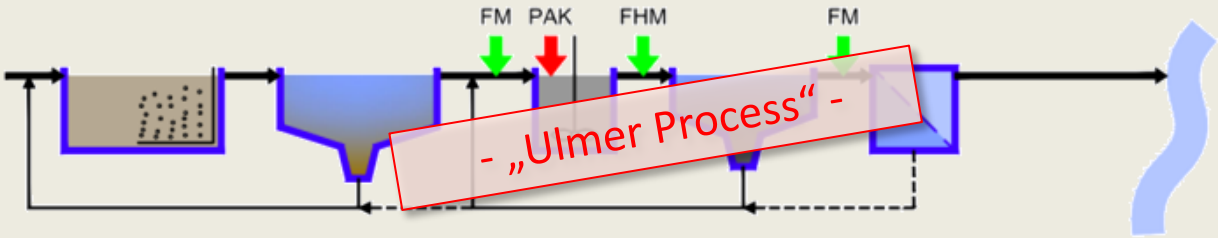
„Simultaneous dosage “

PAC-Dosage in aeration tank

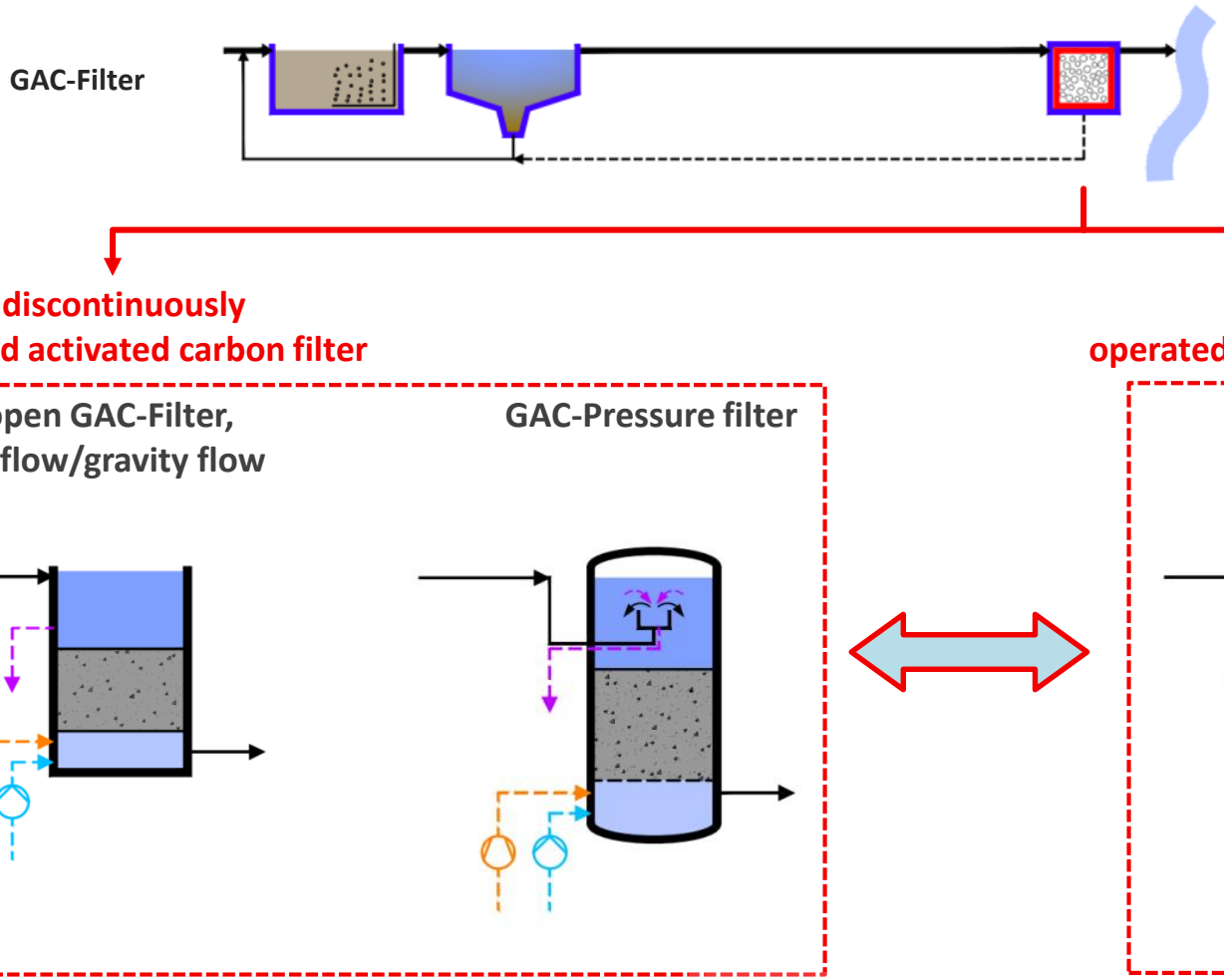
