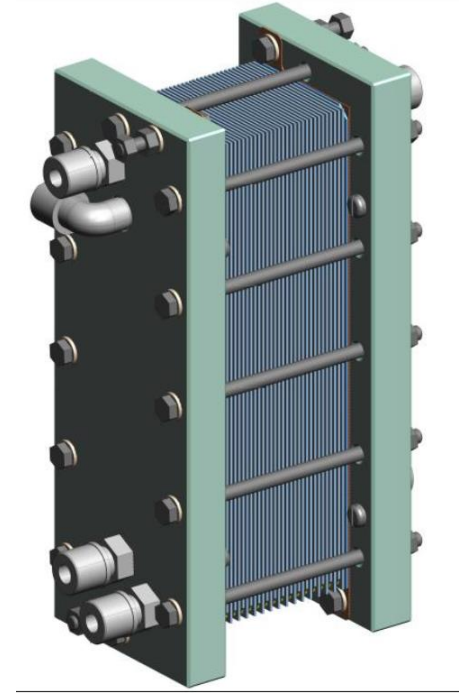
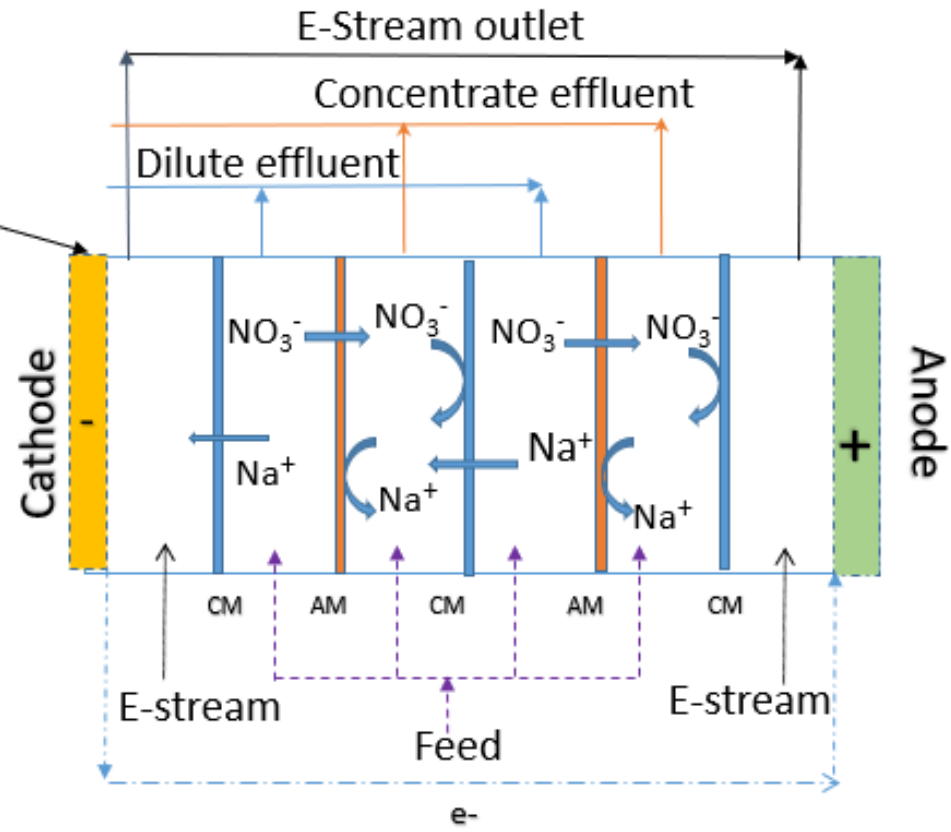


Nutrient recovery from municipal wastewater using ED/EDI

Rubaba Mohammadi





Objectives:

ED and EDI

- Optimization of nutrient recovery from different source point of wastewater treatment plant
- Compare the products
- Compare the energy consumption
- Cost

