AquaNES

Demonstrating Synergies in Combined Natural and Engineered Processes for Water Treatment Systems

Securing water quality of bank filtrate by upgrading single wells with nanofiltration

Challenges

- Well water of the city of Berlin is challenged by increasing sulphate concentrations
- Different organic micro pollutions are present in ground water due to semi closed water cycle
- Operation of capillary nanofiltration under anoxic conditions to prevent precipitation of dissolved iron and manganese

Applied solution

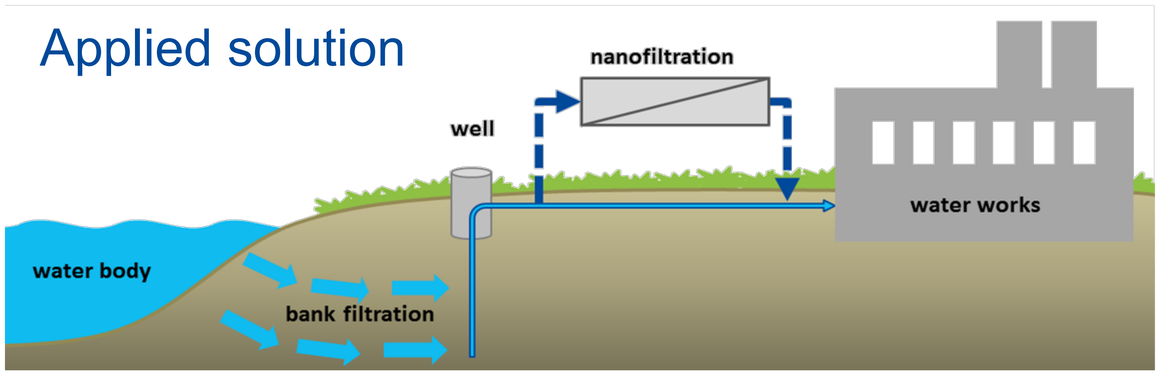

Figure 1. Bank filtration as natural pre-treatment for decentralized capillary NF with new developed LbL coated membrane

Bank Filtration

- 👍 Removal of TOC/ DOC, biopolymers (reduction of membrane fouling), micropollutants (depending on compound & travel time), algae, particles & pathogens
- 👍 Robust system, low risk of failure
- 👎 Dissolution of iron & manganese
- 👎 No SO_4^{2-} removal

Capillary NF

- 👍 Removal of SO_4^{2-}, hardness, TOC/ DOC, micropollutants (depending on size & charge), pathogens
- 👍 Suitable for backwash & flushing
- 👎 Scaling potential by Fe & Mn
- 👎 High energy demand

