



# Ceramic nanofiltration for NOM-ion exchange brine treatment

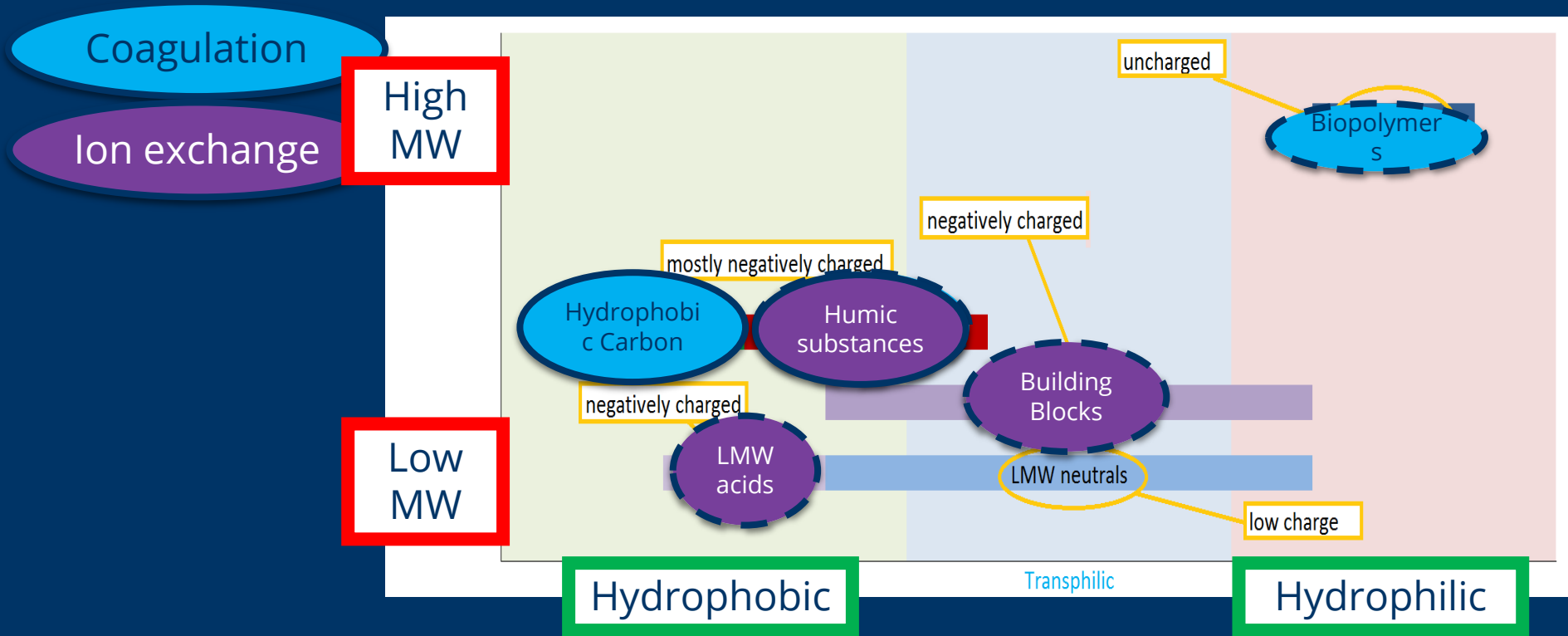