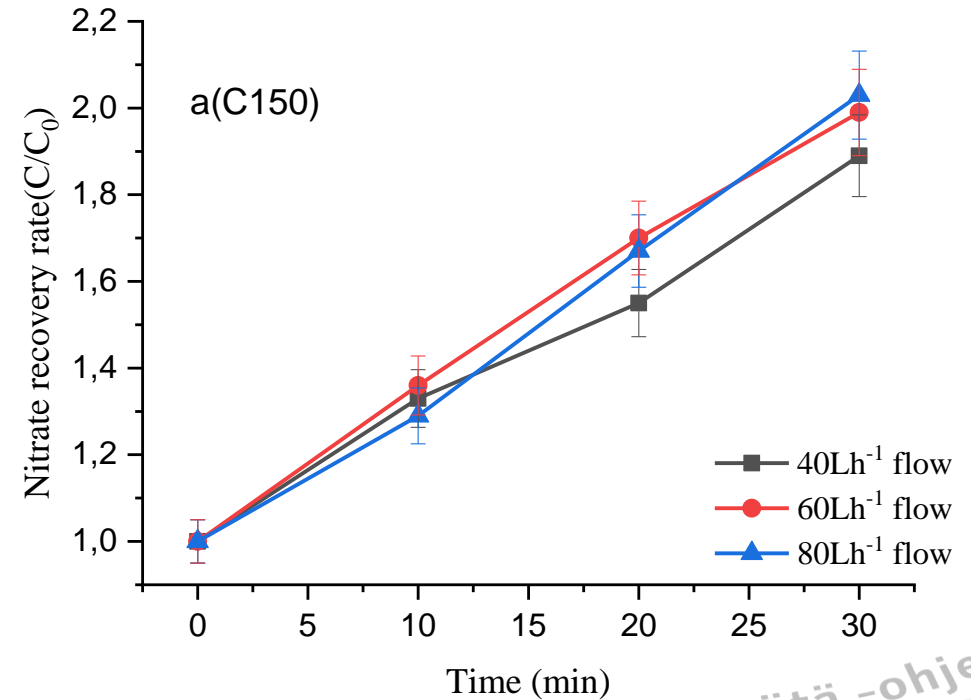
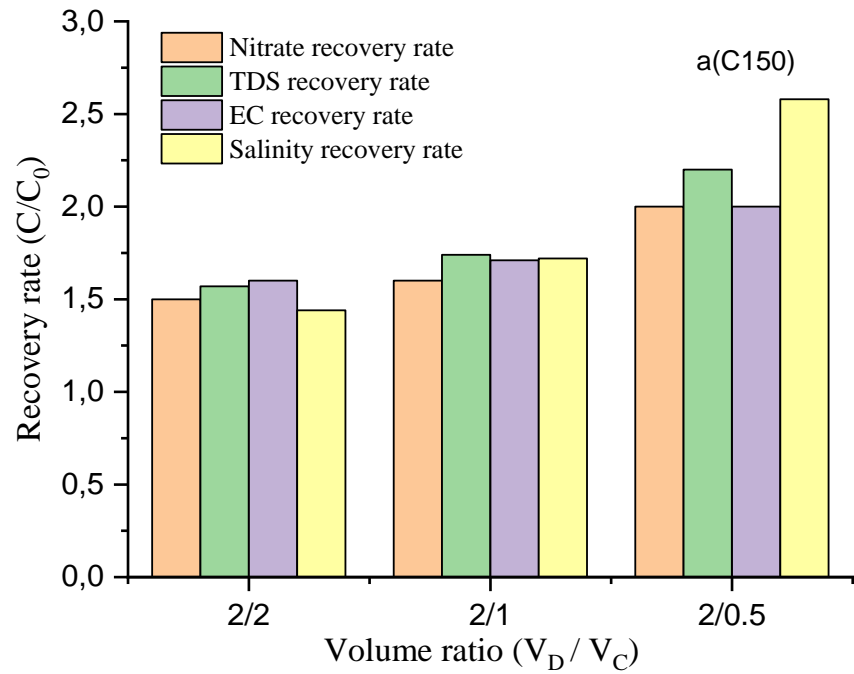
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Effect of volume and flow rate:



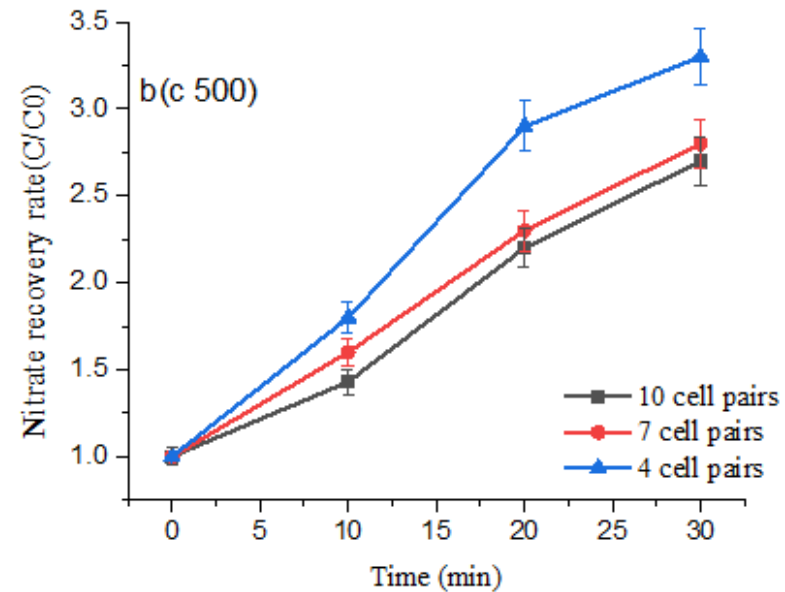
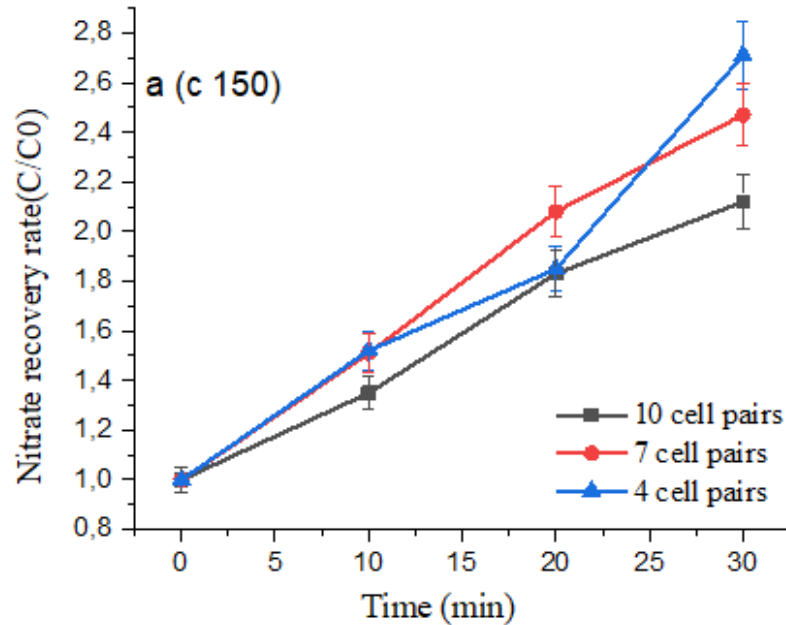
Operating time: 20 minutes, voltage:6.6 v

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Effect of cell pairs:



The recovery rate of nitrate as a function of the cell pairs in 150 and 500 mgL⁻¹ NO₃⁻ concentration (flow rate 60 Lh⁻¹, operation time 30 min, VD/VC 2/0.5).