PAC-Dosage before filter



PAC-Dosage in a separate adsorption Stage



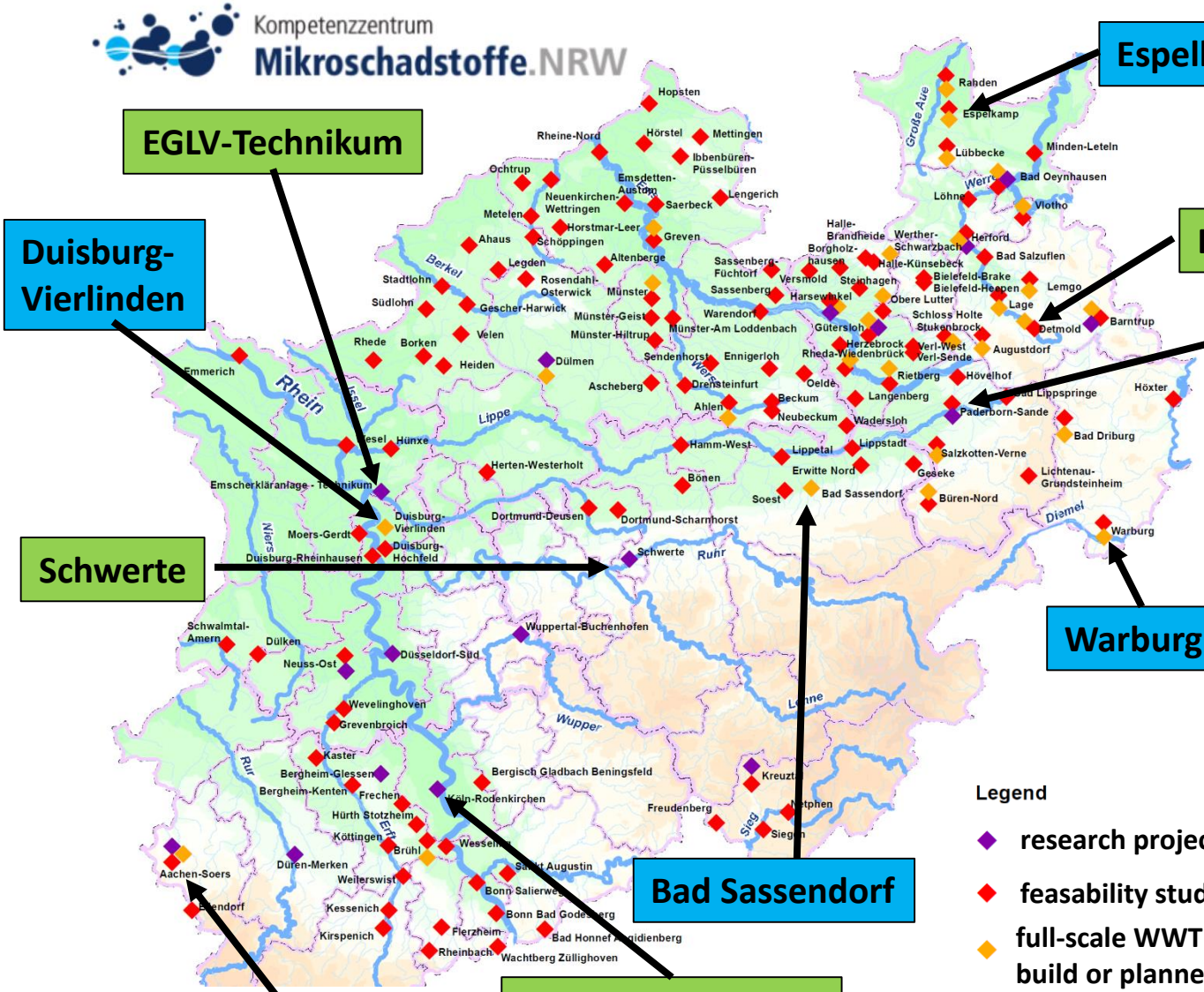
Processes with granular activated carbon



