



Combining fluidized IEX and coagulation / flotation for NOM removal

Liesbeth Verdickt and Klaas
Schoutteten
De Watergroep

De Watergroep

- Drinking water utility in the Flanders
- +- 3 million domestic customers
- Yearly production +- 120 million m³
 - 71% ground water
 - 29% surface water
- Production plants
 - 85 ground water abstractions
 - 5 surface water treatment plants



Surface levels



Water T

	Kluizen	Blankaart
NPOC (mg C/l)	10,3	13,1
Alkalinity (meq/l)	4,0	3,8
pH (-)	8,0 – 8,7	8,0 – 9,2
Conductivity (µS/cm)	574	859
Chloride (mg/l)	48	121
Sulfate (mg/l)	55	88
Hardness (°F)	26	26
Turbidity (NTU)	1,9	4,4
Suspended solids (mg/l)	2,6	9,7
Manganese (µg/l)	114	102
NH ₄ ⁺ (mg/l)	0,2	0,6
Nitrate (mg/l)	6	10
Orthofosfate (mg/l)	0,3	0,8
Chlorofyl (µg/l)		32
C perfringens (/100 ml)	51	166
Coli (/100 ml)	591	1009
Enterococcus (/100 ml)	18	67
E. Coli (/100 ml)	58	230
HPC 22°C (/100 ml)	1612	5910

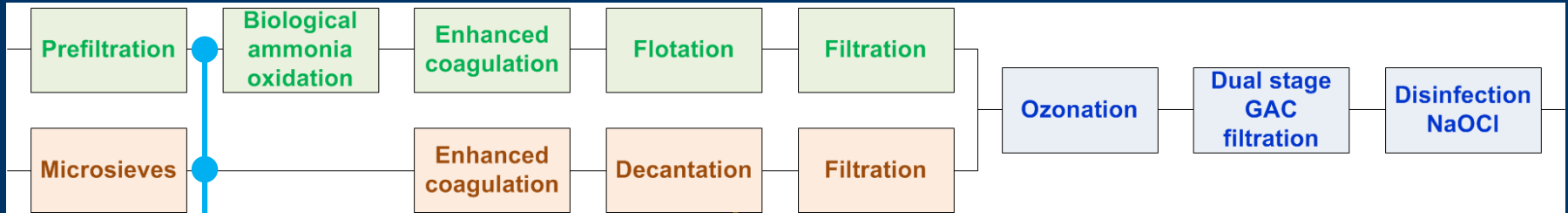
NOM

Works

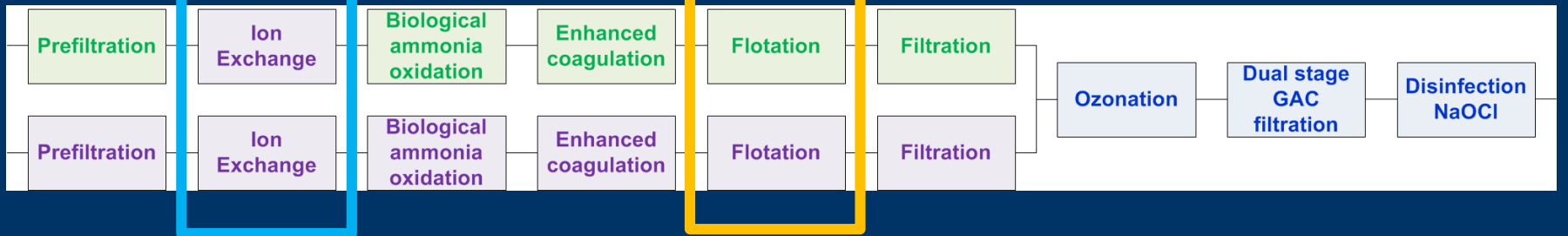


NOM removal WTW Kluizen

Current treatment scheme



Future treatment scheme



NOM removal WTW Kluizen

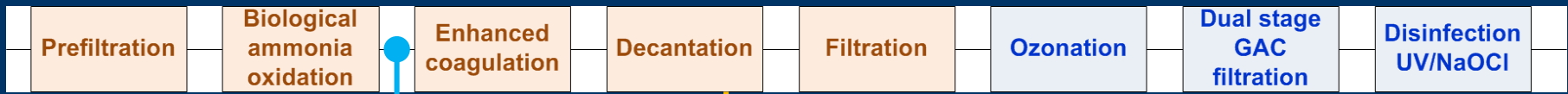
Fluidized bed IEX – coagulation – flotation (2011 – 2013)