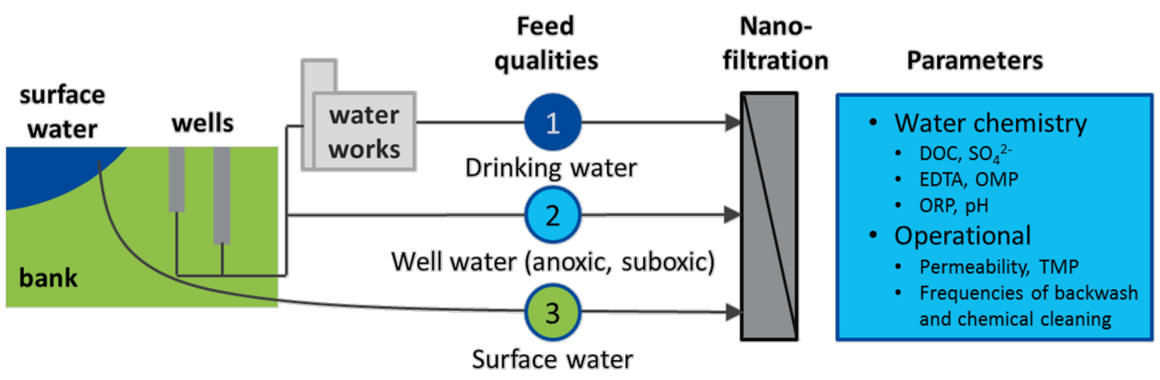

Figure 2. Technical demonstration: pilot test settings and schedule

Lessons learned

- Targeted pollutant removal at single wells
  => less overall treated water volume
- Good removal of e.g. DOC (83%), SO_4^{2-} (65%), Hardness (38%), EDTA (92%)
- Operation under anoxic conditions possible with flux up to 22.5 L/m²*h and recovery up to 75% and chem. cleaning: every 2-3 weeks
- Iron fouling can be removed easily by ascorbic acid or citric acid
- Removal of Fe and Mn only about 50% => post-treatment necessary
- Suboxic operation (0.3 – 0.5 mg O_2/L) => not recommended - Precipitation of Fe/ Mn has to be prevented
- For direct surface water treatment: higher cleaning effort, operation only with lower flux and recovery possible => pre-treatment recommended
- Treatment/ discharge of concentrate must be considered

Contacts

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Results

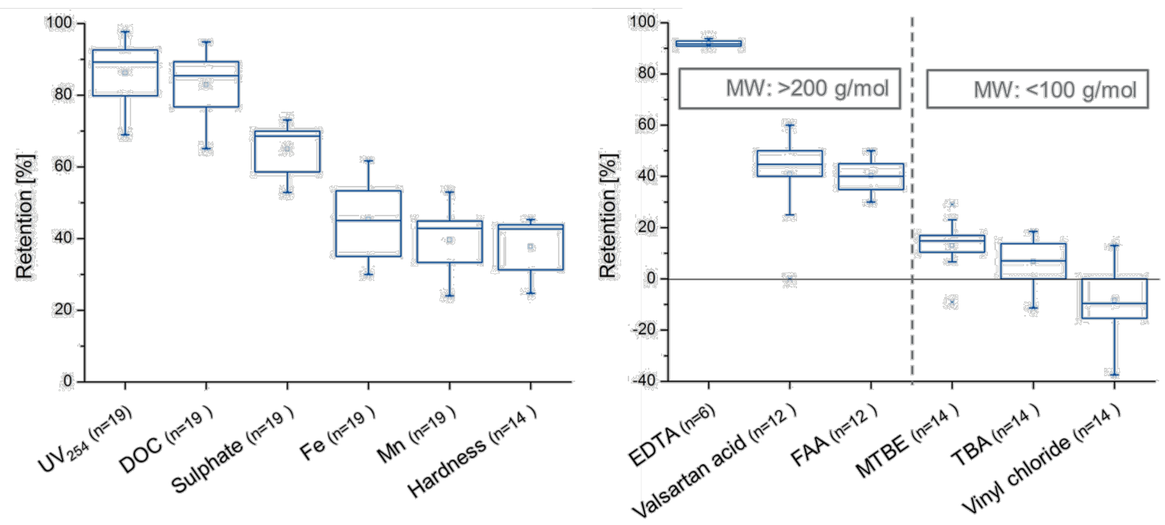
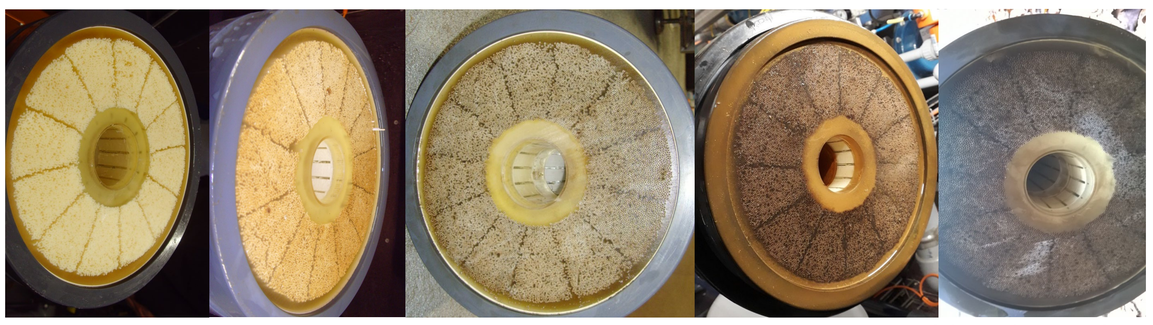