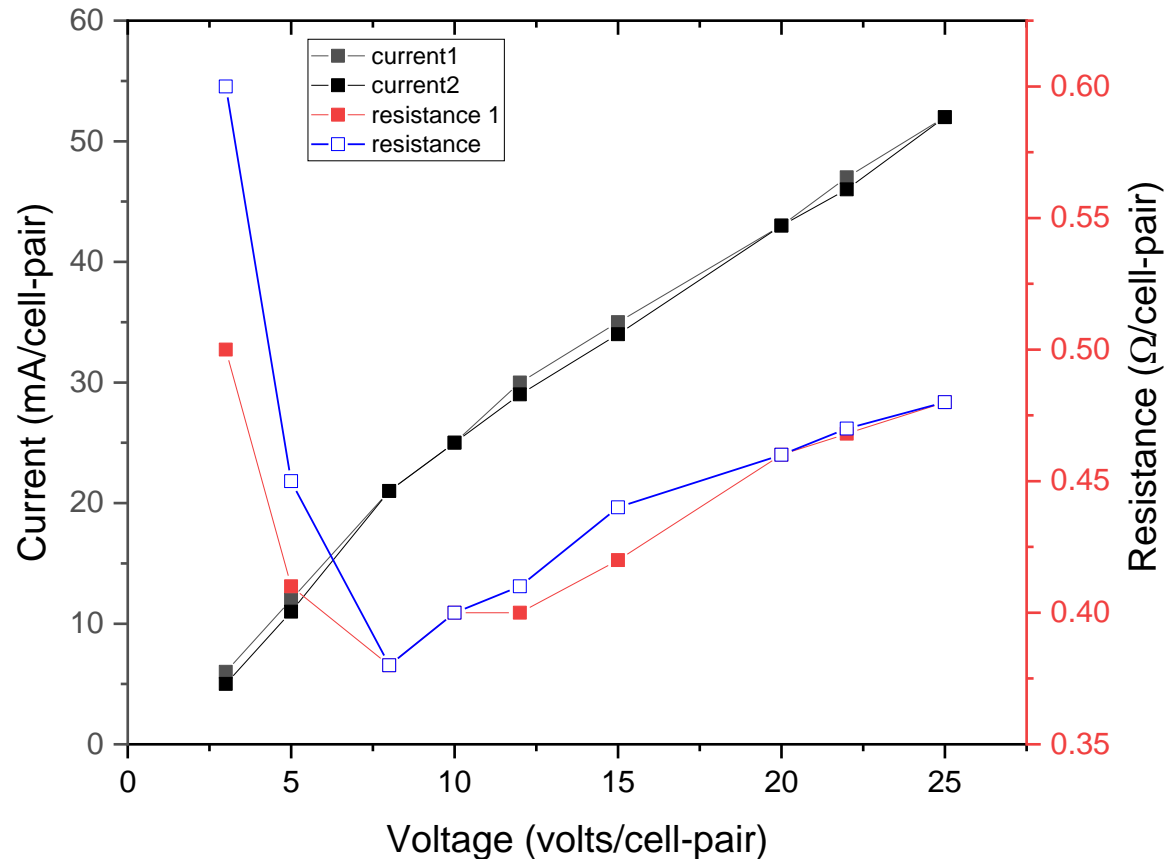
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Nutrient recovery in present of other ions from MBR effluent:



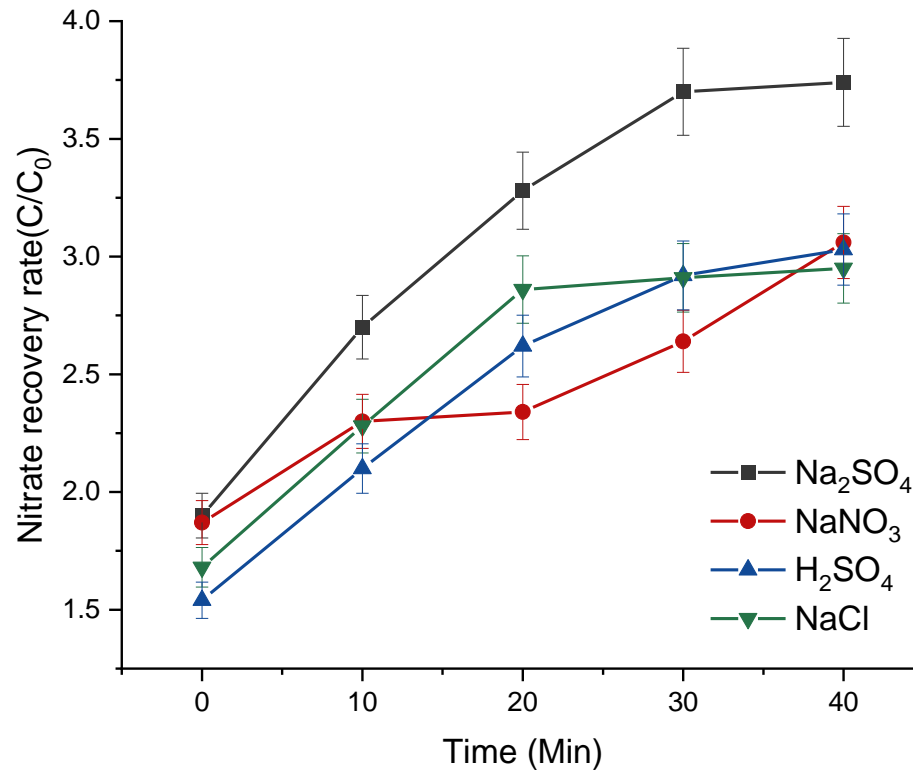
Limiting current density of multi anions solution and MBR permeate

