

REMTECH Europe - Ferrara

Comparison of Different Approaches for the Removal of PFAS in Water

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Topics

- Background
- Remediation
- PerfluorAd Solution
- Results (sites)



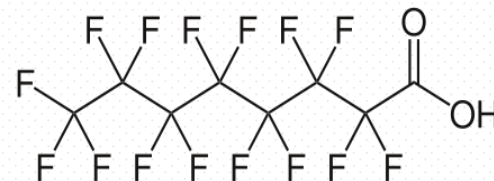
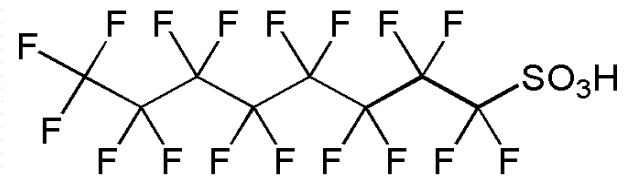
Background – Cornelsen & PFAS

- 2006 - first PFAS site in Germany
- pioneers in PFAS treatment
- identified behaviour of PFAS
- GW treatment up to 2000 gpm



Background - PFAS

- strong chemical connection of C and F
- all H replaced by F: = perfluorinated
- not all H replaced: = polyfluorinated
- Both together PFAS = per- & poly. alkyl substances



Issues in Remediation

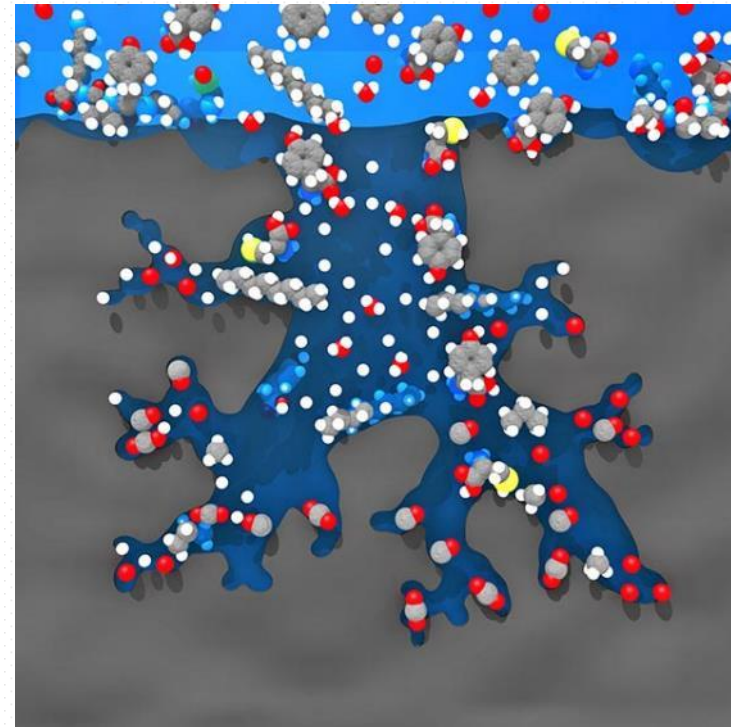
- remediation in soil and water difficult
- high stability (thermal, chemical)
- poor adsorption (GAC, extended plumes)
- no degradation (no in situ)
- a few in the list – large group (>6000)

12	Dodecyl			PFDoA
11	Undecyl			PFUnA
10	Decyl	PFDeS	8:2 FTS	PFDeA ^{1,2}
9	Nonyl	PFNoS		PFNoA ^{1,2}
8	Octyl	PFOS ^{1,2}	6:2 FTS ²	PFOA ^{1,2}
7	Heptyl	PFHpS ²		PFHpA ^{1,2}
6	Hexyl	PFHxS ^{1,2}	4:2 FTS	PFHxA ^{1,2}
5	Pentyl	PFPeS ²		PFPeA ^{1,2}
4	Butyl	PFBS ^{1,2}		PFBA ^{1,2}

Remediation - GAC



Cornelsen – first PFAS site 2006



Normal carbon – re-agglomerated carbon – coconut carbon

Remediation – GAC

- low adsorption rate (0.01%)
- at long residence time (large)
- water chemistry (Fe, particles)
- presence of contaminants/DOC
- carbon changes/disposal
- competition on carbon bed



