AquaNES

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

Combined River Bank Filtration and Ultrafiltration for drinking water treatment

Challenges for drinking water treatment

- 40% of drinking water production in Dresden is based on bank filtration
- Climate change predictions indicate an increased likelihood of extreme events, i.e. floods and droughts in Europe like in 2002, 2013 and 2018
- Increasing peak demand and quality requirements for drinking water
- An economically efficient and safe indirect use of surface water must be adapted to remove emerging pollutants

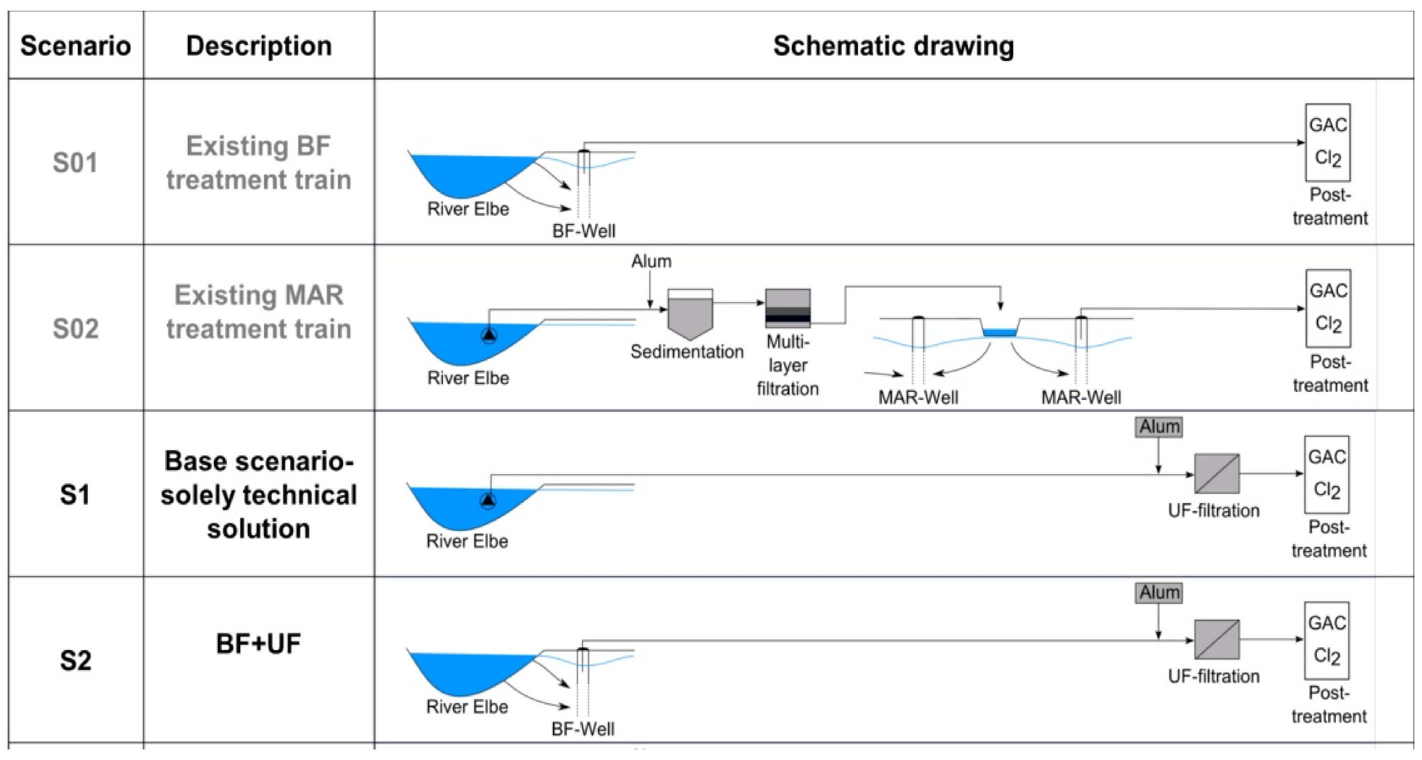

Figure 1: UF-pilot scenarios for AquaNES with treatment trains at waterworks Dresden-Hosterwitz (S01 & S02) with Managed Aquifer Recharge (MAR)

Methodology

Investigation of cNES at fully automated semi-technical operated pilot plant with parameters shown in Tab. 1 and scheme in Figure 2

Table 1. Technical set-up

Set-up	Unit	UF pilot plant	
Street	[-]	1	2
Manufacturer	[-]	GE	Pall
Material	[-]	PVDF	PVDF
Capacity/Street	[m³/h]	15	15
Units	[-]	3	3
Membrane area	[m²]	60	55.7
Discharge	[m³/h]	2-6	2-6
Calculated flux	[L/(m² h)]	30-80	30-90
Feed water	[-]	River+BF+ Infiltrate	River+BF+ Infiltrate