- Fluidized bed IEX reliable enough for full scale application
- >80% reduction in coagulant demand
- Improved overall NOM removal
- Lower mineralisation
- Investment cost IEX compensated by decrease in operational costs
- Need for further research on waste water treatment

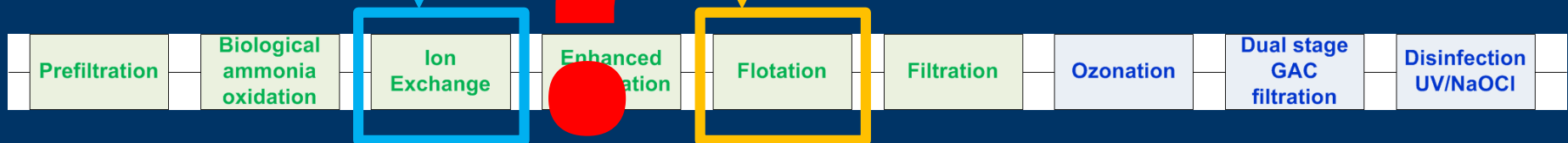


NOM removal WTW De Blankaart

Current treatment scheme



Future treatment scheme



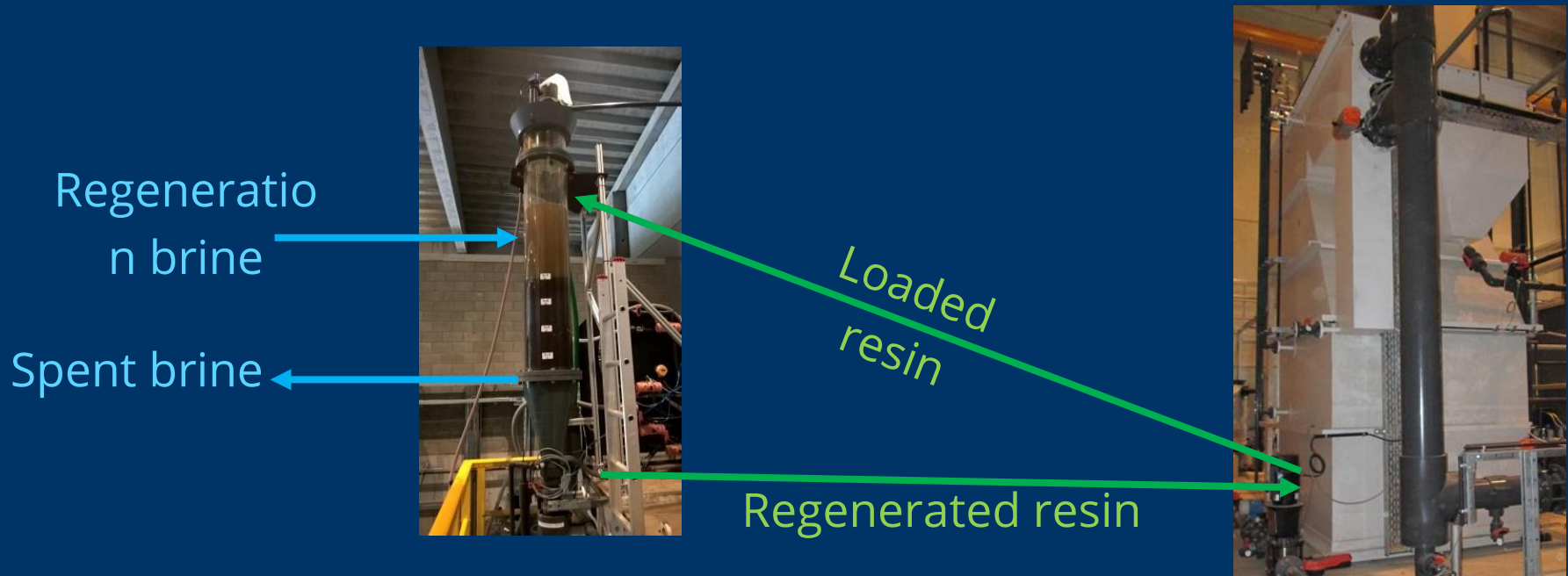
Pilot research WTW De Blankaart

Fluidized bed IEX – coagulation – flotation (2015 – now)

