



O3-STEP Process

Improving the removal efficiency of micropollutants using a combination of ozonation and GAC filtration

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The O3-STEP filter: a promising concept for combined removal of micropollutants, nutrients and TSS

Addition of ozone to the 1-STEP® process leads to an extension of the activated carbon lifetime while obtaining >80% removal efficiency of the Dutch guide substances and maintaining the efficiency on nutrient removal (phosphorus and nitrogen). In addition the limited bromate formed during ozonation was removed by the activated carbon filter. This makes the O3-STEP concept a feasible technology for implementation on wastewater treatment plants.

	Unit	PACAS	Ozone + sand filtration	GAC	O3-STEP only micropollutants	O3-STEP including nutrients
CO ₂ -footprint	kg CO ₂ /treated m ³	122	128	325	162	210
CO ₂ -footprint	ton CO ₂ /year	2,198	1,953	3,009	2,132	2,390
Costs	EUR/m ³	0.05	0.17	0.26	0.15	0.17
Removal efficiency indicator substances	%	70-75	80-85	80-85	80*	80*

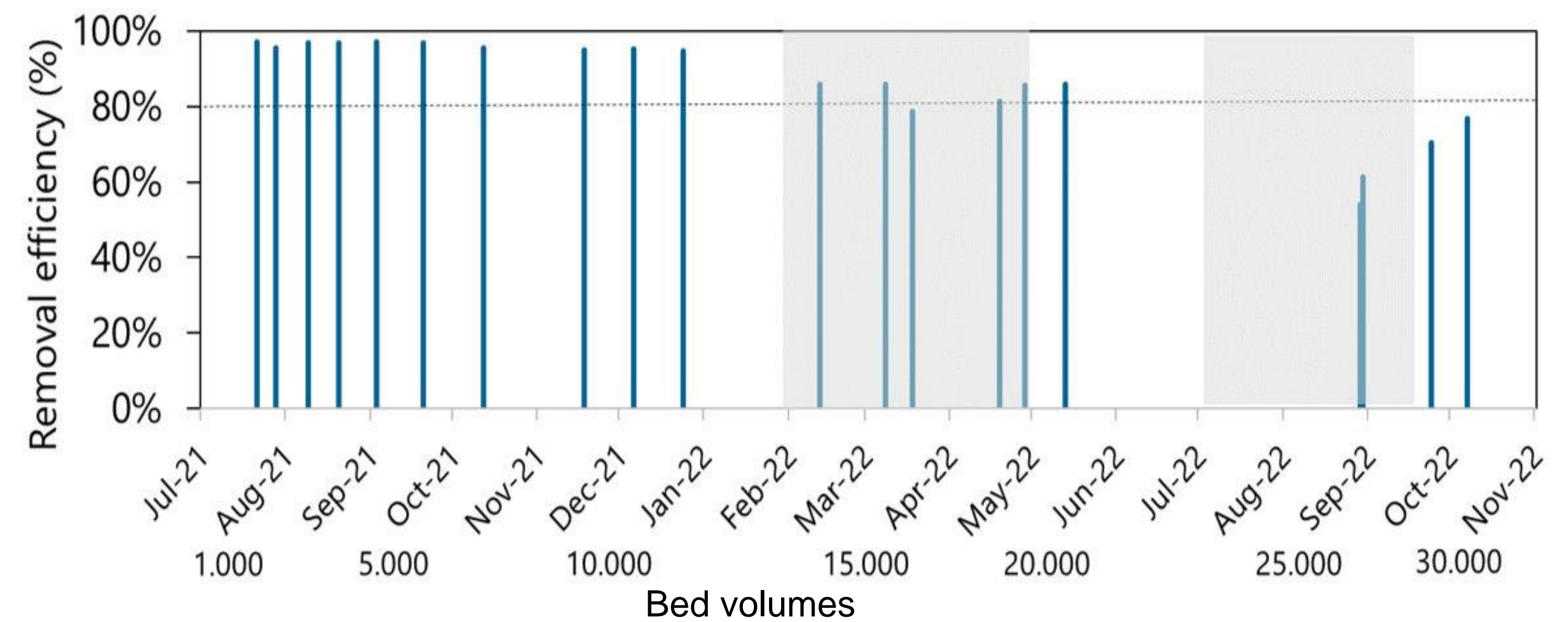
*Depending on the regeneration frequency of the GAC and the specific ozone dosage, a higher efficiency may be achieved, which will also affect costs and CO₂ footprint. Calculations in this report are based on an ozone dose of 0.4 g O₃/g DOC and 35,000 bed volumes.