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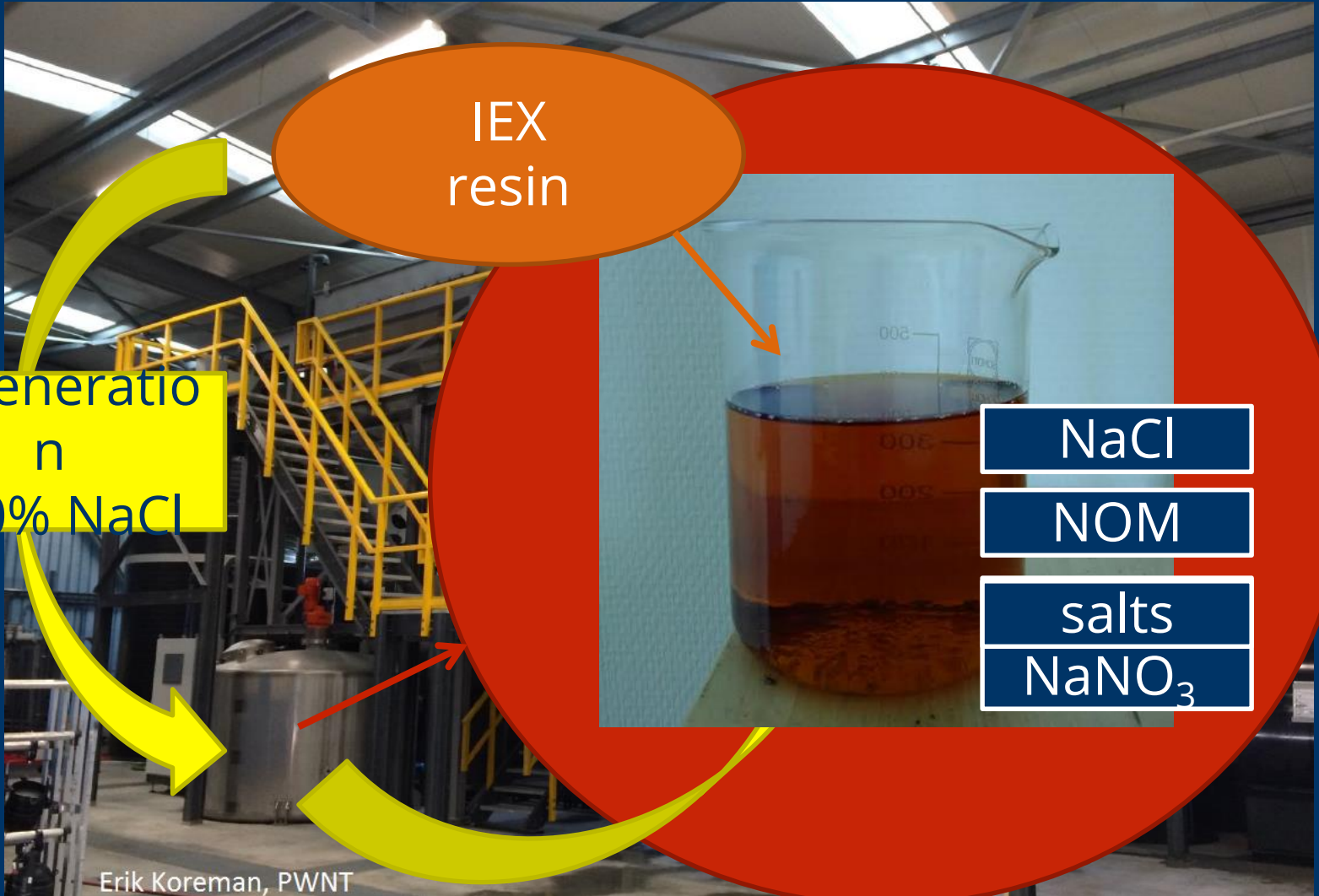
1. NOM-rich IEX brine