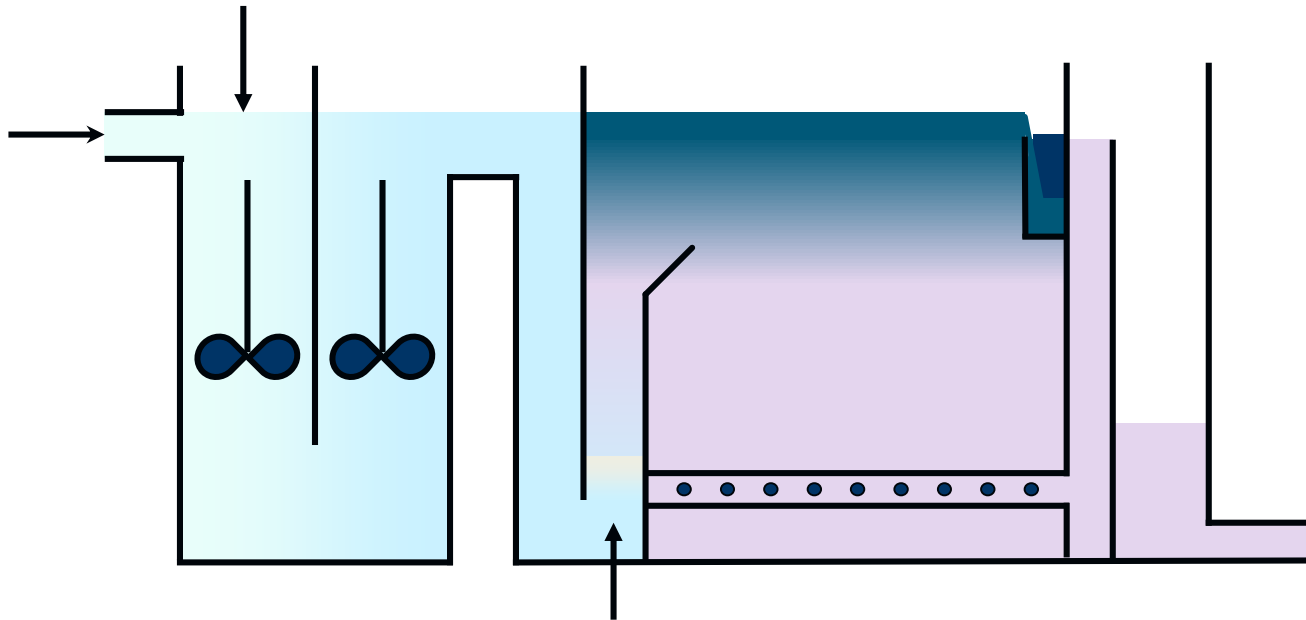


Fluidized bed IEX

Working principle



Coagulation - flotation



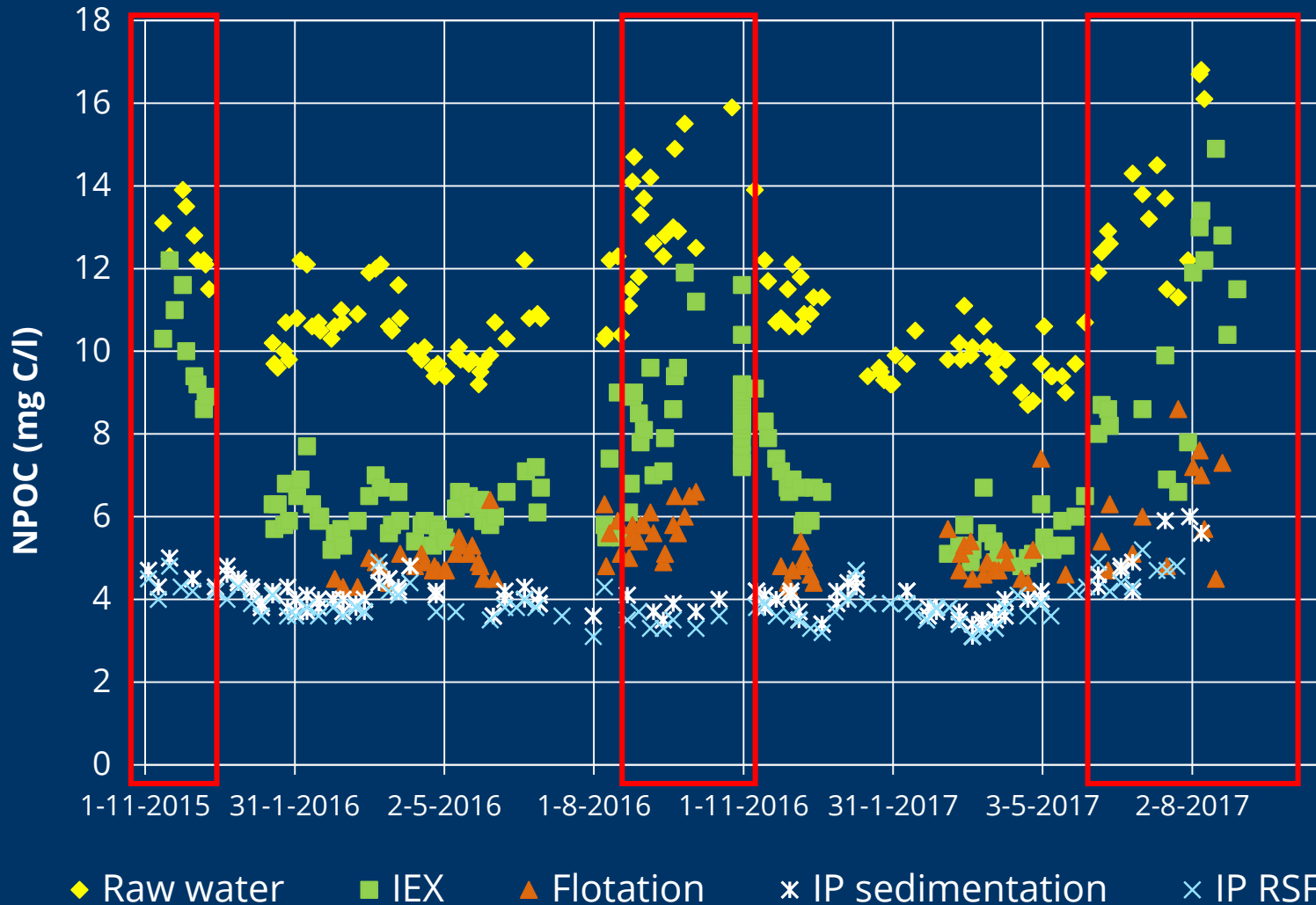
Research questions

- IEX
 - Impact on overall NOM removal efficiency
 - Impact on coagulant demand and optimal coagulation pH
 - Is algae bloom a problem?
- Flotation
 - Can FeCl_3 be applied as a coagulant?
 - Time required for flocculation?
 - What is the maximum surface loading?
 - Operation at low temperature and during algae blooms