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Effect of different electrolyte type on ED efficiency (secondary settling clarifier):

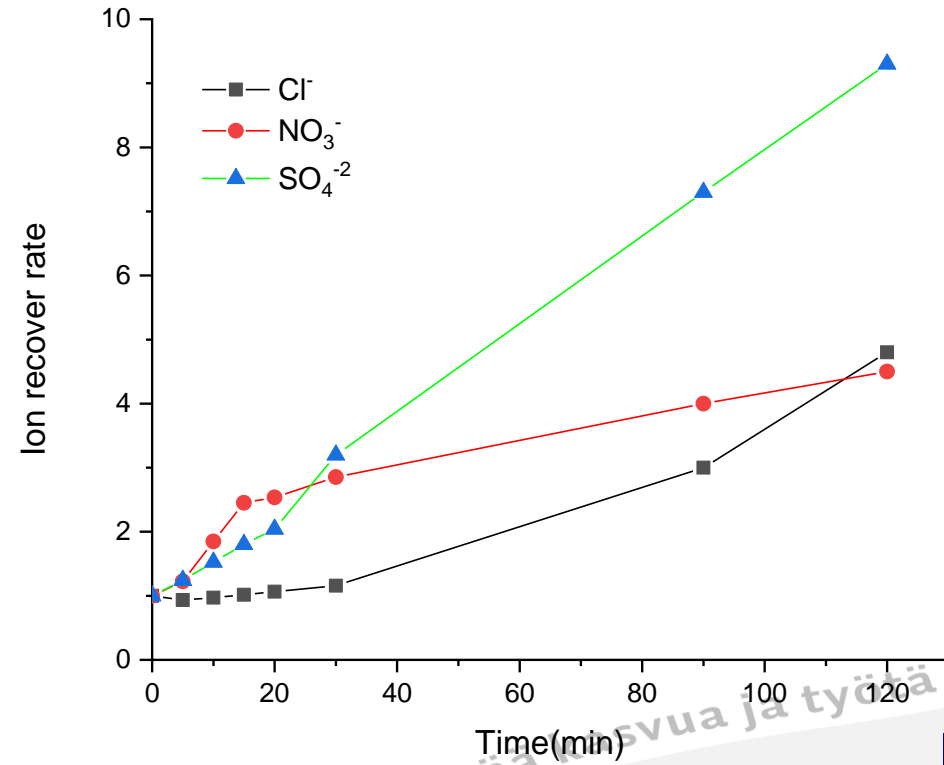
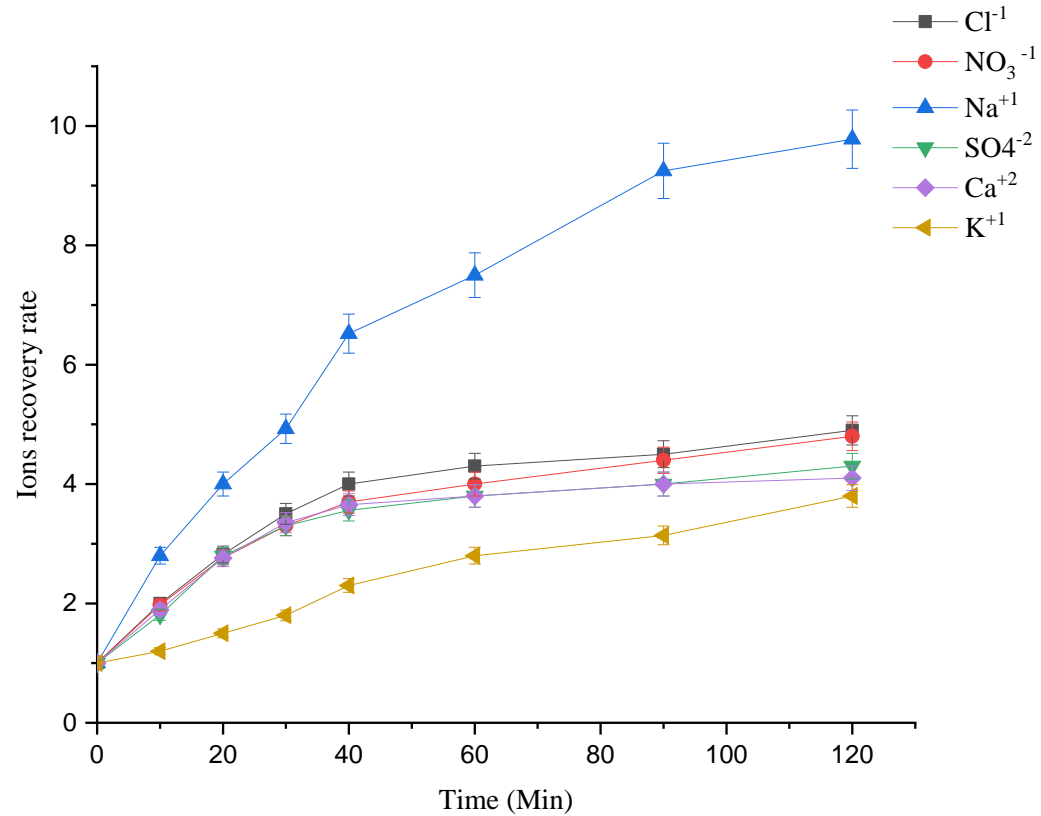