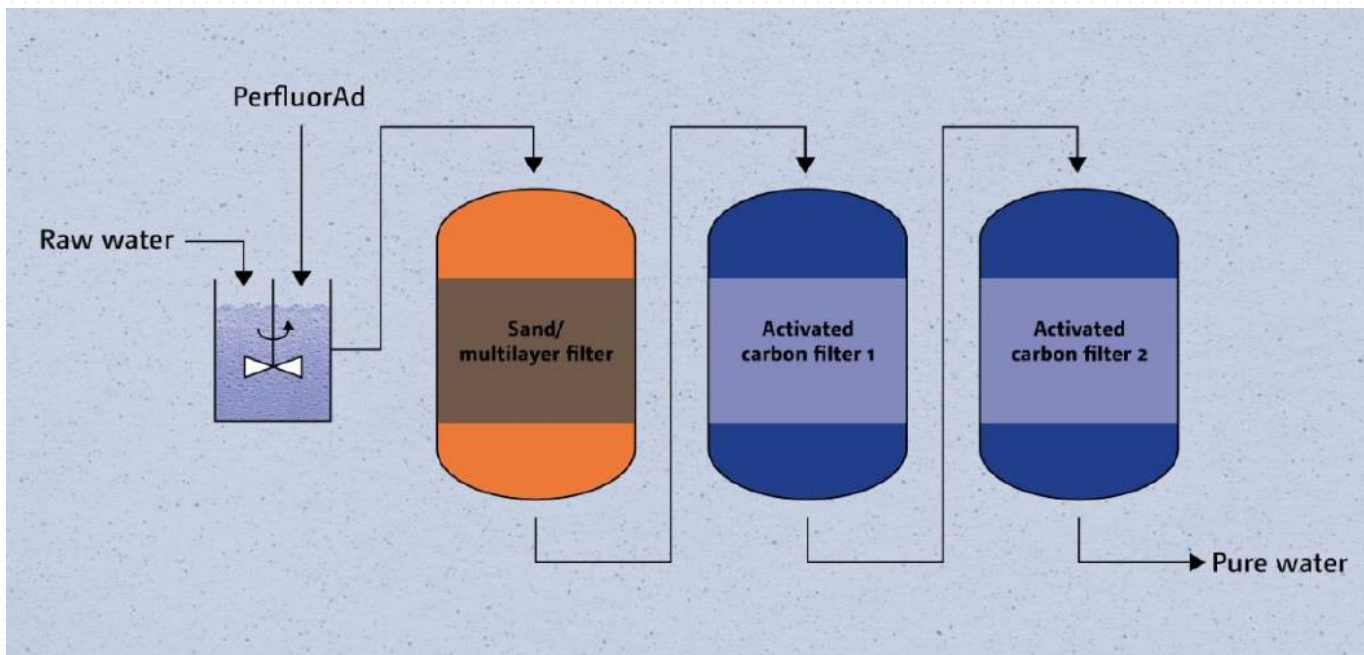
Tool Box - PerfluorAd

- active liquid ingredient
- developed by Cornelsen
- density slightly less than water
- dosed to the water
- no health or safety risk
- bio-degradable