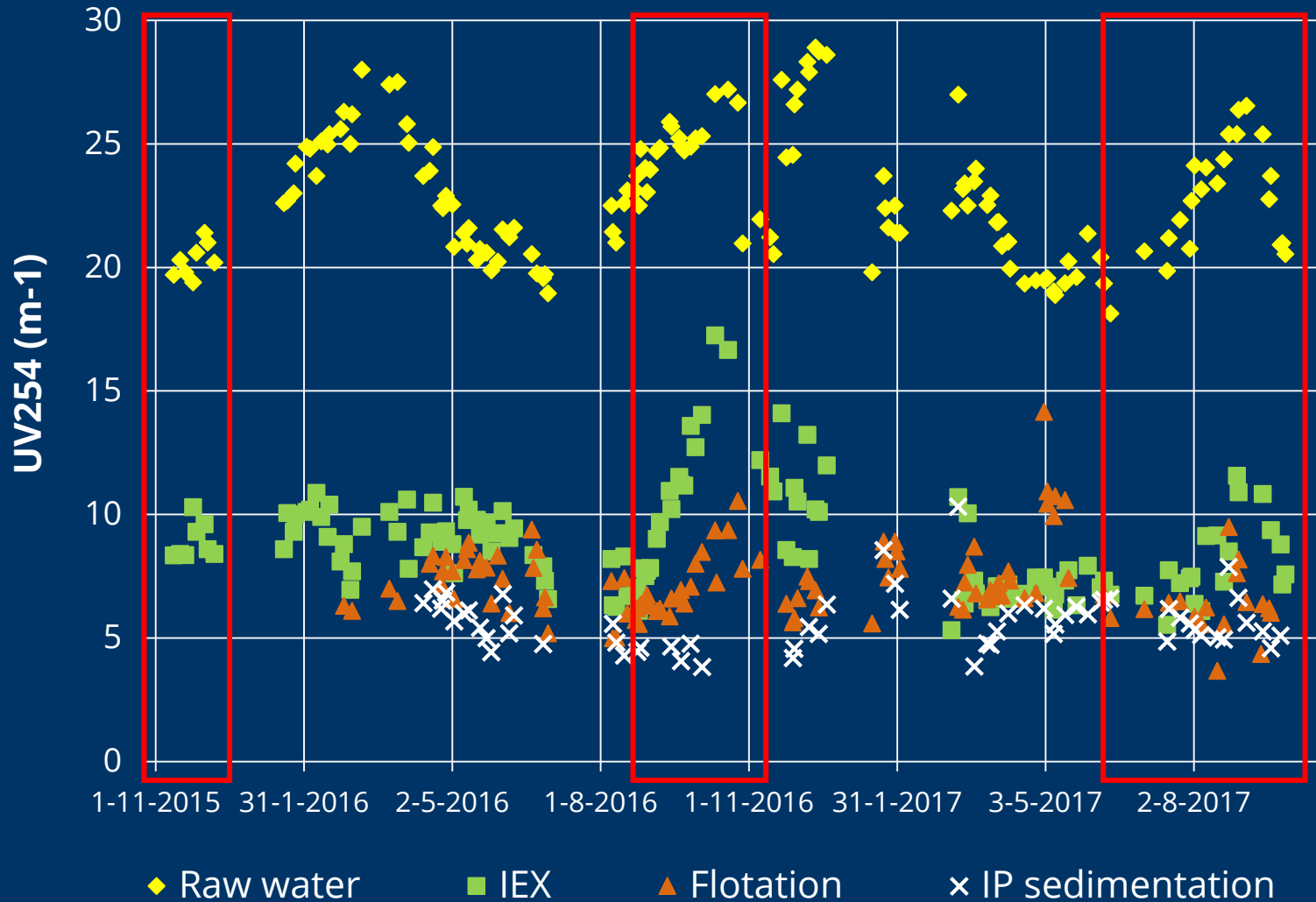
Some results

- NOM removal
- Fluidized bed IEX and algae blooms
- IEX waste water treatment
- Flotation

Results NOM removal



Results NOM removal



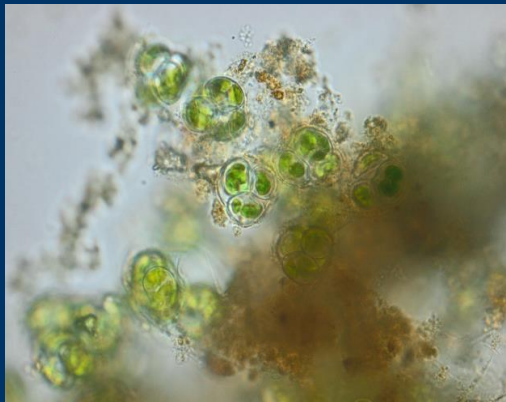
Results NOM removal

- IEX NOM removal efficiency shows strong seasonal variation
- Combination of fluized bed IEX and coagulation / flotation performs slightly worse than the full scale plant with respect to NOM removal
- Less chemicals used

	IEX - flotation	Full scale plant
H ₂ SO ₄ (mg/l)	15	67
FeCl ₃ (mg Fe/l)	12	31
NaOH (mg/l)	13	76
Resin Purolite PPA860S (ml/m ³)	1 – 1.5	-