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Nutrient recovery in present of other ions (secondary settling clarifier and MBR):

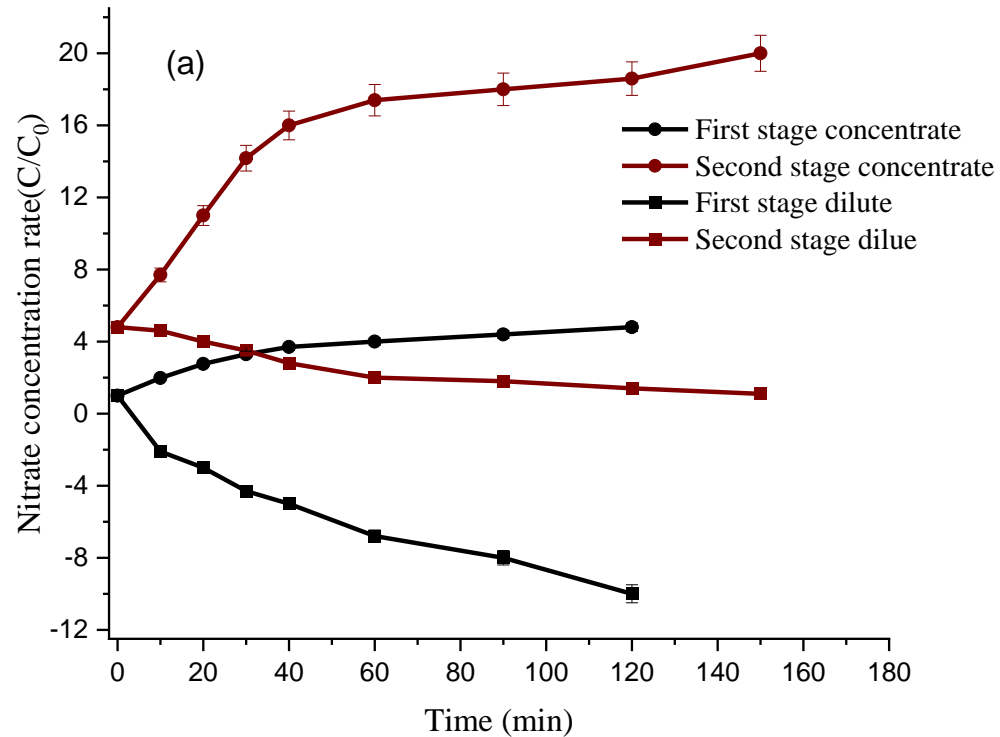


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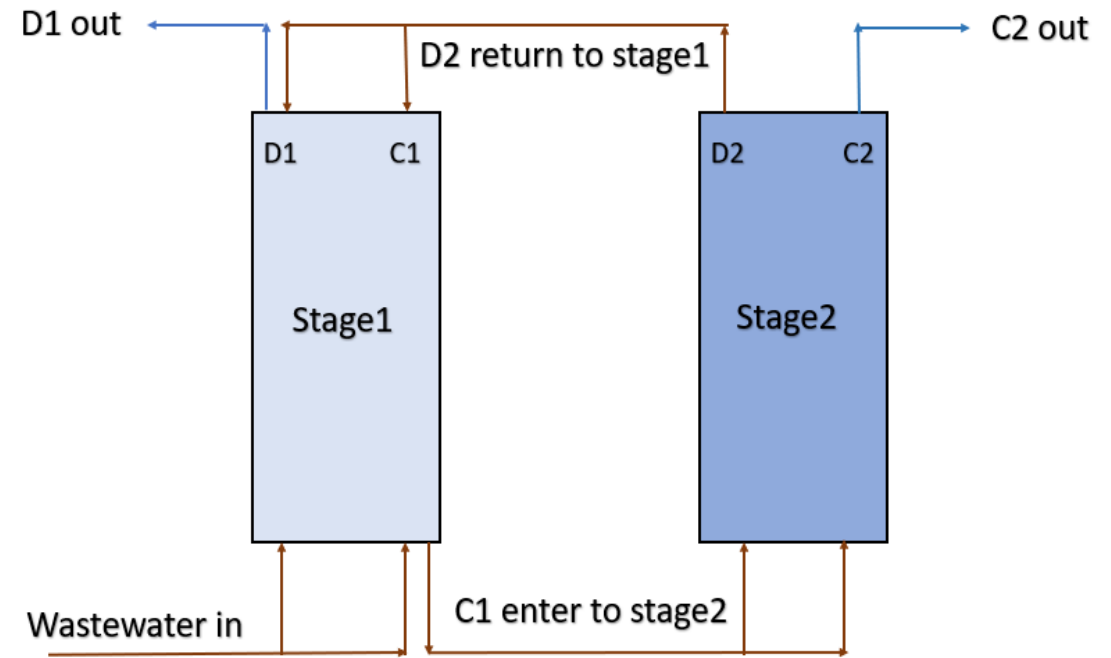
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Two stage batch ED on nitrate efficiency (secondary settling clarifier):



Effect of multi-stage batch ED on NO_3^{-1} recovery and removal rate minus rate numbers represent the removal rate



Process design of the two-stages-batch ED system.

