IEX to control NOM fouling in NF

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Outline

Research goals

Materials and set-up

Results

- Effect of IEX resin
- Process parameters on NF pilot
- Membrane autopsy
- Biological activity IEX resin

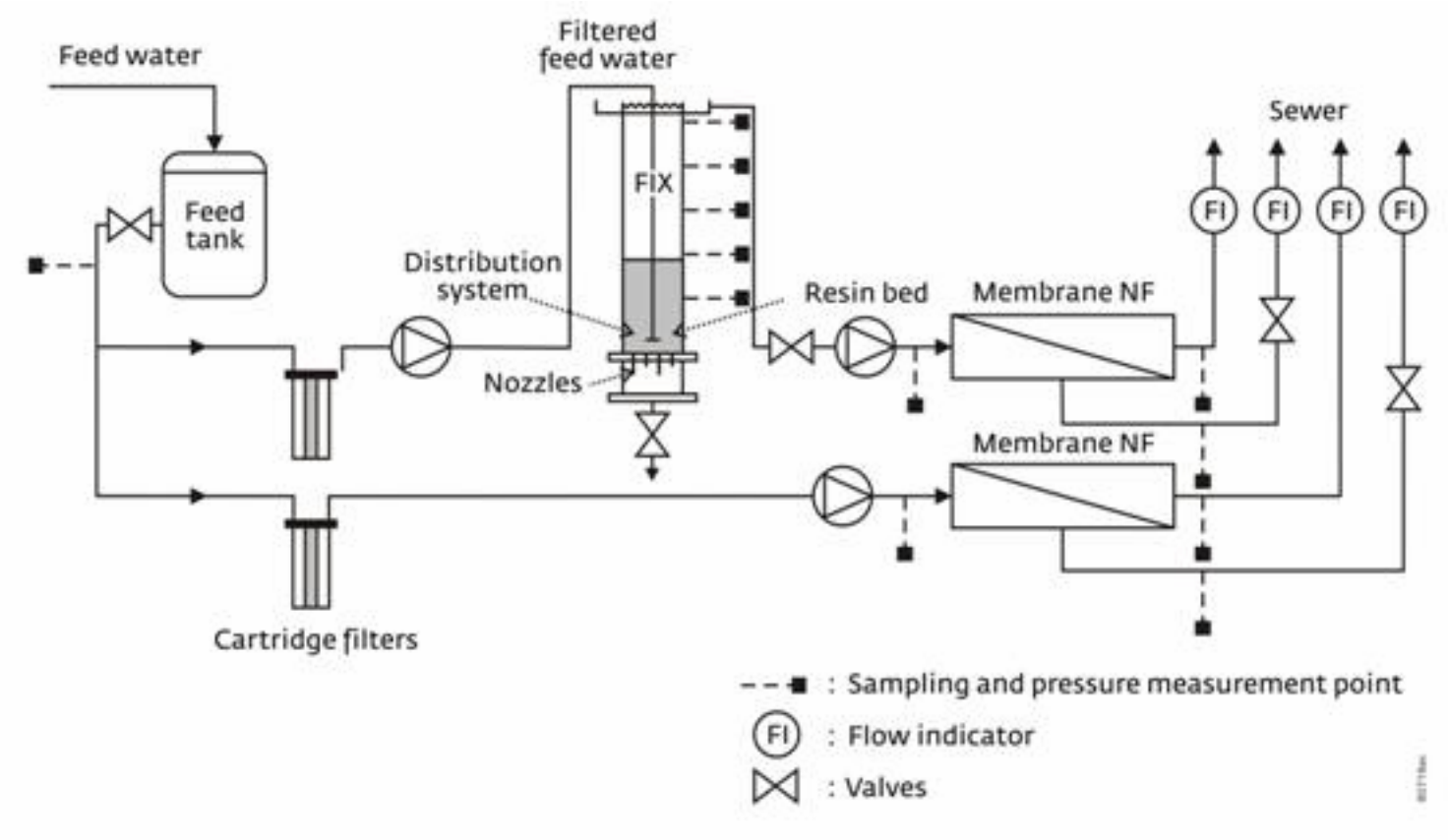
Conclusion

Research goals

Improve downstream processes using a new FIX process to remove NOM

- influence of NOM removal by FIX
- effect of NOM removal specifically on NF
- biological activity of IEX resin