Fluidized bed IEX and algae

- 2016: accumulation of algae in resin bed results in stratification

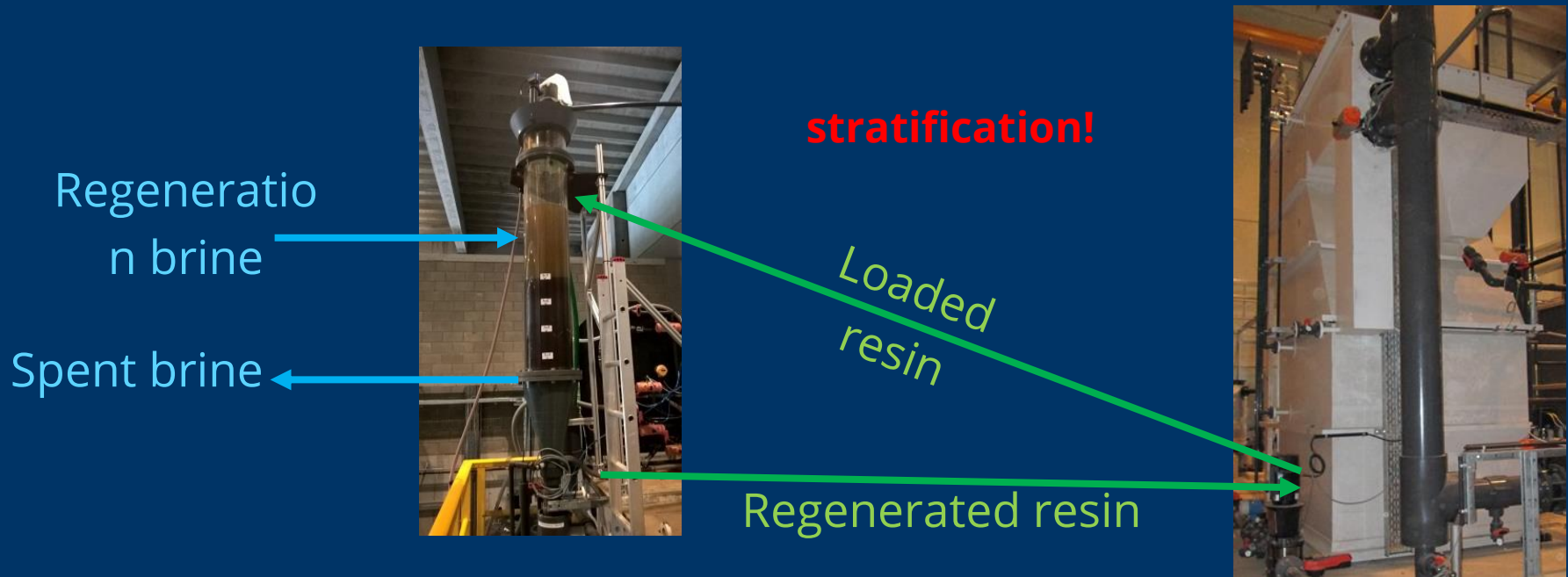


decayed algae

IEX resin

Fluidized bed IEX and algae

- 2016: accumulation of algae in resin bed results in stratification



Fluidized bed IEX and algae

- 2017: more algae, no accumulation in resin bed, no stratification
 - Increased upflow velocity: 20.0 m/h ↔ 17.3 m/h
 - Increased regeneration frequency: 2 ml/l ↔ 1 ml/l

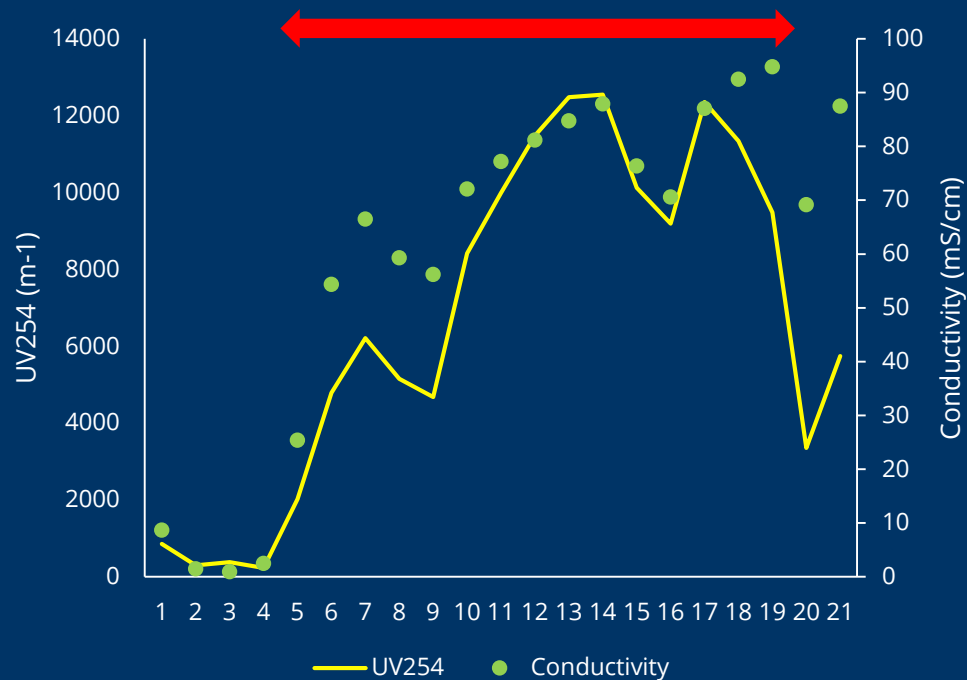
IEX waste water treatment

- Coagulation with FeCl_3 at pH 4.0 and dewatering with filter press
- Recirculation of filtrate to regeneration
- Accumulation of sulfate in regeneration brine seems to have a negligible impact on NOM removal efficiency
- Long-term operation feasible
- Filter cake is a waste