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Parameter	Table	World Health Organization	European Union	Potable water	Diluted product	wastewater	Concentrated product	Concentrated product(s tage2)
Aluminum	Al		0,2 mg L ⁻¹	0.03	0	0.02	0.03	0.05
Cadmium	Cd	3 µg L ⁻¹	5 µg L ⁻¹		0	0	0	0
Calcium	Ca	mg L ⁻¹		56.92	0	52.4	214.48	850
Chromium	Cr	50µg L ⁻¹	50 µg L ⁻¹	0	0	0	0	0
Copper	Cu	"	2.0 mg L ⁻¹	0.26	0	0.02	0.03	0.07
Iron	Fe		0,2 mg L ⁻¹	0.03	0.03	0.12	0.06	0.08
Lead	Pb	"	10 µg L ⁻¹	0	0.07	0.12	2.69	40
Magnesium	Mg			6.51	3.8	1.8	11	31
Nickel	Ni	"	20 µg L ⁻¹	0	0.01	0.01	0.01	0.02
Nitrate	NO ₃ ⁻¹	50 mg L ⁻¹	50 mg L ⁻¹	5.9	10	100.8	460	2002
Total dissolved solid	TDS			168	87.8	503	1740	8019
Electric conductivity	EC		2500 µS cm ⁻¹ at 20 °C	234	124	706	2450	8502
Salinity	Sa	mg L ⁻¹		113	59.4	340	1260	4669
pH				7	7.6	7	7.63	7.5
Phosphorus	P			0	0.16	0.27	5.4	22
Total organic carbon	TOC			3.71	6.32	10.19	16.32	25
Potassium	K			15.2	1	33.55	127.3	381
Sulfate	SO ₄ ⁻²			40.9	18.7	113.3	477.3	1908
Sodium	Na			23	9.1	68.2	659.6	3000
Zinc	Zn			0	0	0	0	0
chlorides	Cl		250 mg L ⁻¹	25.4	6.8	67.8	332.7	1200

Standards for potable water, and chemical analysis of potable water of Mikkeli city, feed wastewater, ED diluted and concentrated product

Total energy consumption: 1.24 kWh kg⁻¹ NO₃⁻¹, 2 L recovered water per 0.5 L concentrated solution

kasvua ja työtä -ohjelma

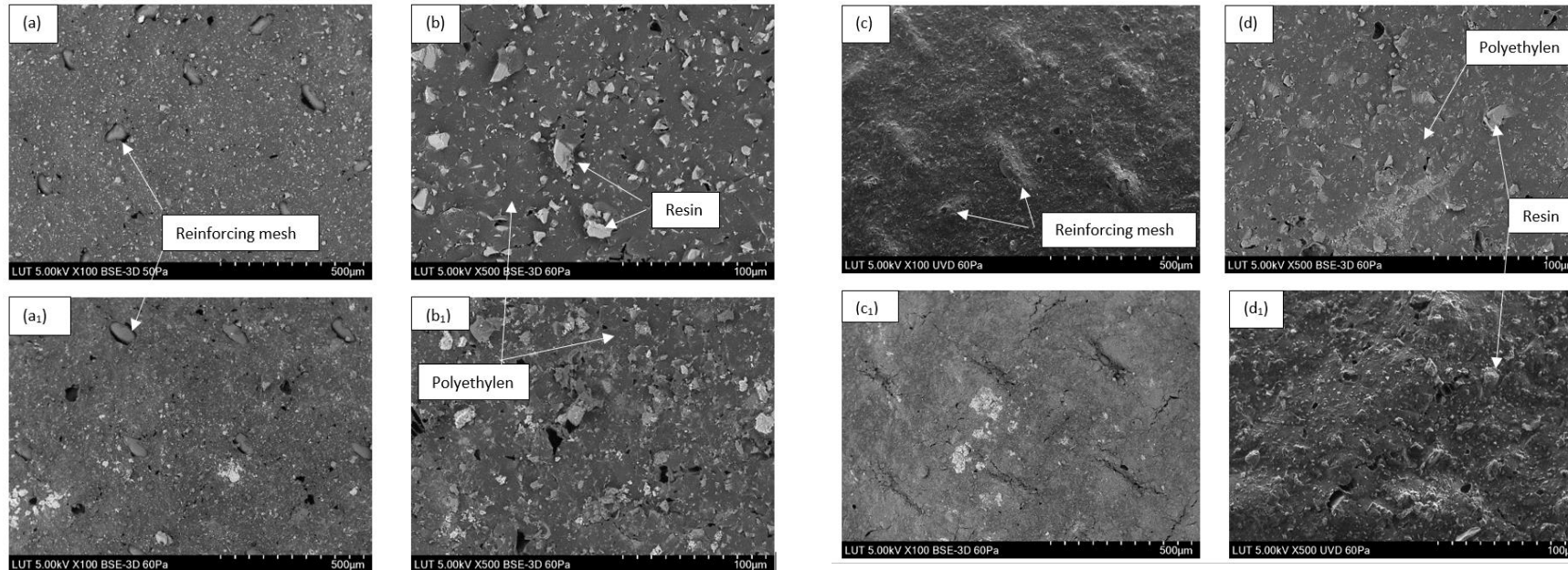
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Fouling:

TOC analysis : The TOC content decreased from $10.19 \pm 1.2 \text{ mg L}^{-1}$ to the average $6.32 \pm 0.5 \text{ mg L}^{-1}$ in the diluted stream in 120 min, respectively; while it increased to average of 16.32 ± 1.5 and 25 mg L^{-1} in concentrated solution after ED treatment in 2 cycles 120 min, respectively.