2. TU Delft: ceramic nanofiltration

# NOM removal: why IEX?



# NOM-rich brine



# Manage brine in DOC2C`s region



# Manage brine in DOC2C` s region

Reuse

Recover

- PWNT, Andijk (NL): 5x
- Vitens, Spannenburg (NL): 3x
- VMV, Blankaart (B): after coagulation

# Manage brine in DOC2C`s region

Reuse

Recover



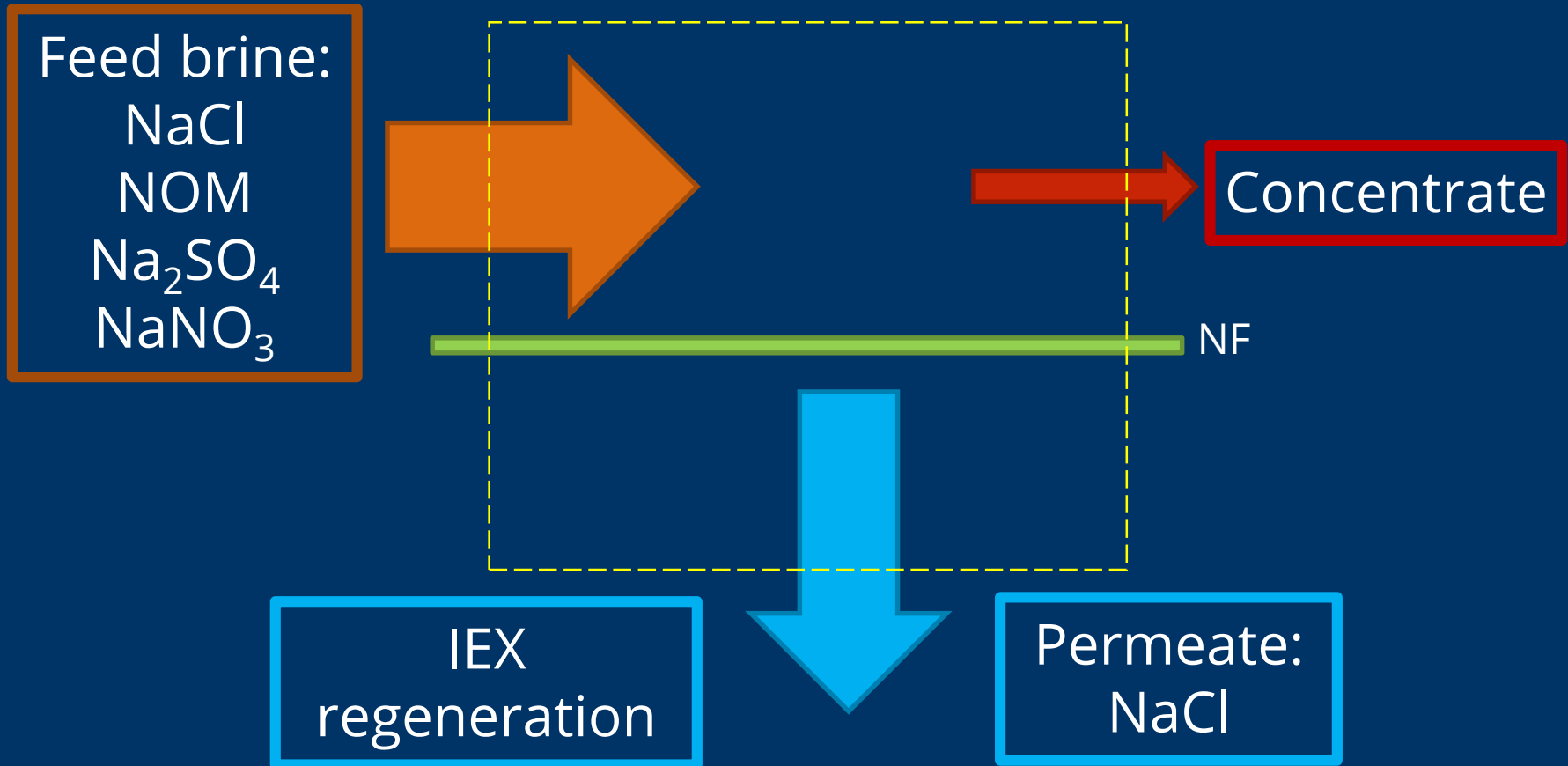
- Vitens, Spannenburg (NL): Nanofiltration.
- PWNT, Andijk (NL): Biological denitrification, Electrodialysis, Dynamic Vapor Recompression. Nanofiltration.
- VITO, (B): Nanofiltration, Membrane distillation.