Flow diagram pilot plant



Materials

Tap water at Kiwa WR location

DOC	1.96 mg/L	o-PO_4^{3-}	34 µg/L
UV_{254}	5.7 m^{-1}	HCO_3^-	265 mg/L
Temp	20.6°C	Cl^-	10.4 mg/L
pH	7.91	SO_4^{2-}	0.15 mg/L
		NO_3^-	<1 mg/L

Lewatit VPOC1071 resin : a strong alkaline, gel type anion exchange resin

Desal HL 4040 type nanofiltration spiral wound membrane

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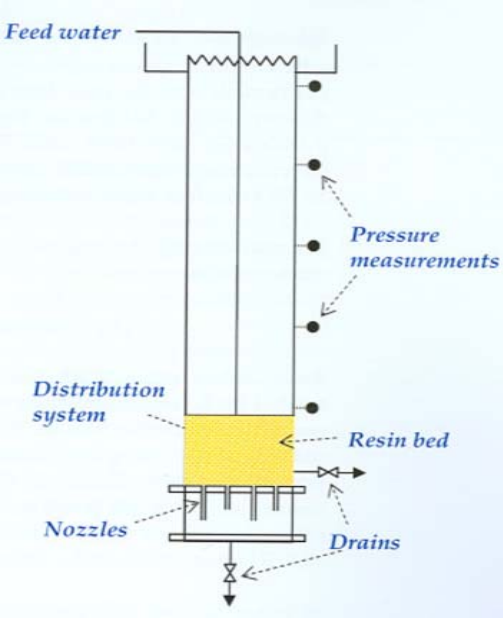
Fluidized Ion Exchange Setup

Feed Flow: 2000 L/h
Resin volume: 175 L
Contact time: 5 min



FIX run time before NF experiment: 12hours
Regeneration: one time

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Nanofiltration Setup

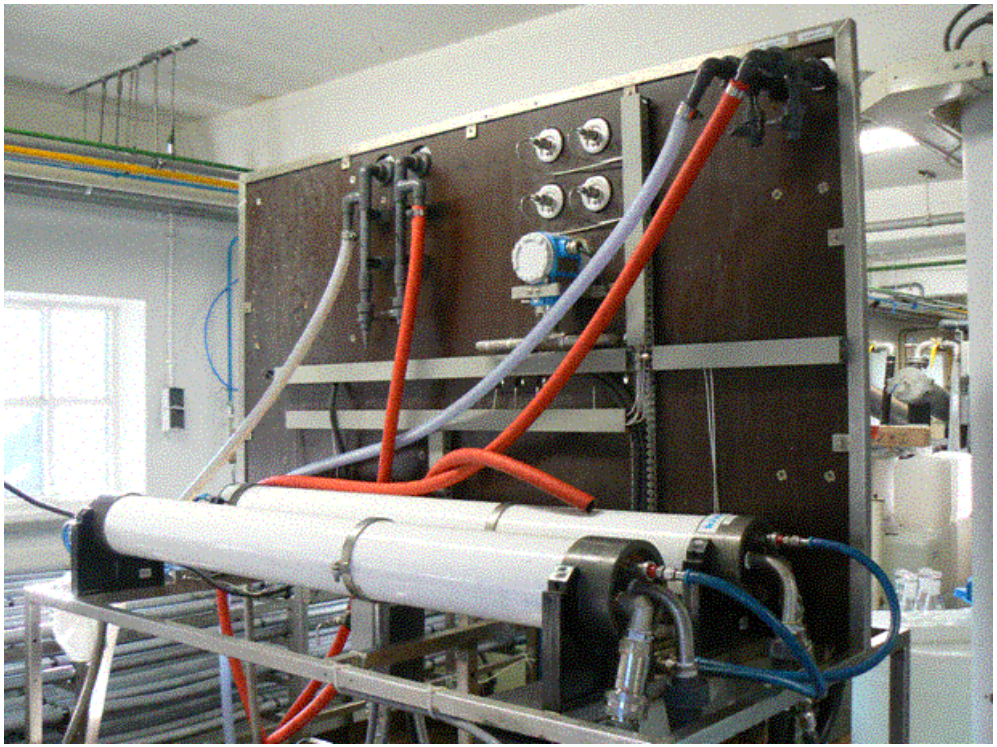
2 modules:

- NF membrane
- NF membrane after FIX column

Total run time: 42 Days

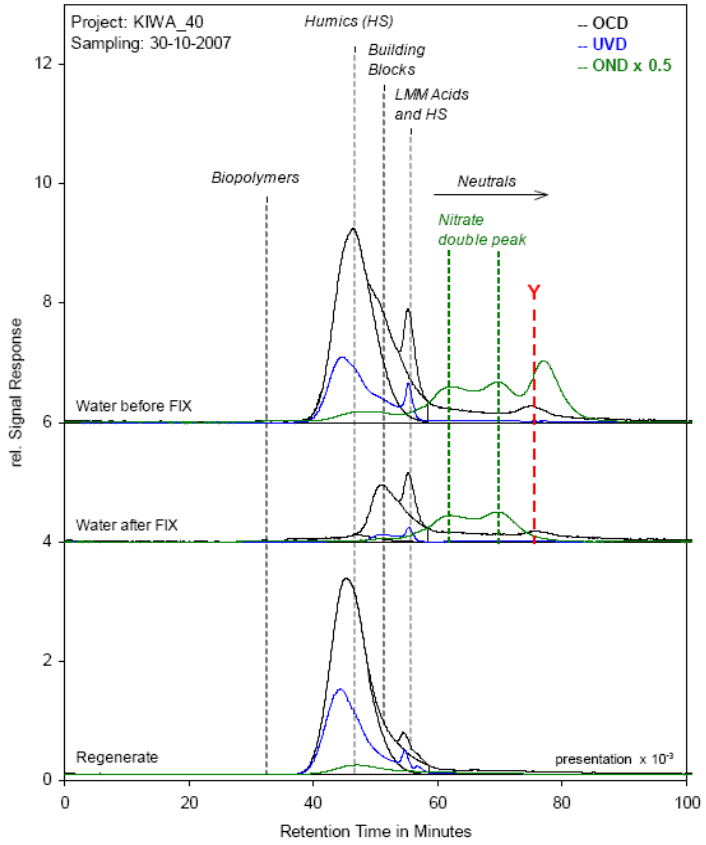
Per element:

- Feed flow: 1500 L/h
- Recovery: 10%



Effect of IEX resin

NOM



	Raw Water	Water after FIX	Removal
	ppb-C		*%*
UVA254	5.8	0.40	93
DOC	2	0.36	82
Biopolymers	17	15	12
Humic substances	1246	111	91
Buildings blocks	285	279	2
Neutrals	267	230	14
Acids	bdl	bdl	

Substantial removal of NOM by FIX

Effect of IEX resin

Inorganic compounds

	Tap Water	Water after FIX
	mg/L	
Na	13.1	15.6
K	1.1	1.3
Mg	7.1	7.6
Ca	75.7	76.7
Fe	0.34	0.10
HCO_3	265	261
Cl	10.4	9.4
SO_4	< 1	< 1

The tap water and the FIX-treated water have approximately the same inorganic composition.