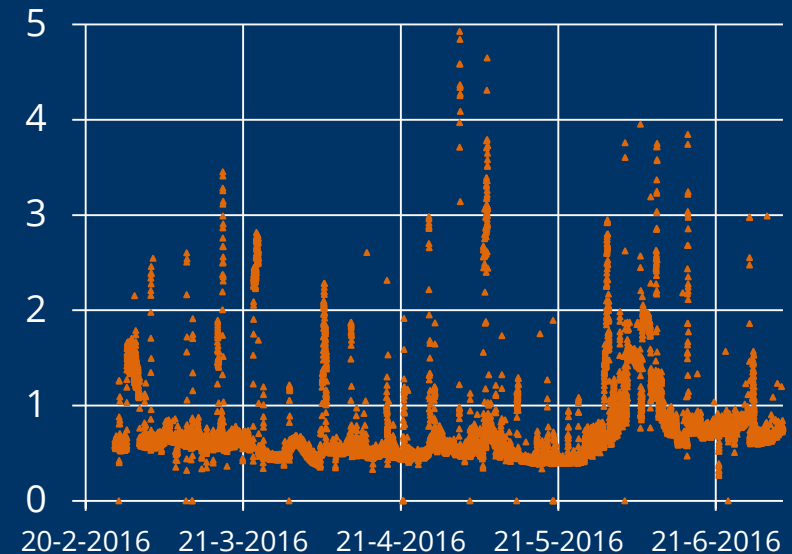
IEX waste water treatment

- Water balance is important!



Flotation

- FeCl_3 can be applied as a coagulant
- A flocculation time of 15 minutes is sufficient
- Hydraulic loading of the separation zone of 20 m/h is a good design value
- Low effluent turbidity, even at low temperature and during algae blooms without coagulation or flocculation aids



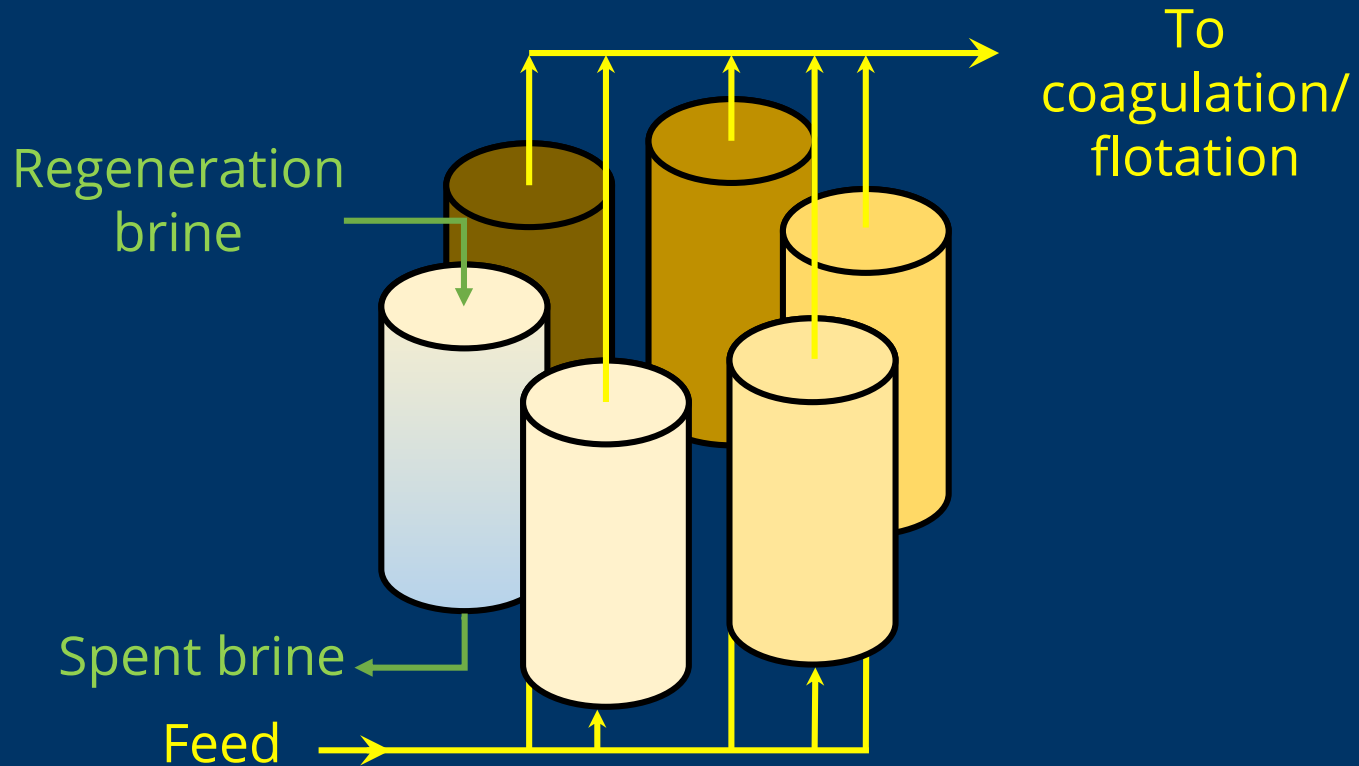
• Turbidity after flotation (NTU)

