2017 Bioremediation Symposium

Technical Solution for the Removal of PFAS in Water

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Topics

- Location
- Background
- Innovative Approach
- Results (2 sites)
- Conclusions



Location



Location



Background

- fire training area east
- soil & groundwater remediation
- from 2004 until 2008 (93 VOC, 23 BTEX, 290 HC)
- discharge of "treated water"
- Hydrocarbons C5-C10 & >C10,
- VOCs
- BTEX



GWB19_20

GWB6

Background

• 2010: first investigation for PFCs

elevated concentrations



Chemistry: Groundwater

Compound	unit	max	min	average
рН		6,1	5,1	5,6
iron	mg/l	33,0	13,0	26,0
voc	µg∕l	49,0	15,0	27,0
BTEX	µg∕l	15,0	0,0	4,0
DOC	mg/l	15,0	7,0	9,0
PFC	µg∕l	777,0	144,0	357,0

- BTEX: ethylbenzene & xylene
- VOC: cDCE, TCE, VC
- hydrocarbons (< & > C 10) & PAH (traces)



Chemistry: PFAS/PFC

PFC/PFAS	unit	average value	percentage
PFBA	µg∕l	6,17	1,46
PFPeA	µg∕l	10,87	2,57
PFHxA	µg/l	26,50	6,26
PFHpA	µg∕l	4,33	1,02
PFOA	µg/l	9,52	2,25
PFNoA	µg/l	0,15	0,04
PFDeA	µg∕l	0,04	0,01
PFUnA	µg∕l	<0,01	
PFDoA	µg∕l	<0,01	
PFOSA	µg∕l	0,20	0,05
PFBS	µg∕l	13,27	3,13
PFHxS	µg∕l	115,78	27,33
PFHpS	µg∕l	8,62	2,04
PFOS	µg∕l	206,39	48,72
PFDeS	µg∕l	<0,01	
4:2 FTS	µg∕l	0,14	0,03
6:2 FTS	µg∕l	17,72	4,18
8:2 FTS	µg/l	3,98	0,94

Sum PFAS
Average 423,60 µg/l
Maximum 522,24 µg/l
Minimum 243,44 µg/l

Lab Test

- challenge 2010: groundwater remediation
- lab tests with water (PFC town vs. gw site)
- Various techniques selected & tested
- sorption: activated carbons, ion exchanger
- Nanofiltration
- Reverse osmosis
- electrochemical



Lab Test

- short vs long chain PFAS
- 2 normal carbon, 1 IX, 1 synthetic carbon
- adsorption 0.015 vs 0.02/0.21 w-%



Lab Test + PerfluorAd

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

best performance



cornelser

Innovative Approach

- PerfluorAd dosed to contaminated water
- dosing rate adjustable
- PFAS concentration or target concentration
- micro floccs are generated (PFAS)
- removable by precipitation or filtration
- acts as pre-treatment step to GAC





Innovative Approach

- additional pre-treatment unit
- key to success: filtration
- removes majority of the PFAS



Results: Nuremberg

- first field test on site in 2014 (Sep-Nov)
- most economical technique
- data evaluation
- selected technique for up-scale
- installation Sep 2015





Treatment Plant PerfluorAd



PerfluorAd

Results: Nuremberg

- flow rate about 2 m³/hr
- effluent target 0.3 µg/l (ppb)
- sum: PFOS + PFOA + PFHxS
- plus max 0.23 µg/l PFOS
- remote control
- just 1 or 2 site visits per week



Results: Removal Rate



PerfluorAd

Conclusion Nuremberg

- data from field test confirmed
- no influence by iron or DOC on PerfluorAd
- Iron-removal required due to GAC
- removal rate for PFC more than 90%
- PFAS get collected in sludge
- no carbon change required





Field Test Duesseldorf

- PFAS from aircrarft crash
- about 35 ppb in groundwater
- comparison of two approaches:
 GAC only vs. PerfluorAd + GAC
- water from one well split into two lines
- field test for 6 months



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PerfluorAd

Effluent GAC 1 & 2



PerfluorAd

Effluent GAC 1 & 2





PerfluorAd

Conclusion Duesseldorf

BLUE: carbon only

- rapid increase of PFAS at GAC 1
- happens delayed at GAC 2

GREEN: PerfluorAd (pre-tr.) + GAC

slight increase at GAC 1 with pre-treatment

- no incrase at GAC 2 with pre-treatment
- removal rate PFAS at about 70%



Conclusions

- PFAS on carbon wide range of adsorption
- PFAS components (VC & PCE)
- and GAC itself (normal synthetic)
- pre-treatment with PerfluorAd
- less PFAS pressure on GAC
- less difficulties with adsorption
- much longer lifetime for GAC





Conclusions

- small extra to a GAC system
- filtration is the key
- up to 95% PFAS removed
- adjustable to concentrations (400 35 ppb)
- majority of PFAS collected in sludge
- reduced volume of waste with PFAS
- more economical





Thank you very much!

- Questions? Questions? Questions?
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PerfluorAd