- Total capacity of the pilot plant 20 m³/h with flow direction OUT/IN
- MN removal by In-line electrolysis cell
- Online measurement of all operating parameters
- Lab analytics of selected microbiological and organic parameters
- Measurement of microbiological parameters: adenosine triphosphate (ATP), BACTcontrol and flow cytometer

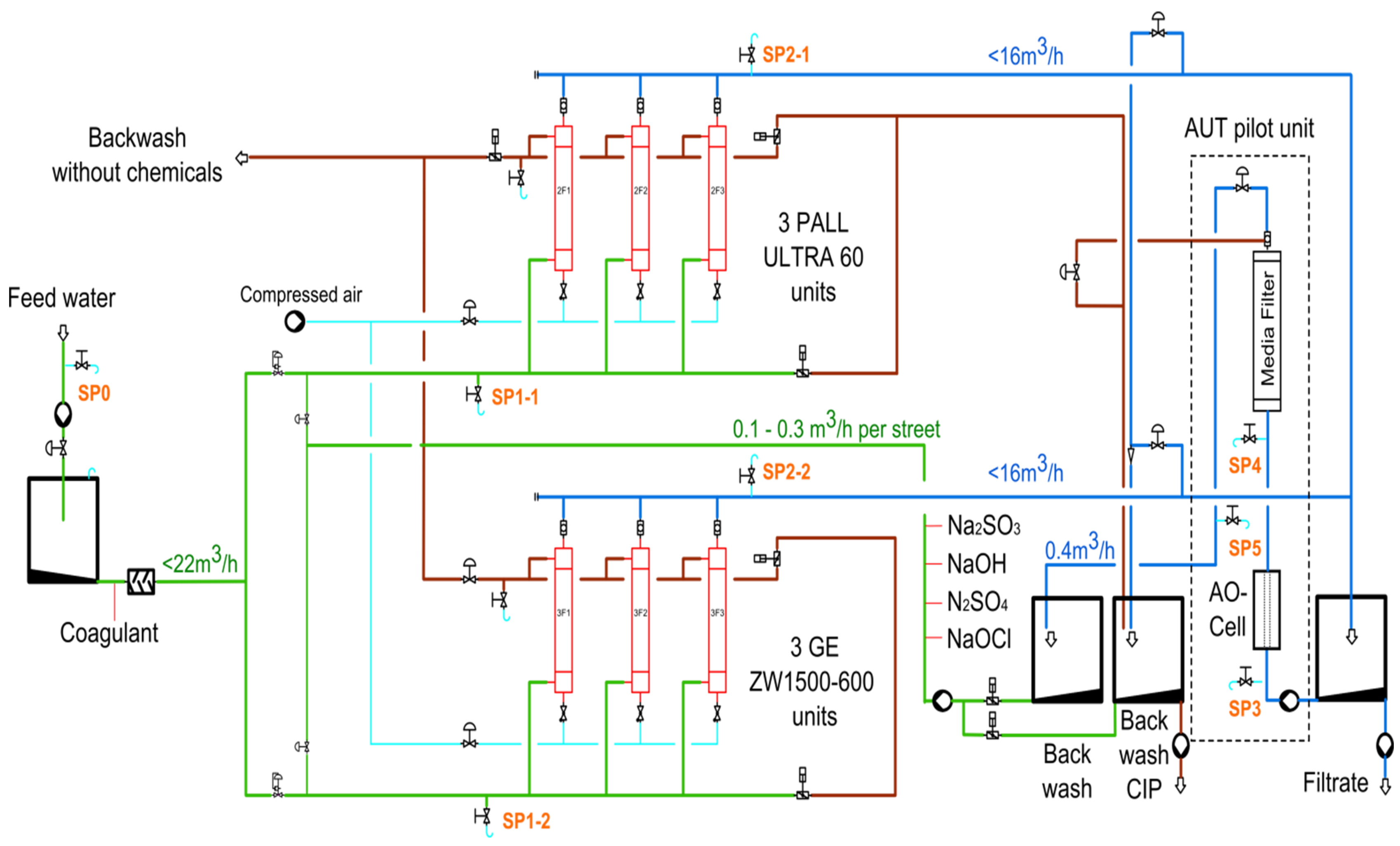

Figure 2. Set-up of UF plant with in-line electrolysis cell by AUTARCON

Demonstrated solution and aim of the study

- River bank filtration (RBF) is effective in removing organic pollutants but could face microbial breakthroughs during extreme hydrologic events
- Ultrafiltration (UF) is reliable in particle removal and microbiological contaminants even during extreme events
- Demonstrate the cNES innovation of combined RBF and UF as reliable multi-barrier against pathogens independent of climatic extremes
- Highlight the advantages of RBF for the cost effective operation of UF membranes: reduced fouling potential, lower energy consumption and combined removal rates