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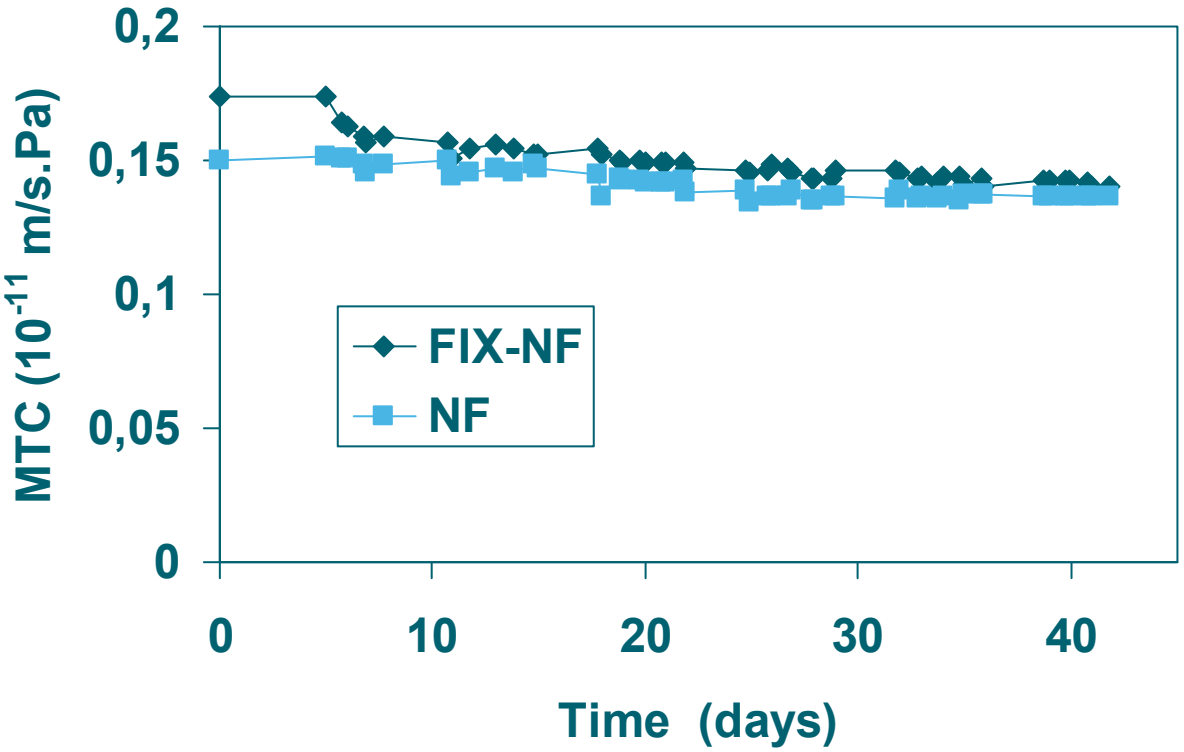
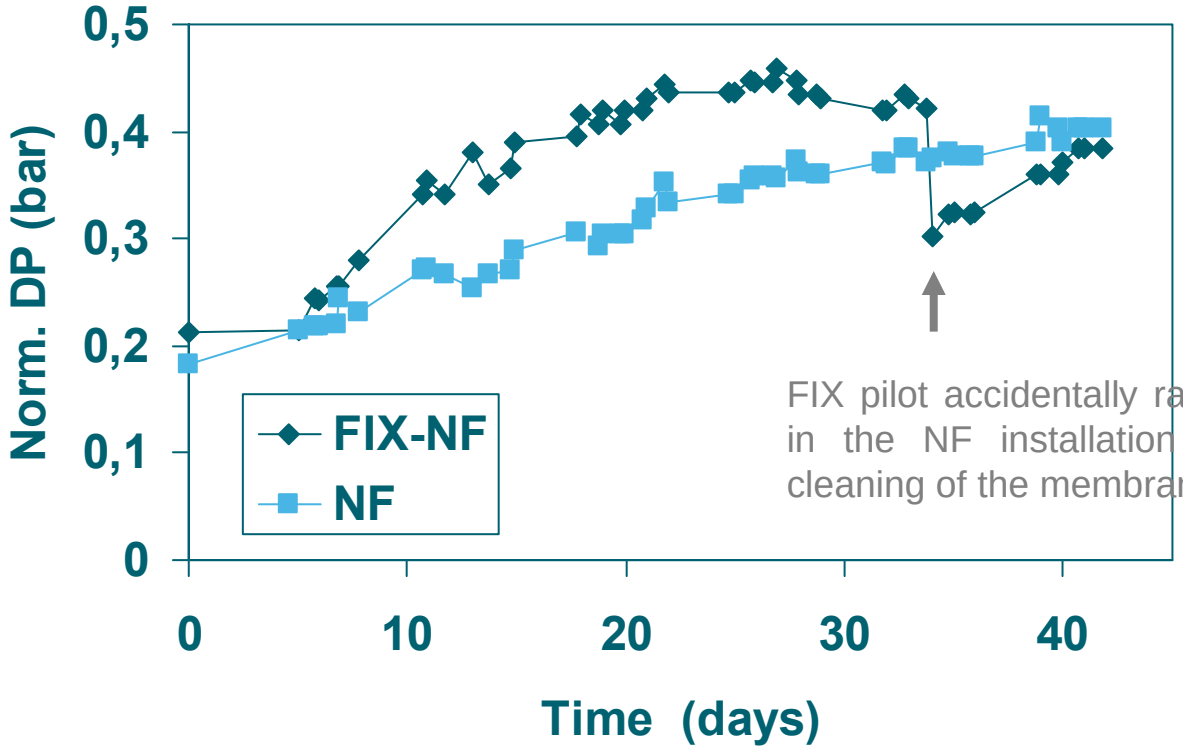
Process parameters on NF pilot