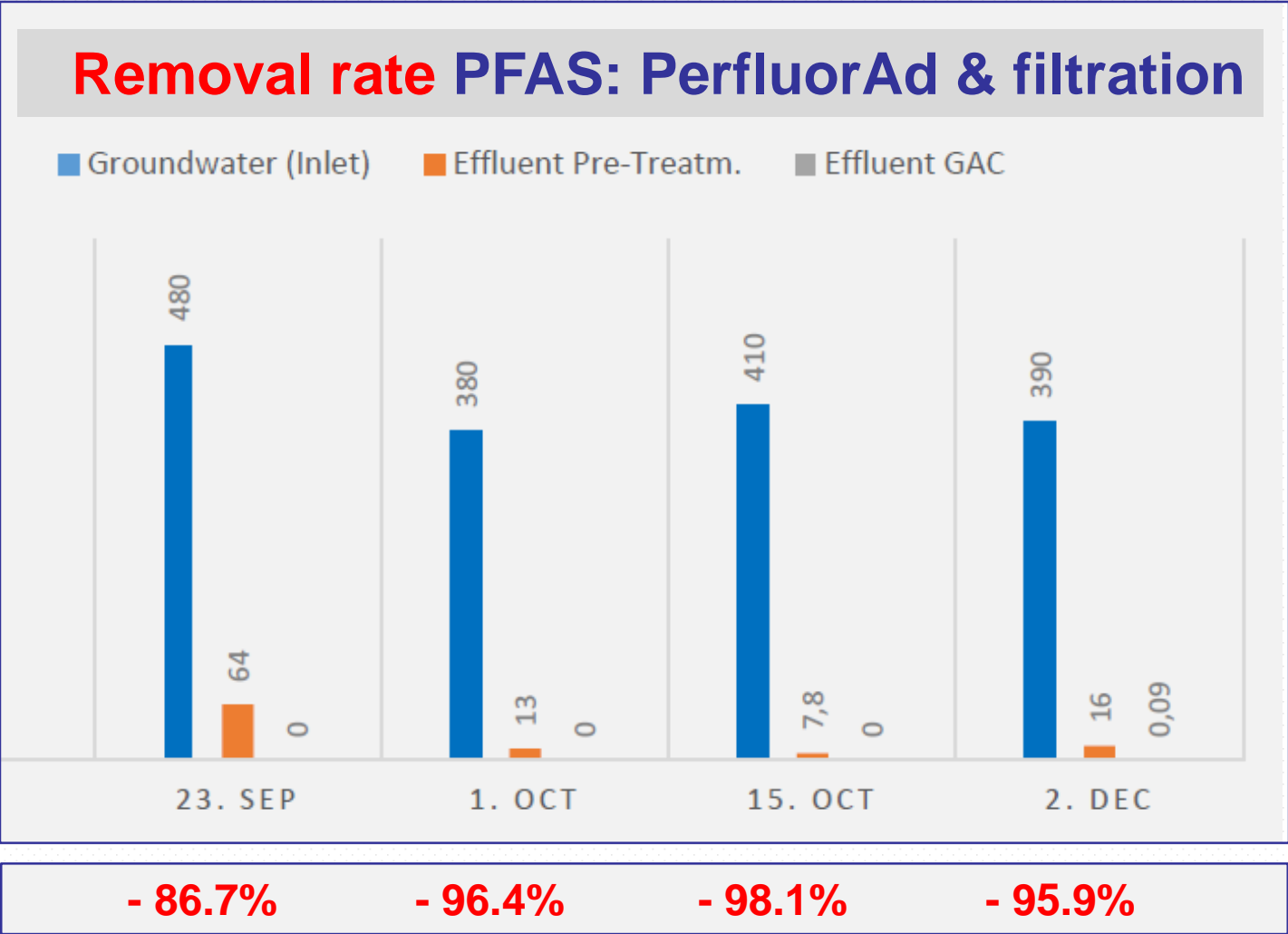


Tool Box - PerfluorAd

- pre-treatment module (to GAC)
- PerfluorAd + PFAS generate particles
- key to success: filtration
- removes majority of the PFAS (up to 99%)