Ozonation plants in North Rhine-Westphalia

Kompetenzzentrum Mikroschadstoffe.NRW

DWA Klare Konzepte. Saubere Umwelt.



Anzahl kommunaler Kläranlagen in NRW

Bemessung EW [E]	Anzahl der Anlagen in NRW	Anschlussgröße [E]	Ausbaugröße [E]
< 10.000	227	653.831	856.655
10.001-100.000	314	9.129.647	11.694.252
> 100.000	69	17.096.923	22.186.988
Gesamt	610	26.880.401	34.737.895

Mikroschadstoffentfernung in kommunalen Kläranlagen in NRW

Ausbaugröße EW [E]	Großtechnische Untersuchung	Machbarkeitsstudie/ technisches Konzept	Kläranlagenausbau (inkl. Anlagen in Planung bzw. im Bau)
<10.000	1	2	1
10.001 - 100.000	6	90	21
> 100.000	10	34	8
Gesamt	17	126	30

Stand: 05/2018

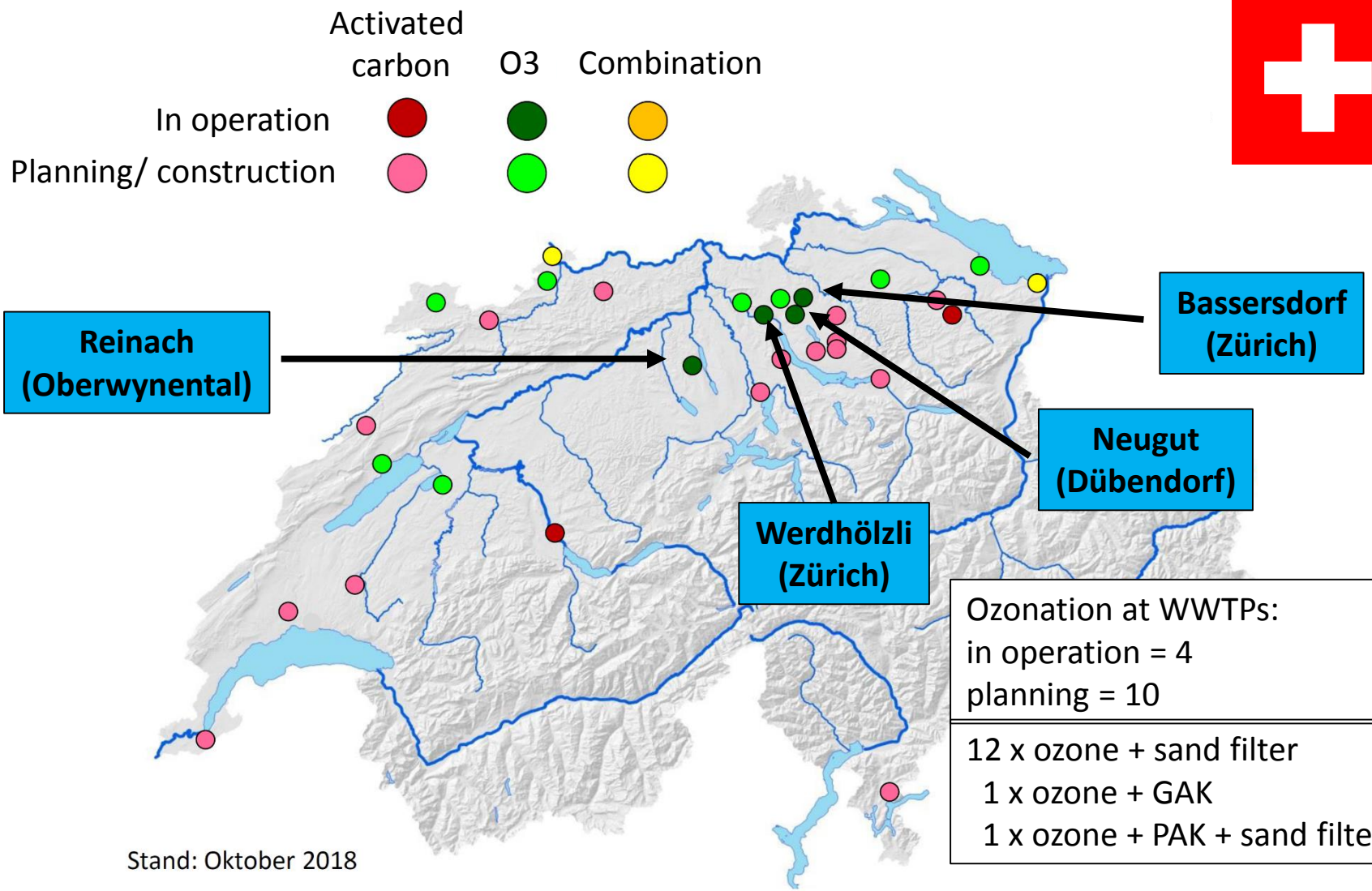
Legend

- research projects at full-scale plants
- feasability studies
- full-scale WWTP upgrade (ozone, PAK or GAK; build or planned)

Ozonation in operation

Current/former research

Micropollutant elimination at WWTPs in Switzerland



Ozonation at WWTPs:
in operation = 4
planning = 10

12 x ozone + sand filter
1 x ozone + GAK
1 x ozone + PAK + sand filter

Quelle: VSA-Plattform «Verfahrenstechnik Mikroverunreinigungen»