Membrane Transport Coefficient (MTC)



Process parameters on NF pilot

Normalized pressure drop



FIX pilot accidentally ran dry: it introduced air in in the NF installation possibly resulting in a cleaning of the membrane

Membrane autopsy

Membrane Extraction

Extraction procedure :

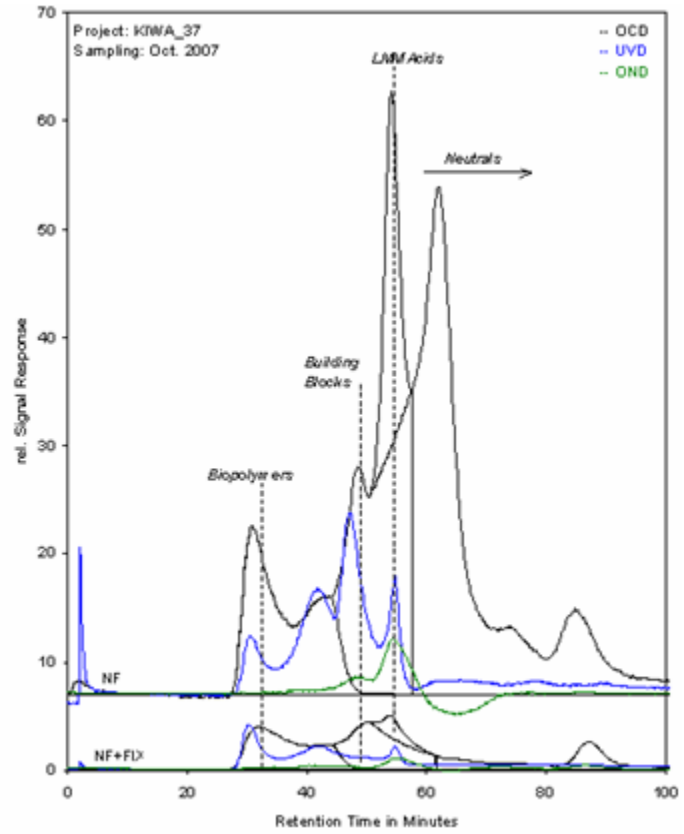
MilliQ water, 100cm^2 membrane, 1 min sonication

Organic matter: UV, DOC, FEEM and LC-OCD

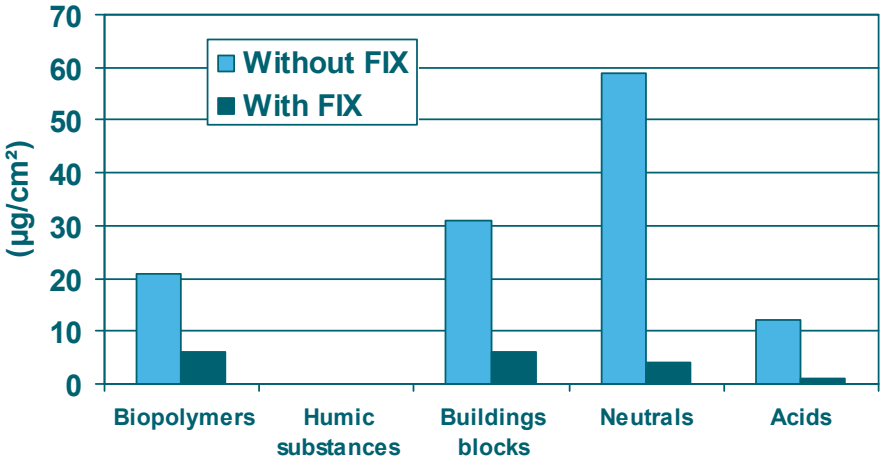
	UV (m^{-1})	DOC (mg/L)	SUVA (L/mg.m)
NF membrane	**97**	**70**	**1,4**
NF+FIX membrane	**35**	**12**	**2,9**