Surface image of membrane(a,b):fresh surface of CEM ,(a₁ , b₁):used surface of CEM,(c,d):fresh surface of AEM,(c₁ , d₁):used surface of AEM

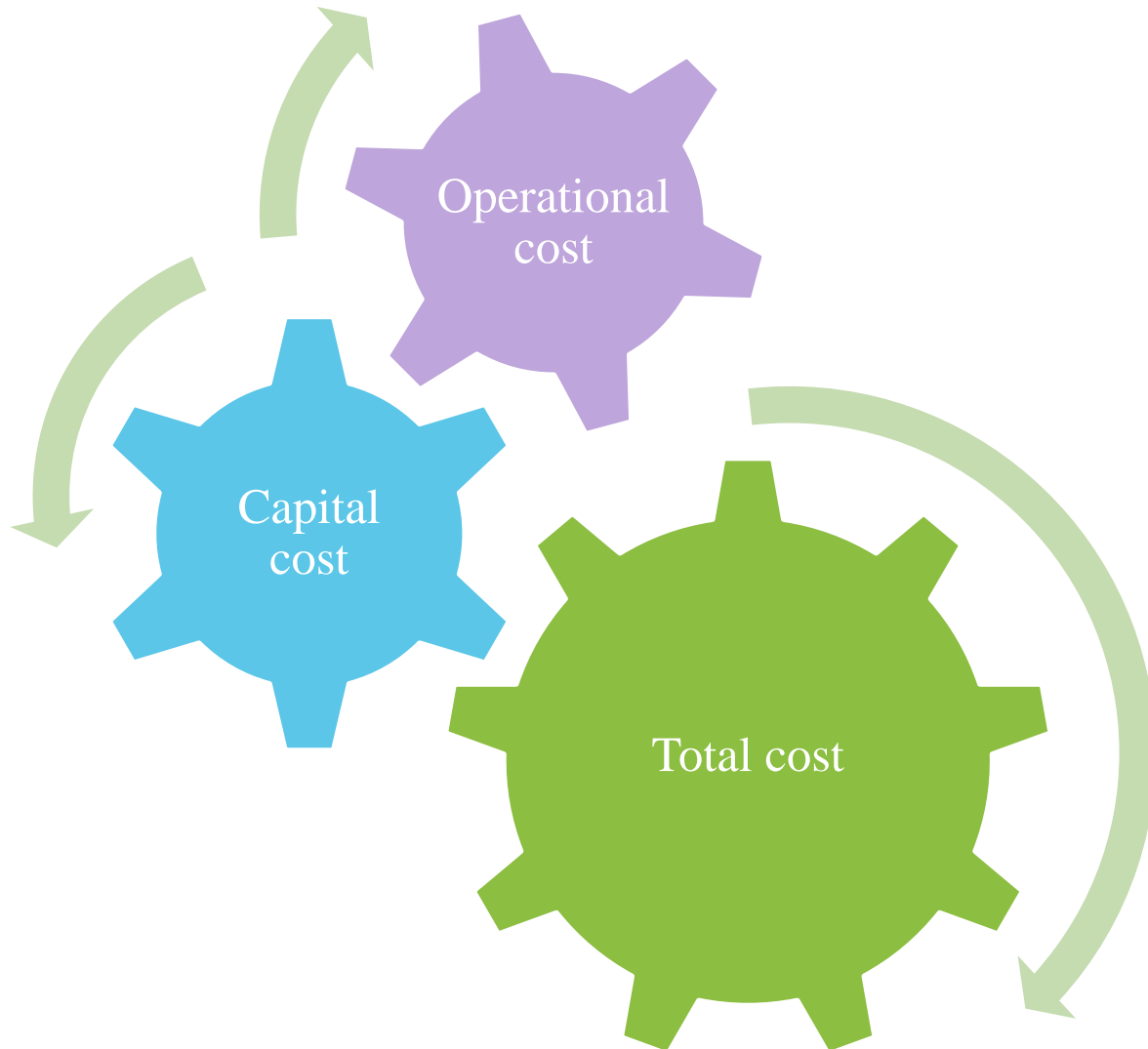
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Total cost:



component	Price
Electrodes	340 €
membrane	85 € /m ²
Spacer	50/m ²
pump	
Valve	
Dosing pump	
Conductivity probes	
pH probe	
Power panel	
flow alarm	
flowmeter	
Blower pump	
Electrolyte salt	
electricity	
personnel	
shipping	
training	