1. NOM-rich IEX brine

2. TU Delft: ceramic nanofiltration



# Nanofiltration NOM-rich brine



# NF membranes for NaCl recovery

- Cleaning and handling

resistant

- Passage of Cl<sup>-</sup>

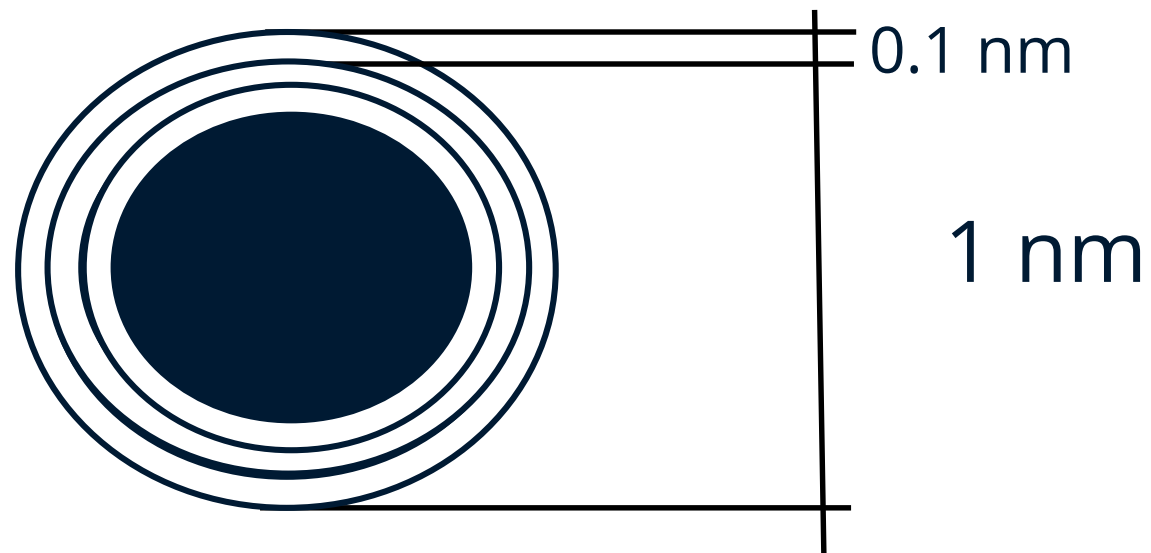
uncharged