Performance and results

Table 2. Water quality for feed water and permeate from the ultrafiltration

Parameter	Feed	Permeate		Feed	Permeate	
(average values)	Elbe (n = 14)	UF 1 (n = 9)	UF 2 (n = 9)	BF (n = 17)	UF 1 (n = 17)	UF 2 (n = 17)
Colif. bac. [1/100ml]	3814	0	0	16	0	0
Turbidity [FNU]	9.8	0.1	0.1	0.5	0.1	0.1
DOC [mg/l]	4.9	4.8	4.8	2.2	2.2	2.2
Mn [mg/l]	0.3	<0.01	<0.01	0.1	0.1	0.1
Cell-bound ATP[RLU]	11880	45	37	84	32	28

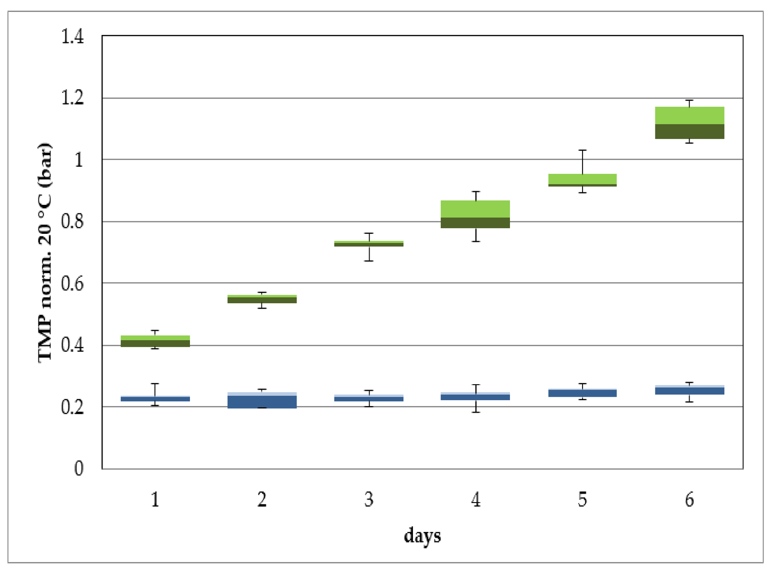

Figure 3. Transmembrane pressure for UF 1 during filtration of Elbe water (green) and BF (blue), flux 50 L/m²h

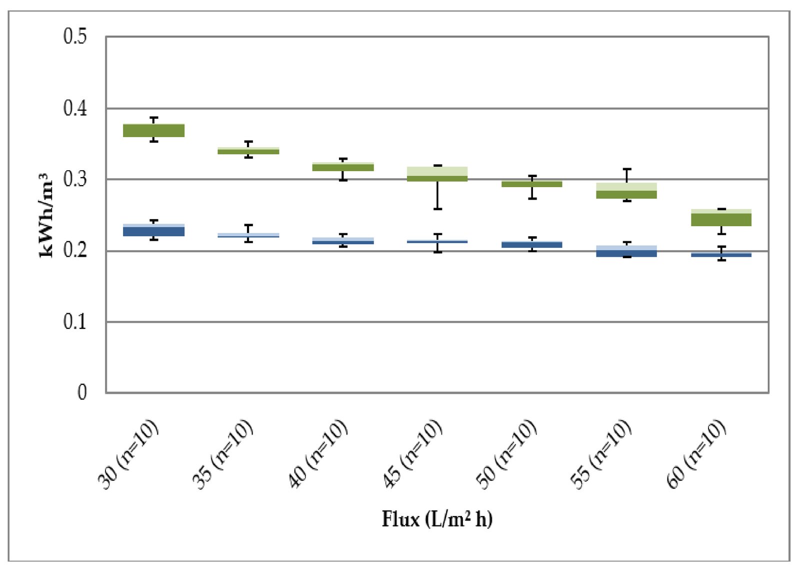

Figure 4. Energy consumption per m³ filtrate produced from Elbe water (green) and BF (blue) with identical operation settings of UF 1 & 2

- Almost complete removal of turbidity and bacteria (coliforms, ATP) independent of feed water quality (Table 2)
- Higher DOC and bacteria counts in feed water (Elbe river) leads to a higher fouling potential (0.14 bar/d) compared to bank filtrate as feed (0.005 bar/d)
- In-line electrolysis cell by AUTARCON reduces dissolved manganese in the permeate (< 0.01 mg/l) to protect the membrane from fouling (Figure 3)
- Energy consumption decreases with increasing flux to 0.19 kWh/m³ for bank filtrate and to 0.25 kWh/m³ for Elbe river water

Conclusions

- Feasibility of combining RBF and UF has been demonstrated
- cNES leads to a more efficient and economically feasible water treatment for safe drinking water production

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