Membrane autopsy

Membrane Extraction



LC-OCD results



There is less organic matter on the membrane after the FIX treatment

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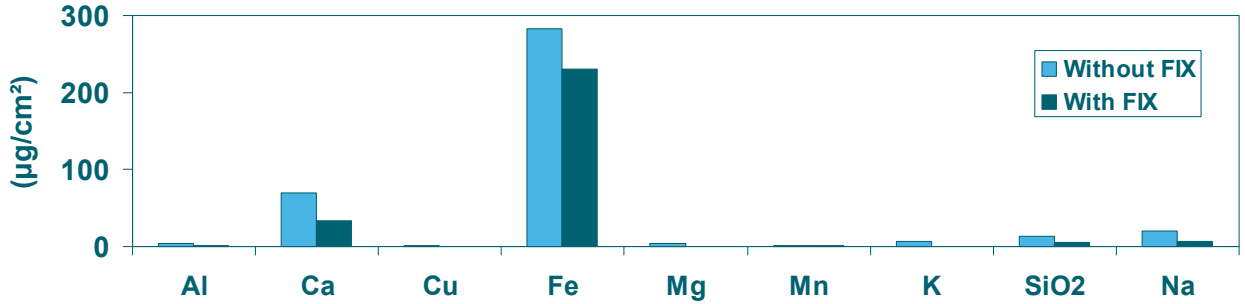
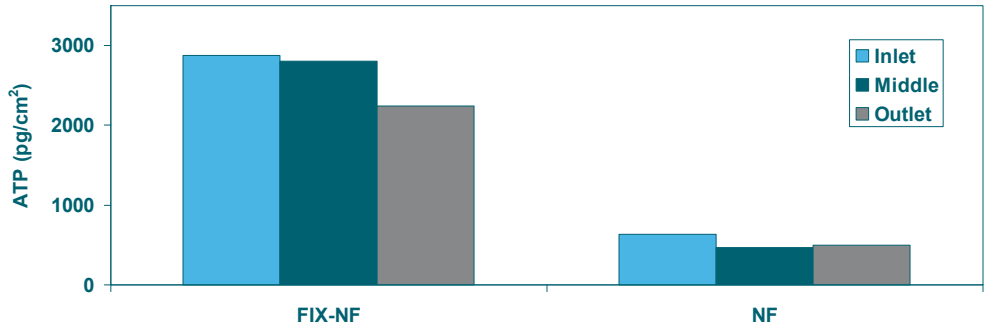
Membrane autopsy

Membrane Extraction



Inorganic matter:
ICP-MS

There is less inorganic matter deposit after FIX treatment



Biomass:
ATP

More active biomass on the NF membrane after FIX

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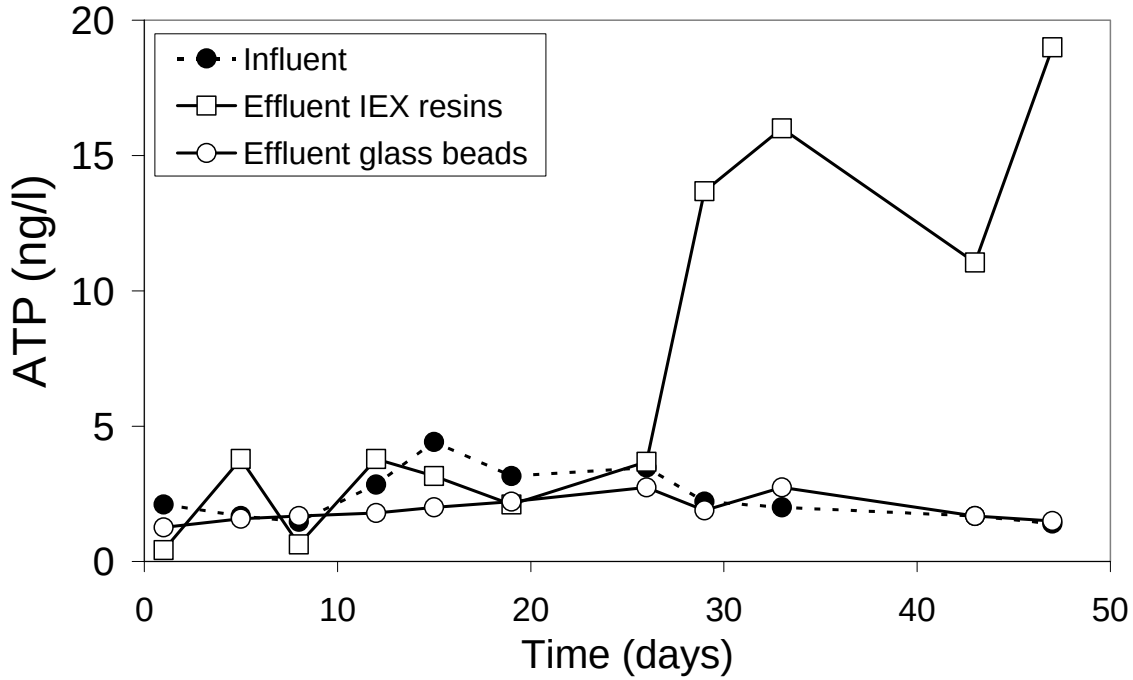
Effect of IEX resin