- Retention of SO<sub>4</sub><sup>-</sup> and NOM

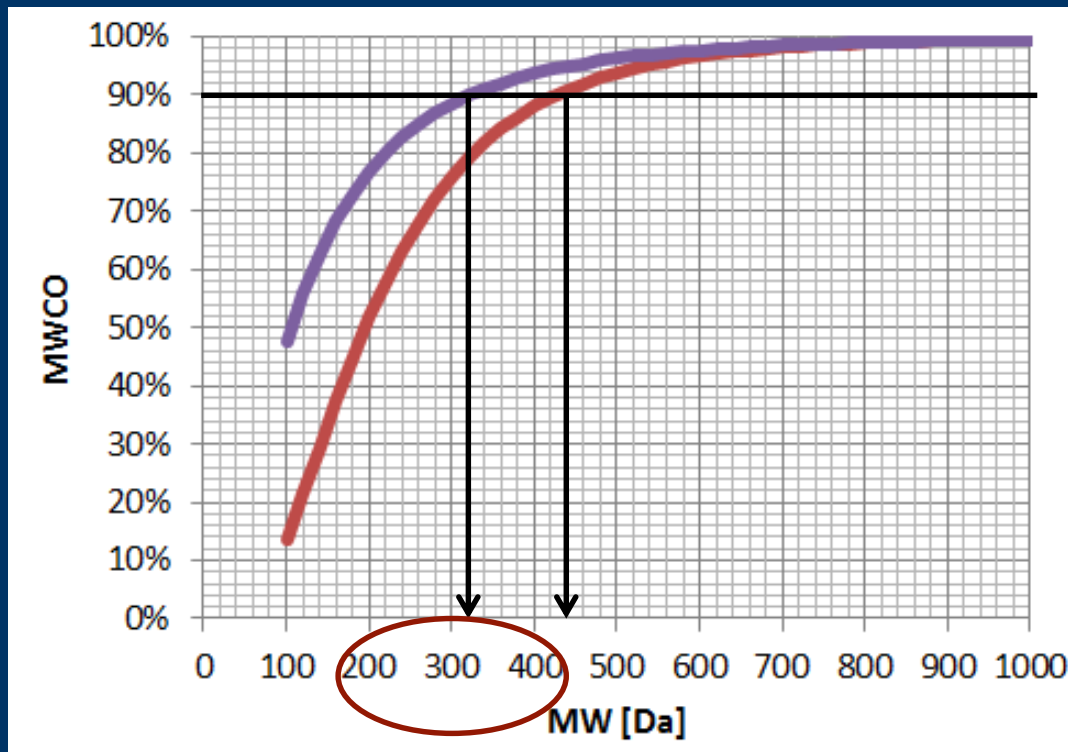
Atomic Layer Deposition

Ceramic membrane

# Pore size reduction: TiO<sub>2</sub> ALD



# Pore size reduction: TiO2 ALD

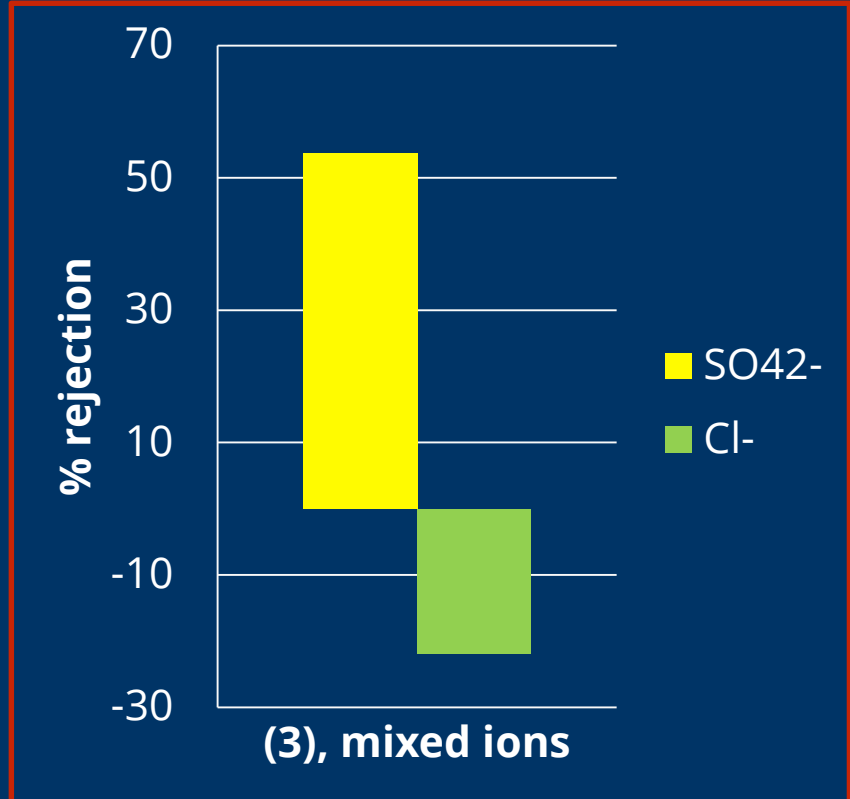
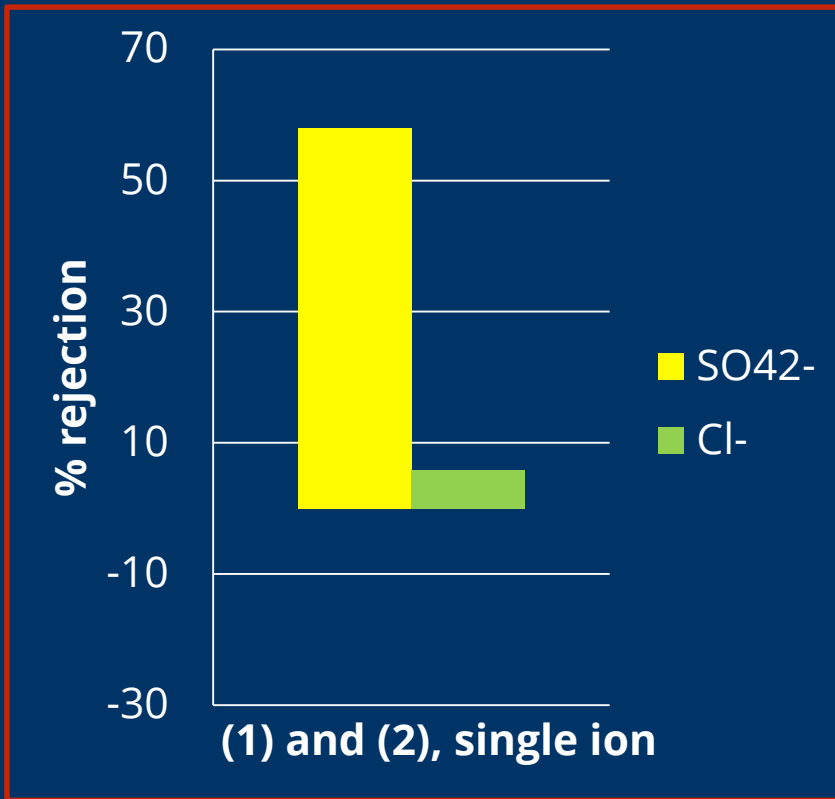