WWTPs with full-scale ozonation

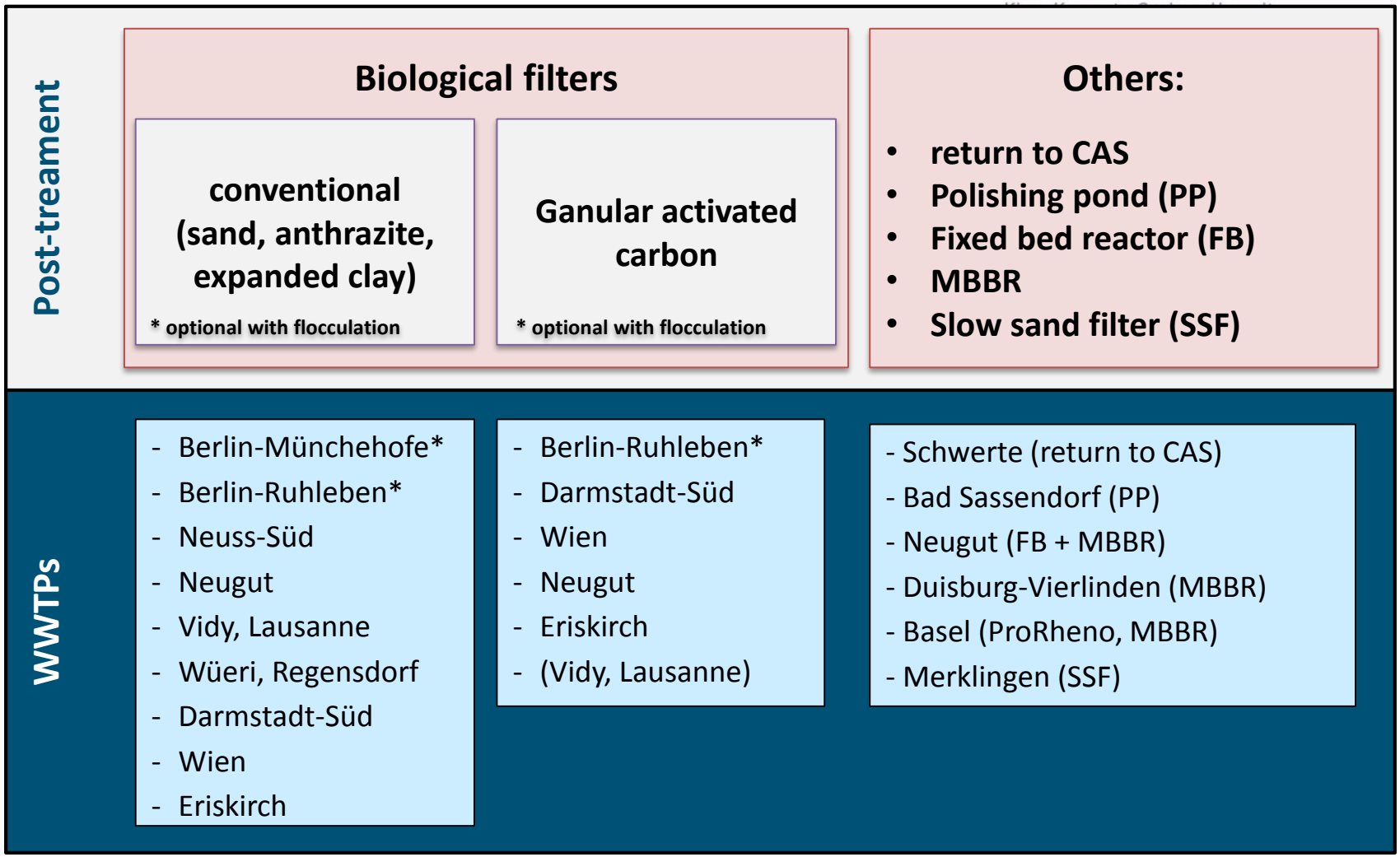
	design capacity [1000 PE]	Start of operation	D_{DOC} [$mgO_3/mgDOC$]	treatment capacity	O_2	Ozone-injection	reactor depth [m]	reactor type	HRT [min]	Post-treatment
Aachen Soers*	458	2018								MBBR# + sand filter#
Bad Sassendorf*	13	2009								polishing pond#
Duisburg-Vierlinden*	30	2011								MBBR
Espelkamp	33	2017								polishing pond#
Lemgo	98	Planned 2019								sand filter#
Schloß Holte-Stukenbrock	60	Planned 2018								polishing pond#
Warburg	70	2016								MBBR
Weißenburg in Bayern*	35	2017								sand filter / BAC
Altenrhein	> 75	2018								GAC
Neugut*	150	2014								sand filter#
Werdhölzli, Zürich	670	2017								sand filter#