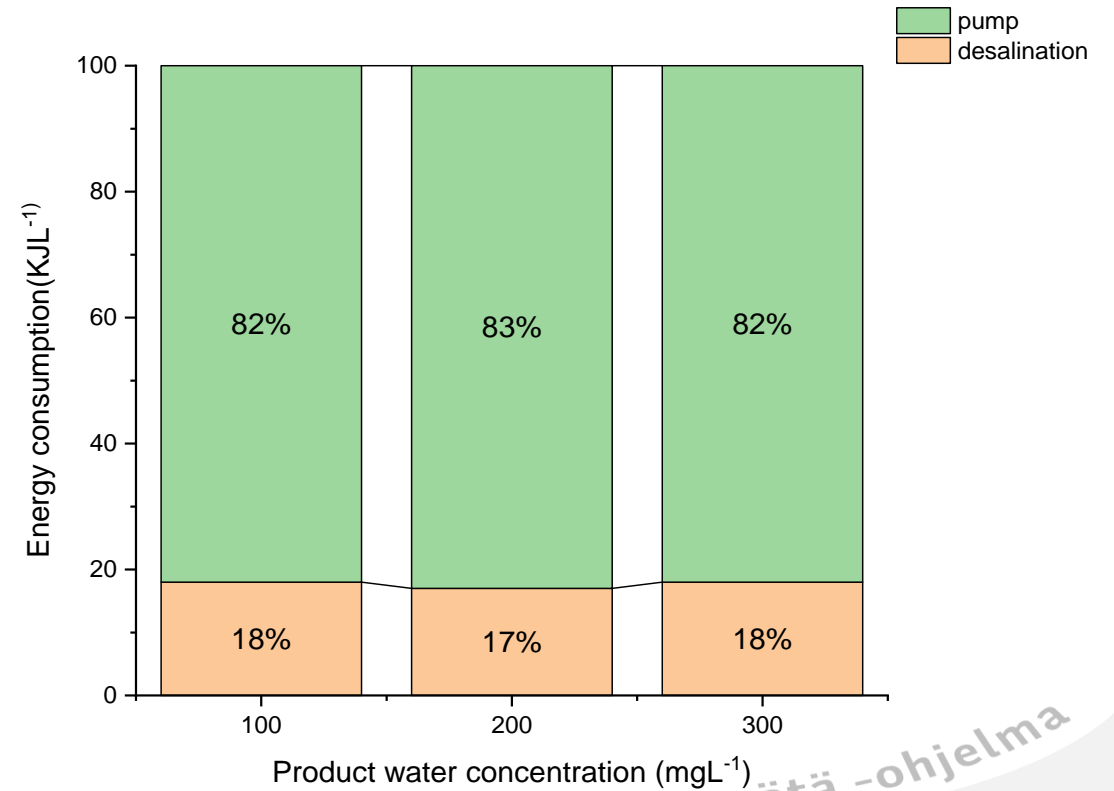
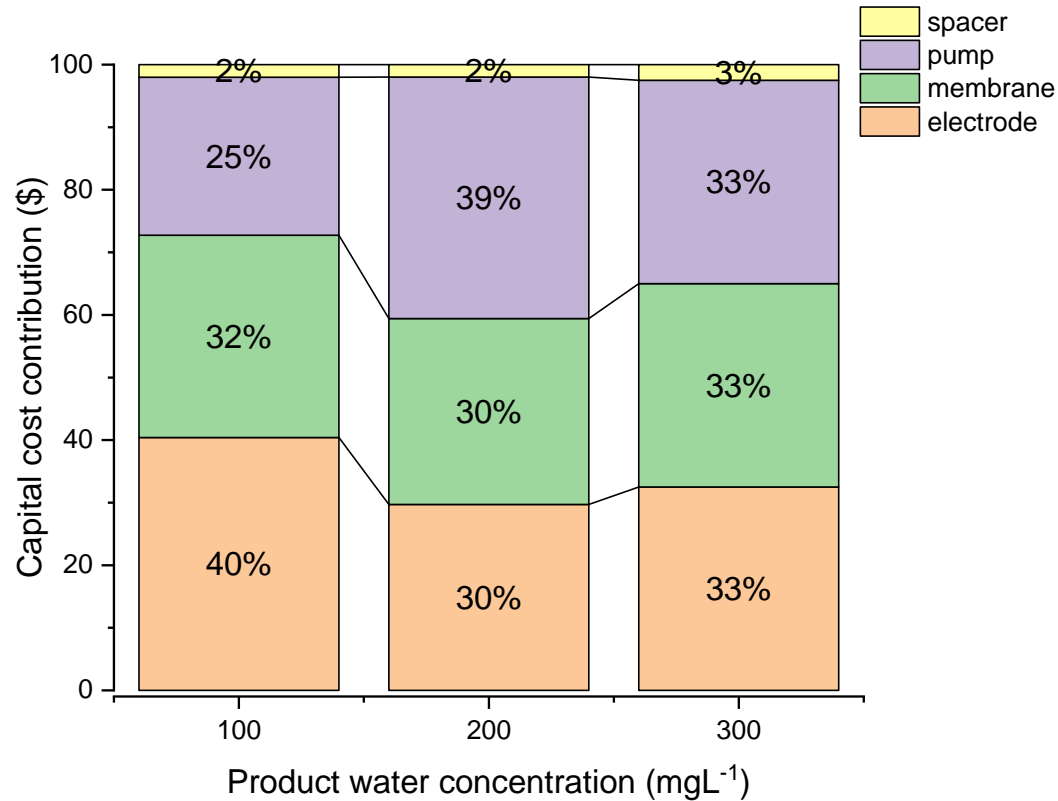
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Operational and capital cost:



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Thank you of you and Mikkeli treatment plant operators

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