NOM  
separation

Biopolymers	>10000 Da
Hydrophobic C	1000-800 Da
Building Blocks	600-350 Da
LMW	<350 Da

$\text{SO}_4^{2-}$  and  $\text{Cl}^-$   
separation

# Electroneutrality (mixture)



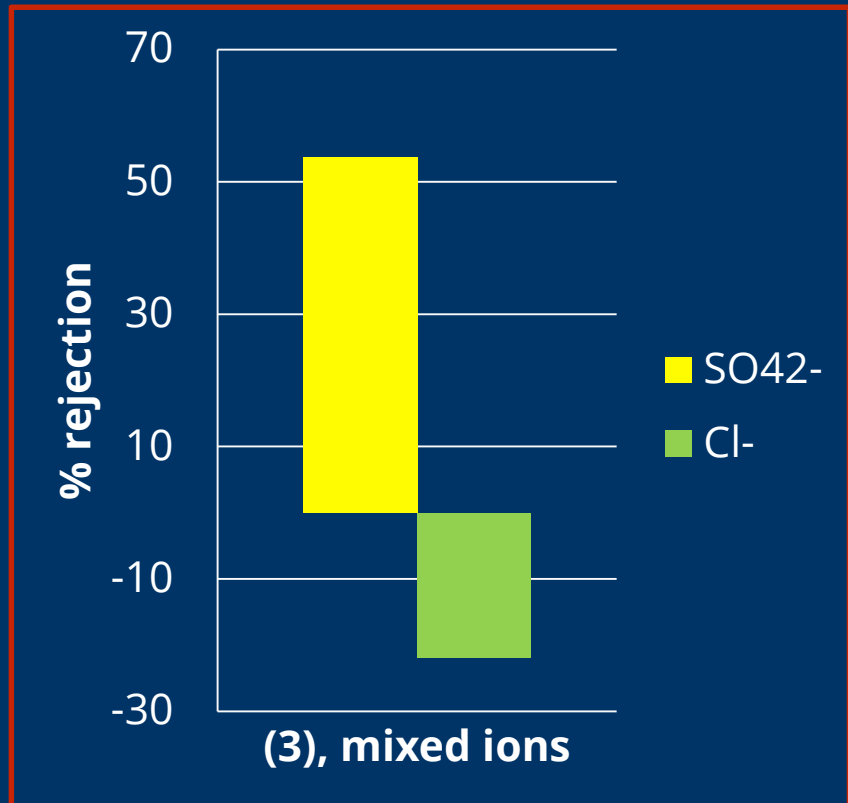
# Nanofiltration in DOC2C`s region

Site	NOM permeate (feed) mg/L	Cl <sup>-</sup> permeate (feed) g/L	SO <sub>2</sub> <sup>4-</sup> permeate (feed) g/L	Reference
Spannenburg	0.125 (45) PtCo humic acids	23 (22.5)	Not available	Schippers et al., 2005