From 1-STEP® to O3-STEP®

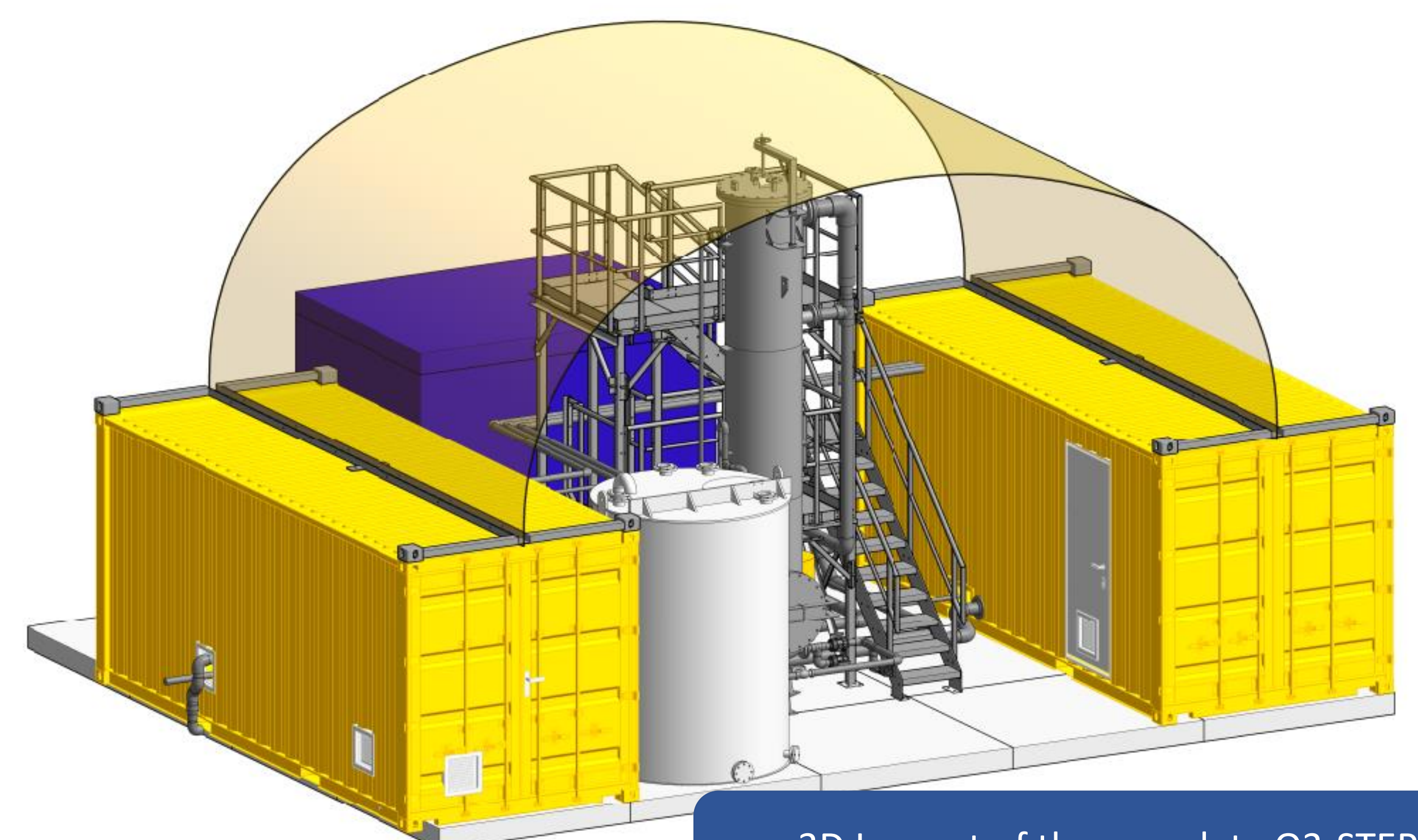
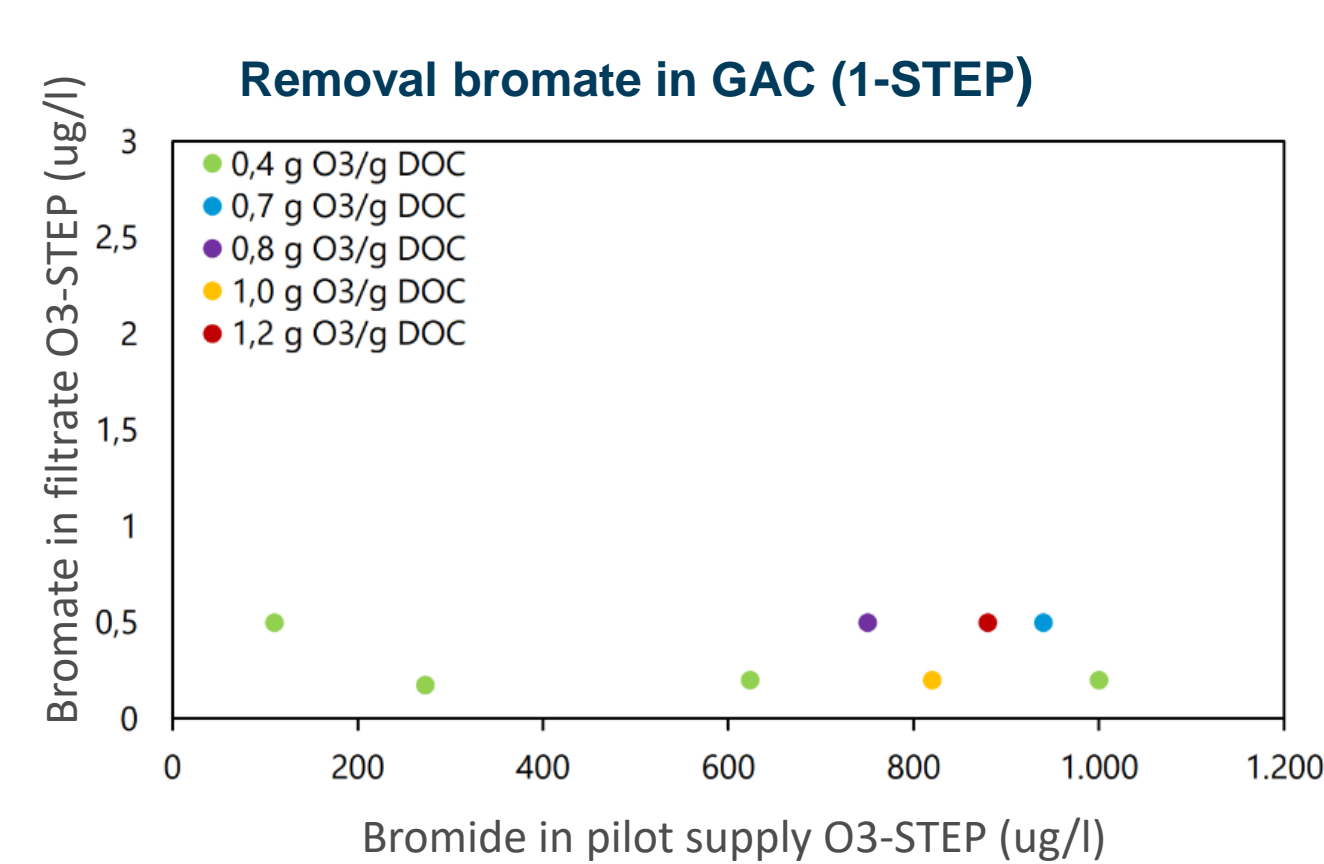
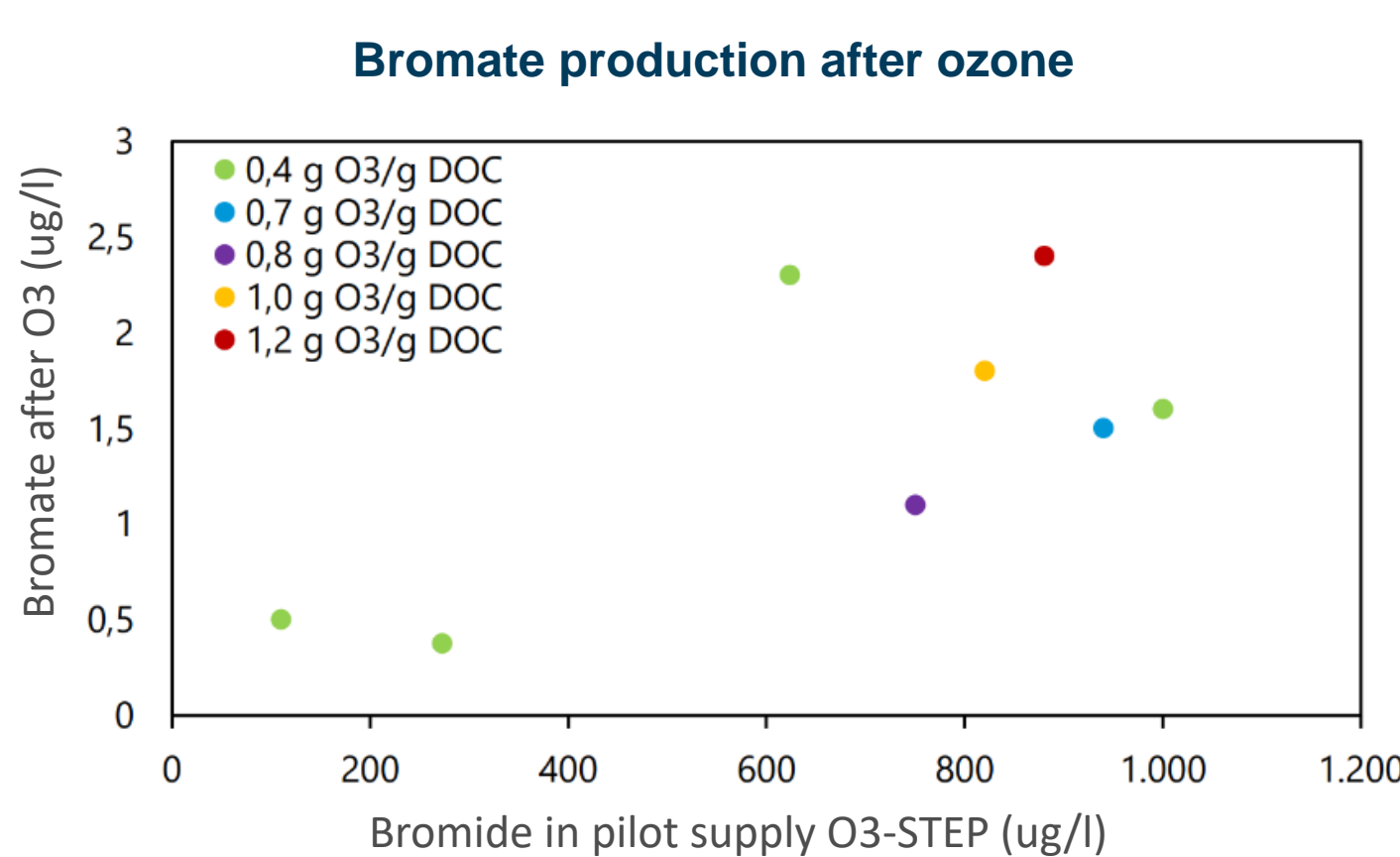


Addition of ozone results in degrading a wider range of the micropollutants present and extending the lifetime of the activated carbon considerably.

High removal efficiencies are reached throughout the complete lifetime of the pilot (grey blocks indicates lowered or no ozone injection)



Controlling Bromate using O3-STEP



3D Lay-out of the complete O3-STEP pilotplant, researched from July 2021 until October 2022

Pilot conclusions

The combination of ozone and activated carbon allows a higher and broader removal efficiency of micropollutants than each technique separately (by combining ozonation, coagulation, adsorption, biological degradation, filtration). Addition of ozone increased the lifetime (treated bedvolumes) of the 1-STEP filter significantly, reducing the total CO₂ footprint.

As can be seen in the figure, the removal efficiency of the system was over the desired 80% even when the zone injection was lowered or removed (grey blocks) due to mechanical failures.

Bromate levels were below the discharge limit after the O3-STEP of 1ug/L even with elevated ozone dosages.