See talk of M. Stapf in next session

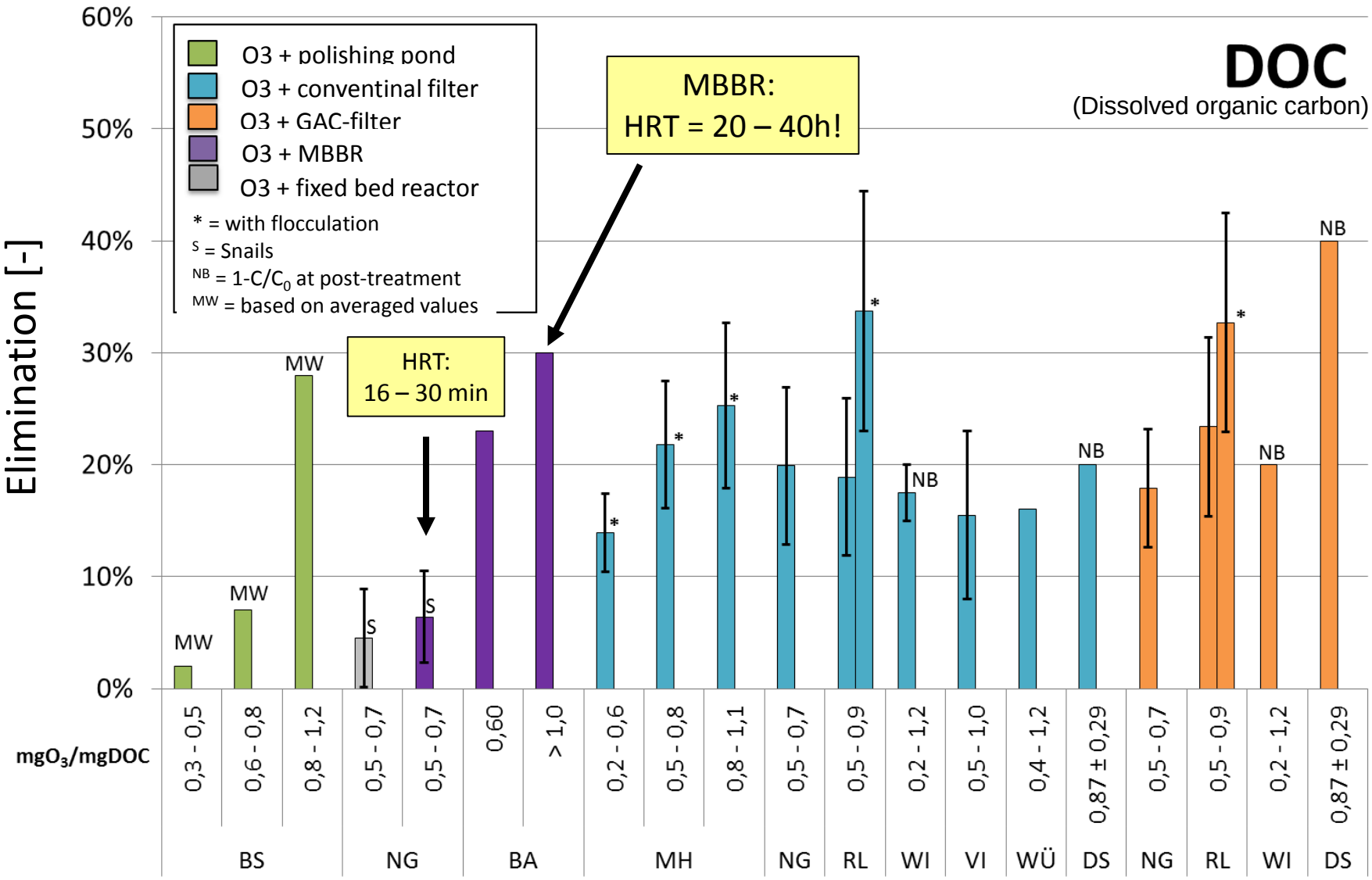
* sites with (former) research activity

allready existing

Evaluated ozonation post-treatments

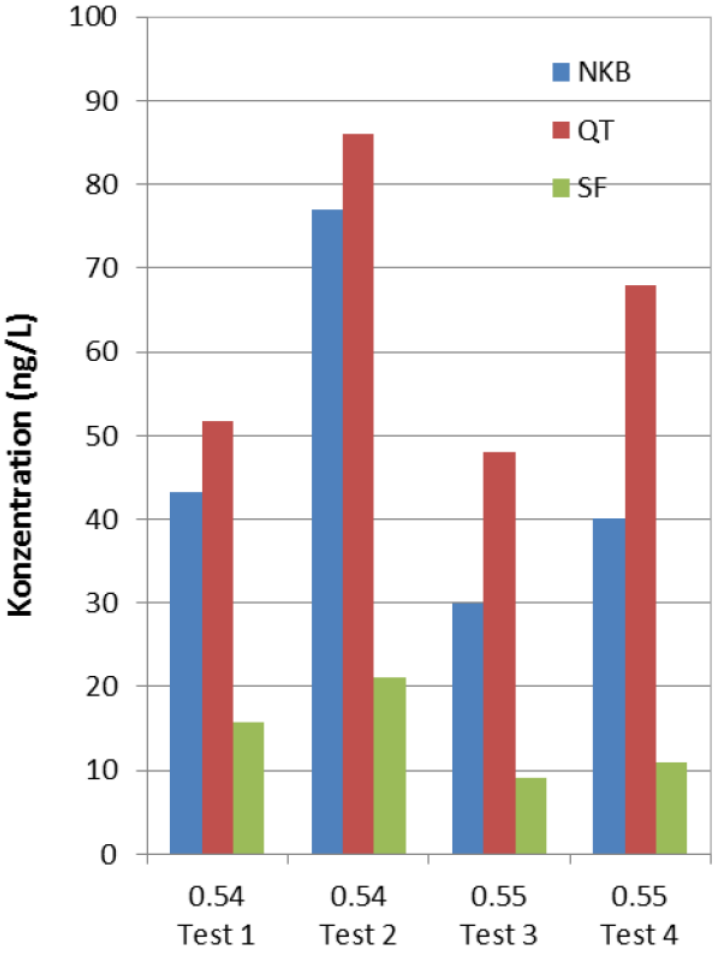


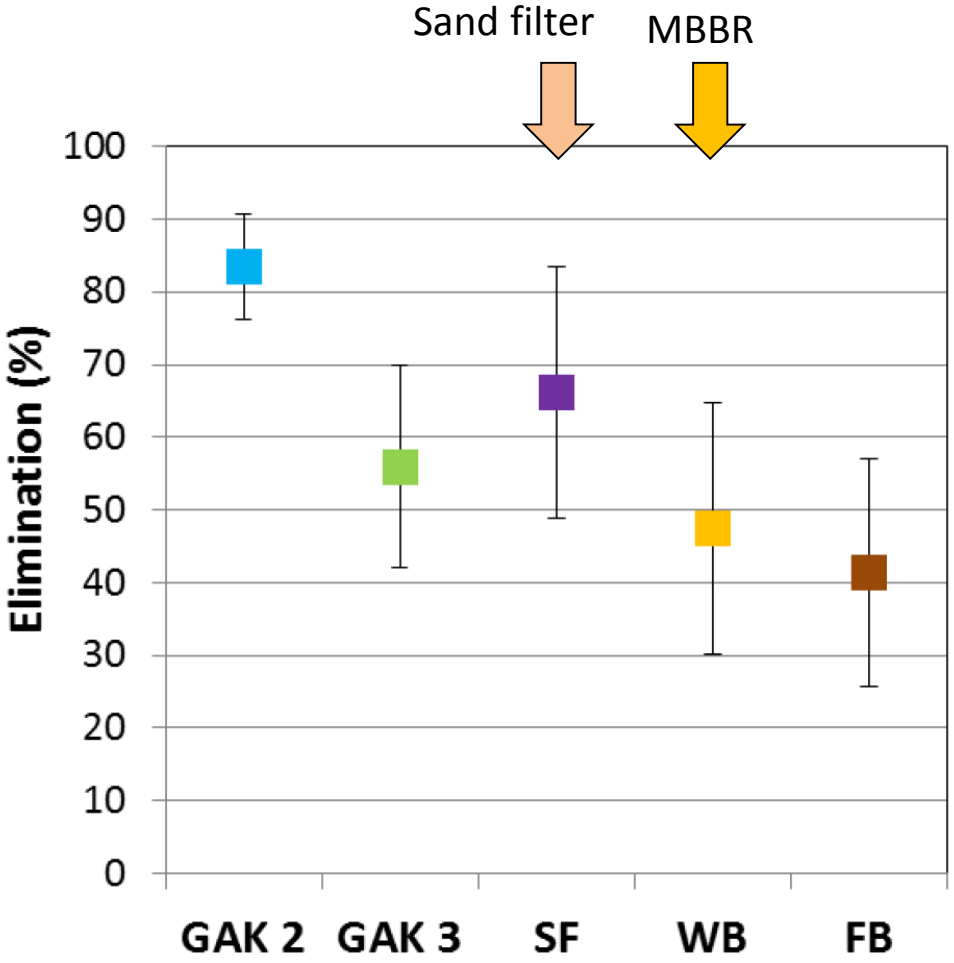
Ozonation and post-treamtent



Fate of NDMA at ozonation + post-treatment

NDMA = N-Nitrosodimethylamine





➔ results of project ReTREAT (EAWAG, Switzerland)

Summary

- Legal situation in CH/DE very different
- Activated carbon and ozonation are both options with several full-scale implementations
- Operational full-scale ozonation plants:
  - 7 in DE and 3 in CH
- Selection of post-treatment often determined by existing infrastructure
- Limited knowledge on ozone and MBBR in DE/CH

End of overview!

Literature

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