Andijk	6-90 (200-500) DOC	6-35 (7-28)	0.2-3.5 (6.5-11)	Vaudevire and Koreman, 2013
Somewhere in Belgium	2.2 (4) TOC	14.7-15.1 (20.1)	<0.003 (0.088)	Ceulemans et al., 2015

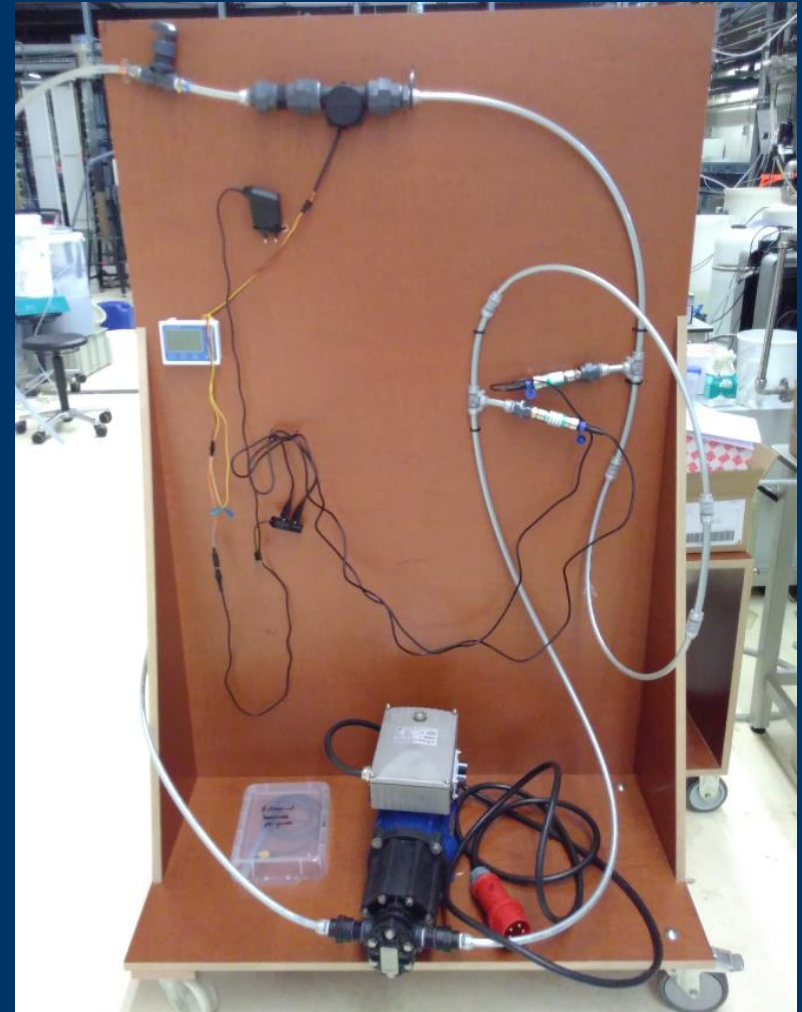
# Electroneutrality (mixture)

Donnan exclusion

Steric effect?



# Test NF installation





# Conclusions

- Ongoing research on NOM-rich brine
- TU Delft: modified ceramic membranes
- Steric effect of ceramic nanofiltration for NaCl recovery



Thank you!