What options do we have?

- IEX with higher resin dose
 - ⇒ Concentration step in waste water treatment required!
 - ⇒ Carousel system (no freshly regenerated resin to regeneration system & positive impact on algae accumulation)
 - ⇒ Costs will increase
- Coagulation – flotation on raw water
 - ⇒ High coagulant demand and low coagulation pH
- Combination of coagulation – flotation with NOM removal step after RSF
 - ⇒ IEX in fixed bed systeem

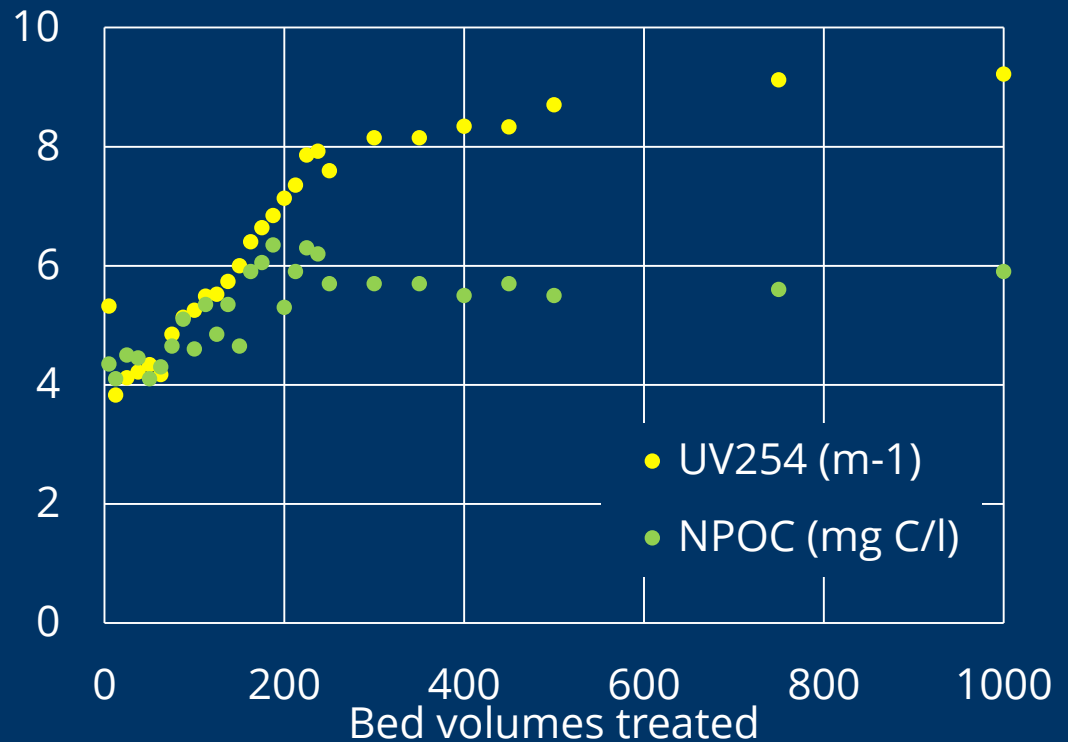
IEX with higher resin dose

Carousel system



IEX with higher resin dose

NOM removal efficiency



Coagulation / flotation / RSF / IEX

- Can chemicals usage in the coagulation step be reduced if turbidity removal is the main target?
- Pilot plant RSF and IEX in fixed bed
 - Achievable NOM removal?
 - Resin choice
 - Additional cost?