Biological activity of the IEX resin

ATP: FIX experiment is repeated in a small columns filled with (i) Lewatit VPOC 1071 resin and (ii) glass beads during 45 days



Effect of IEX resin

Biological activity of the IEX resin

Autopsy analysis:

	ATP (pg/cm^2)	TDC (cells/cm^2)
Glass beads	**1.1**	**6.10^4**
IEX resin	**121**	**$3.1.10^6$**

Higher ATP values for resins compared to glass beads

2 Hypotheses:

1- IEX resins contain constituents from the manufacturing process acting as nutrients for bacterial growth

2- NOM accumulated in IEX bed act as nutrients for bacterial growth

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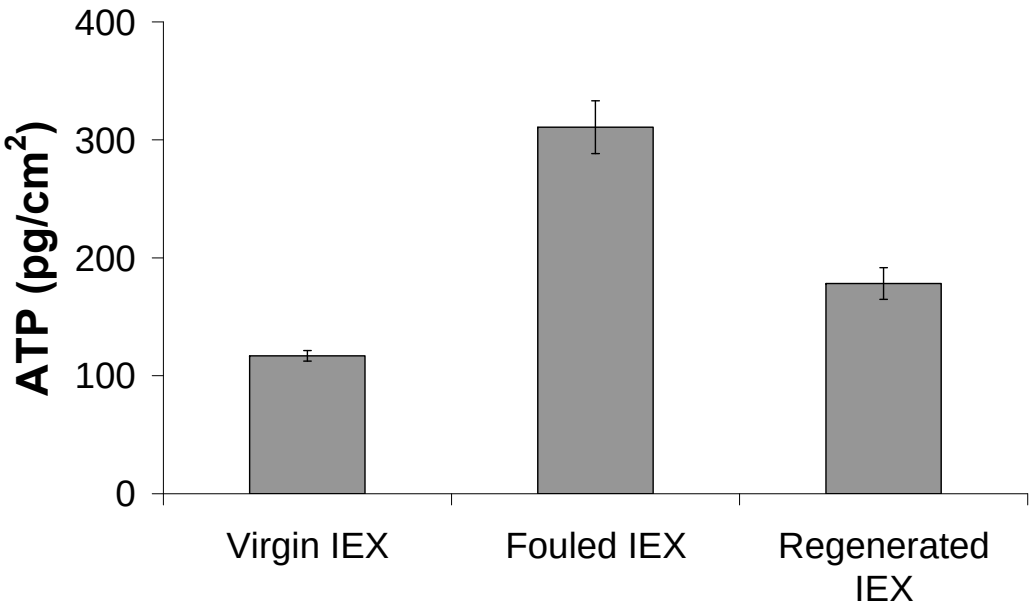
Effect of IEX resin

Biological activity of the IEX resin

BPP tests of IEX resins



Higher release of growth promoting material for fouled IEX resins

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Conclusions

FIX followed by NF experiment

- *Water quality analyses*: There is less NOM after the FIX treatment
- *Autopsy results*: There are different types of fouling types on the membrane **Organic and Biofouling**

- **More biofilm formation** on the NF membrane after FIX treatment. Accumulated NOM as nutrients
- **Less organic fouling** on the NF membrane after FIX treatment. It is due to NOM removal by IEX resins

FIX treatment does not improve NF

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Thank you for your attention

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