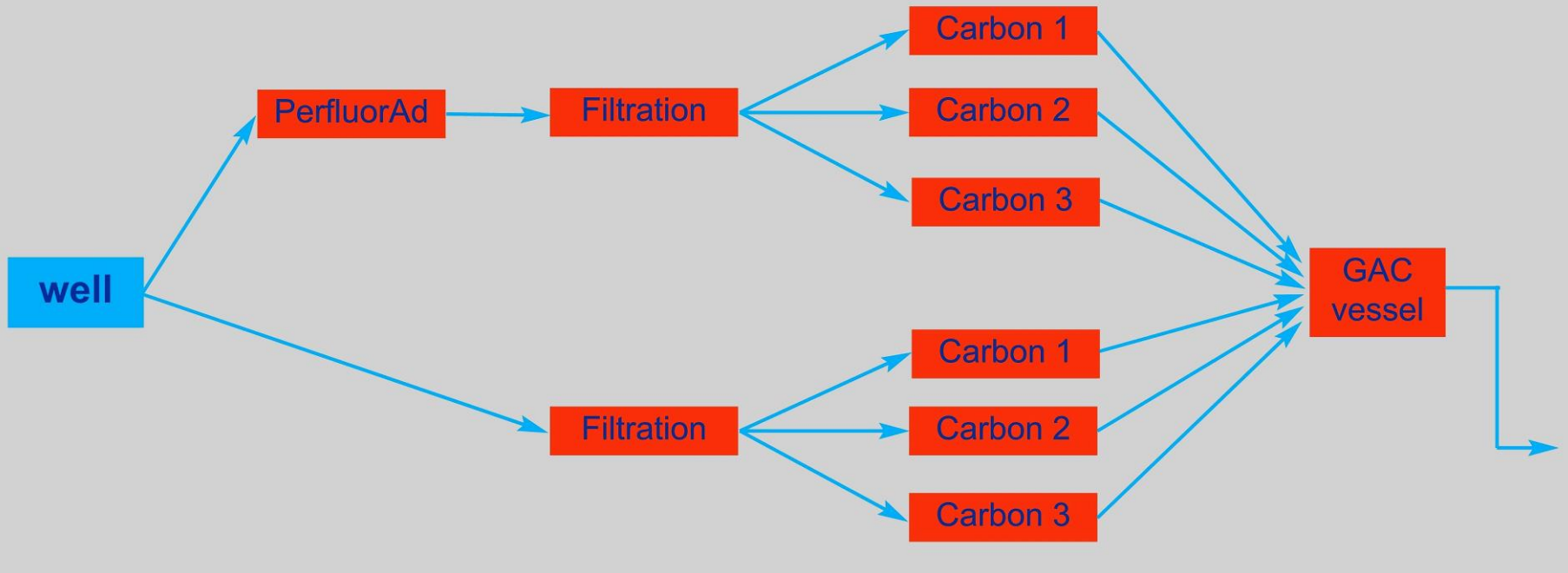


Results - Nuremberg



Key:
14 PFC
in ppb

Scenario – Field Test



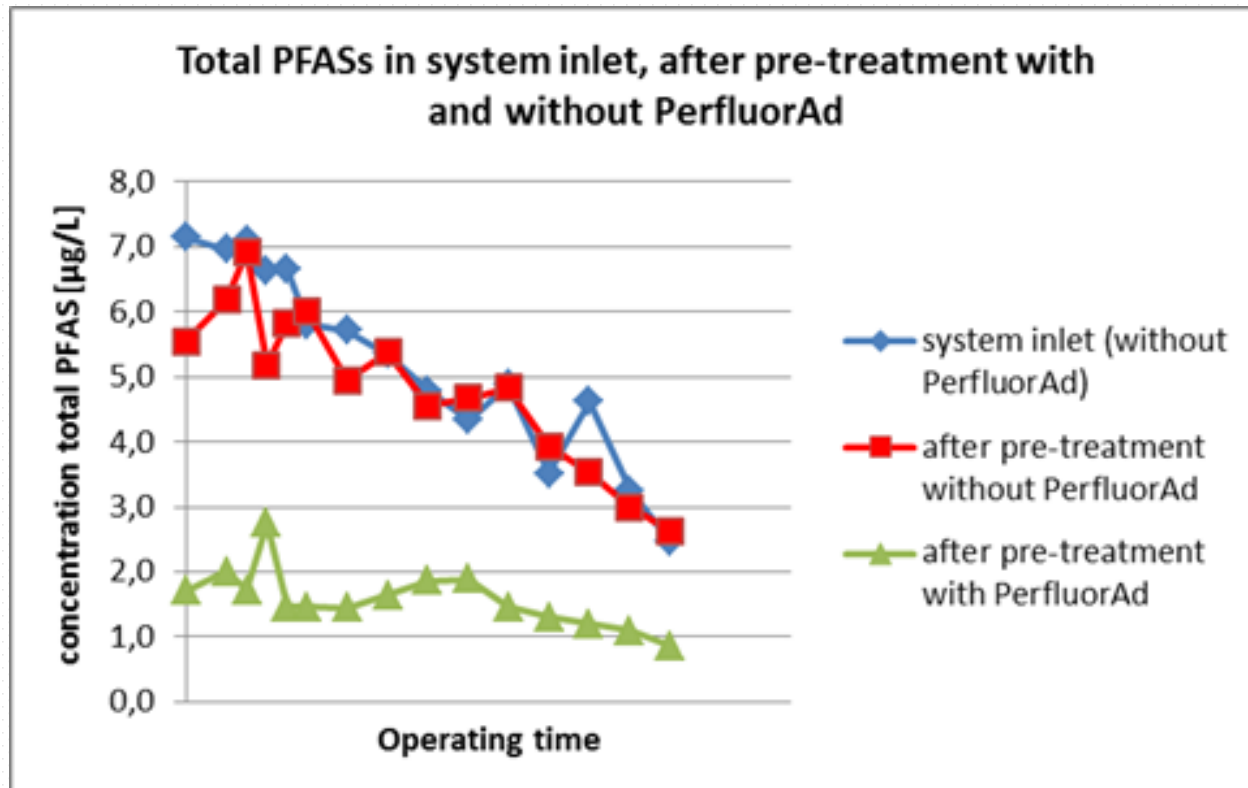
Results – Field Test

- period >5 months (2016)
- decreasing concentrations

PFAS		July	%	Oct	%
PFBA	µg/l	0,087	1,22	0,022	0,89
PFPA	µg/l	0,34	4,76	0,091	3,69
PFHxA	µg/l	0,37	5,18	0,064	2,59
PFHpA	µg/l	0,084	1,18	0,017	0,69
PFOA	µg/l	0,16	2,24	0,025	1,01
PFBS	µg/l	0,085	1,19	0,017	0,69
PFPeS	µg/l	0,072	1,01	0,014	0,57
PFHxS	µg/l	0,84	11,75	0,087	3,53
PFHpS	µg/l	0,058	0,81	<	0,00
PFOS	µg/l	4,3	60,17	2	81,07
6:2 FTS	µg/l	0,75	10,50	0,13	5,27
PFAS	µg/l	7,146		2,467	