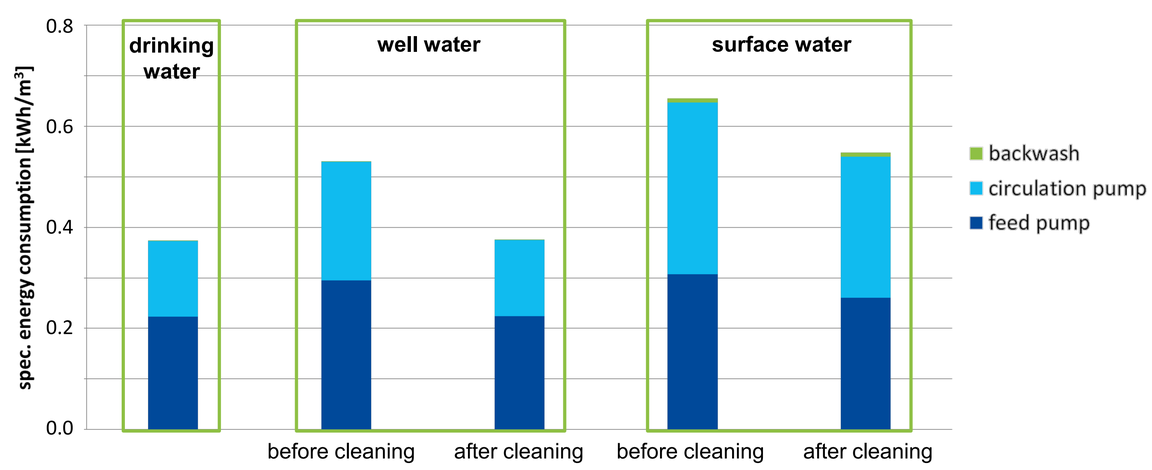
Figure 3. Retention of compounds (well water, flux 22.5 L/m² h, rec 75%, cfv 0.5 m/s)



new | 19 weeks drinking water | 15 weeks anoxic well water | 34 weeks anoxic + 2 weeks suboxic well water | 34 weeks anoxic + 6 weeks suboxic well water

Figure 4. Irreversible impurities on membrane, after chemical cleaning

Raw water source	Chemical cleaning recommendation
drinking water	2 – 4 times per year
anoxic well water	every 3 – 4 weeks
suboxic well water	every day, pre-treatment recommended
surface water	every 1 – 3 days, pre-treatment recommended



no cleaning	1 cleaning per week	3 cleaning per week
filtration time 24 h	filtration time 24 h	filtration time 1 h
flux: 22.5 L/m²*h	flux: 22.5 L/m²*h	flux: 15 L/m²*h
recovery: 75%	recovery: 75%	recovery: 50%
crossflow velocity: 0.5 m/s	crossflow velocity: 0.5 m/s	crossflow velocity: 0.5 m/s

Figure 5. Energy consumption for different operation conditions

Benefits

- Easy to operate and easily scalable, Applicable without pre-treatment
- Higher flux and lower TMP compared to RO
- Additional barrier against pathogens
- Removal of dissolved less degradable contaminants
- Reduction of precursors for disinfection-byproduct formation
- Handling of concentrate

Favourite Application:

- Partial flow treatment (also for drinking water => less cleaning effort)
- Single well water treatment to prevent shut-down in case of specific contamination

KOMPETENZZENTRUM WasserBerlin | PENTAIR | Berliner Wasserbetriebe

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