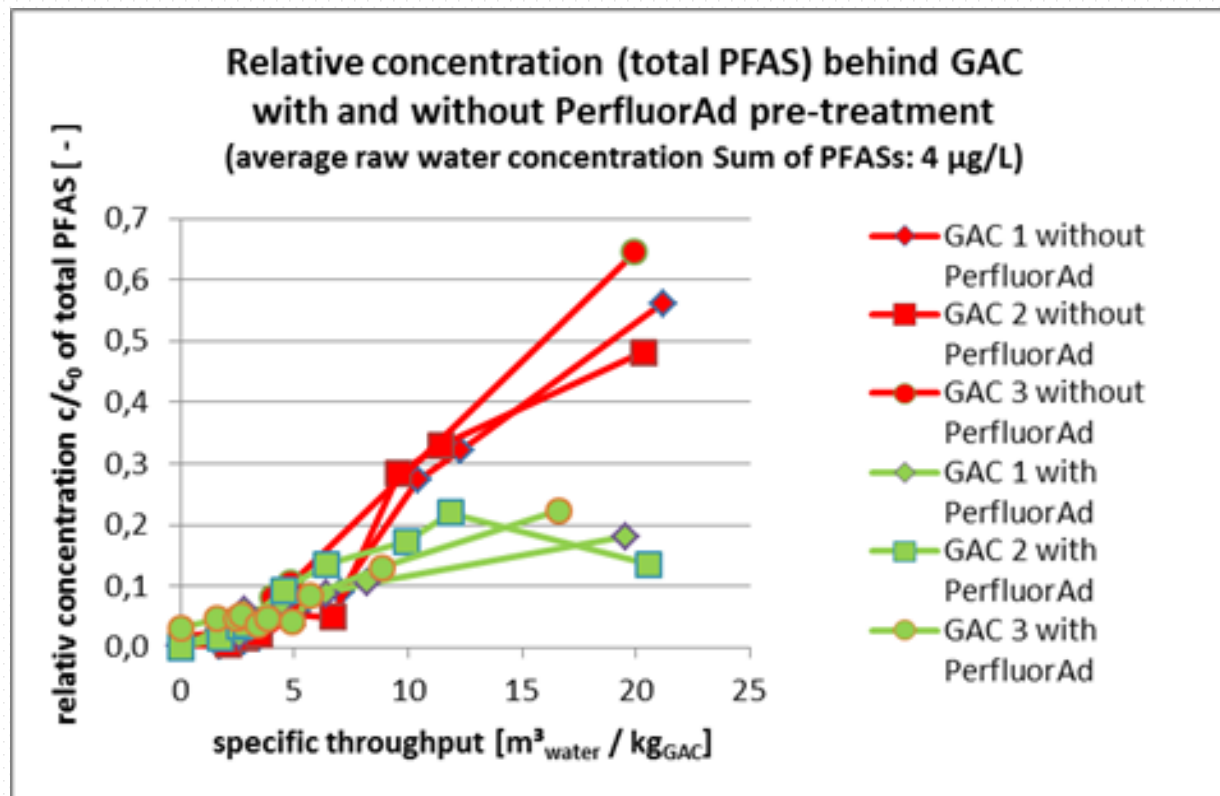
Results – Field Test

- filtration only: no change
- pre-treatment: much lower

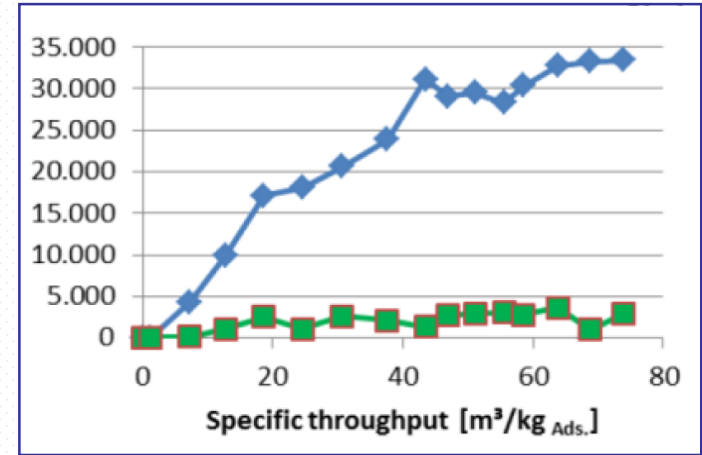
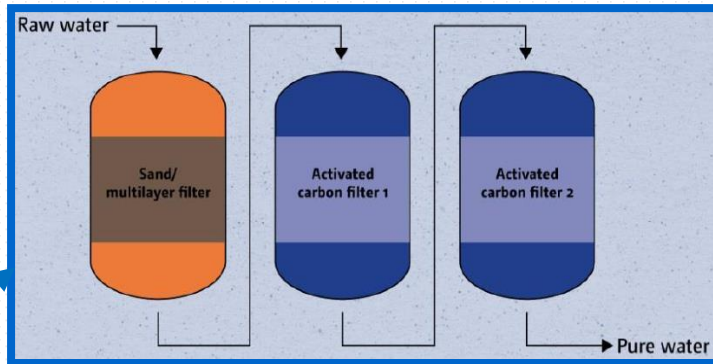


Results – Field Test

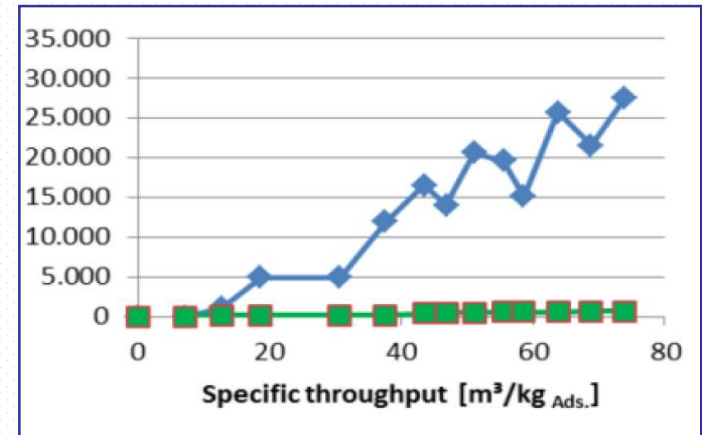
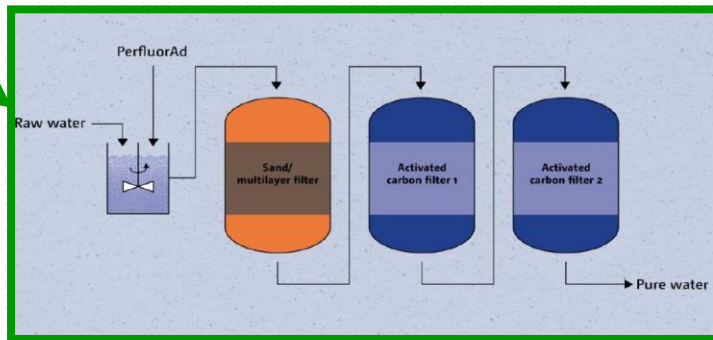
- sampling & lab works by 3rd party
- conclusions: -15% cheaper with pre-treatment



Results - Duesseldorf



Effluent 1st GAC vessel



Effluent 2nd GAC vessel