

Setup of a 20 m³/h ED/RO plant to produce pure water from river water.

A case study focusing on the electrodialysis process and the compatibility with RO pretreatment

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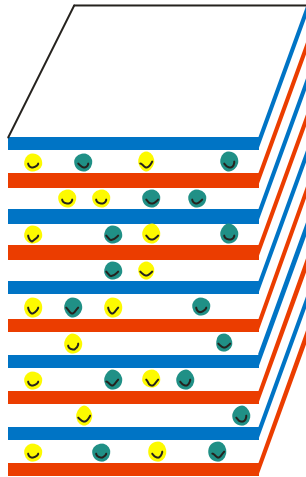


Electrodialysis principle

- Anions move towards anode
- Cations move towards cathode
- Cation exchange membranes let cations through and block anions
- Anion exchange membranes let anions go through and block cations
- Electroneutrality



Electrodialysis Model



Principle of electrodesalination is a stack of alternating cation and anion exchange membranes.

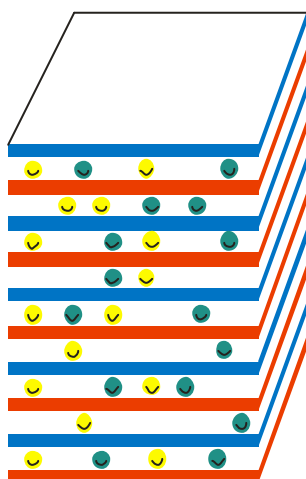
Model:

A tower block with alternating red and blue floors, filled with people

Looking down, you may see either blue or red floors.



Electrodialysis Rules



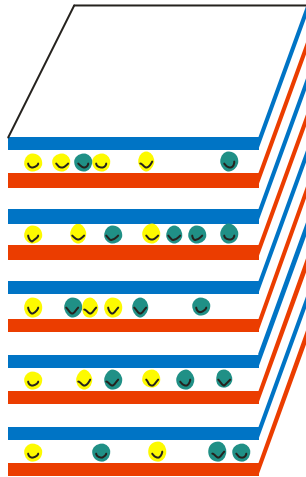
- Yellow: go up! Do not pass blue ceiling!



- Green: go down! Do not pass red floor!



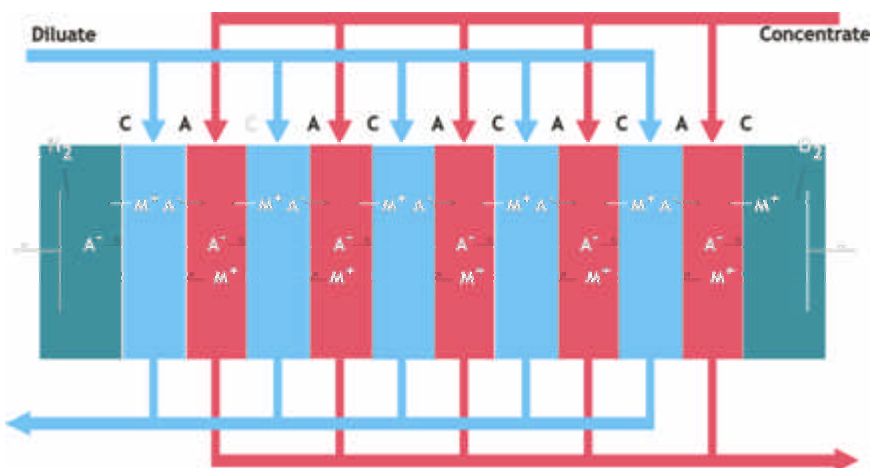
Apply Rules



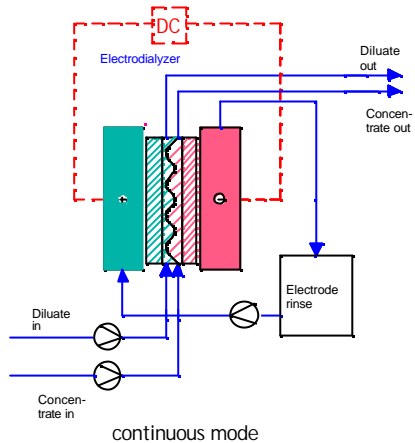
- All have moved until the blocking rule apply.
- Result is: blocking rule apply in each second floor.
- Note: We ignored the electroneutrality, for instance.



An ED stack scheme



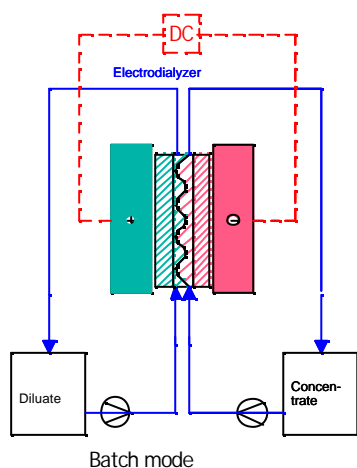
Continuous ED processing



- A Diluate enter the cell, will be processed and leave the cell as the finished product.
- The solute for the uptake of the ions enter the cell and leave it as the final concentrate.
- Electrode rinse will be circulated (option: use of concentrate stream)



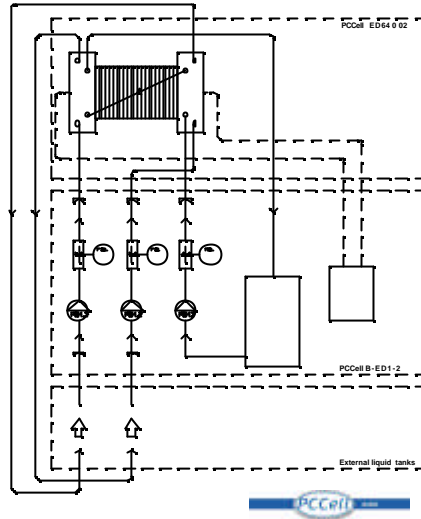
Batch ED process



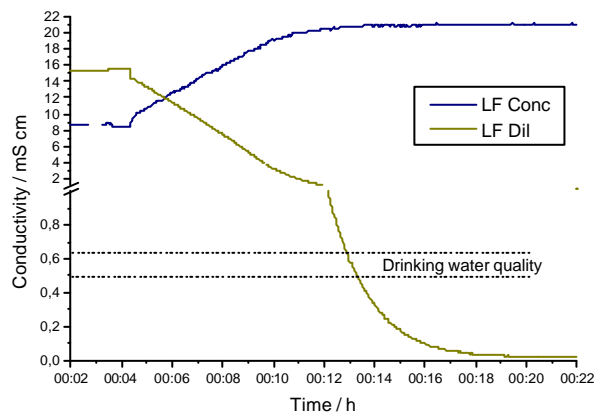
- Each process solution is hydraulical seal and circulated often.
- Ionic concentration shift slowly; each solution remain the same.



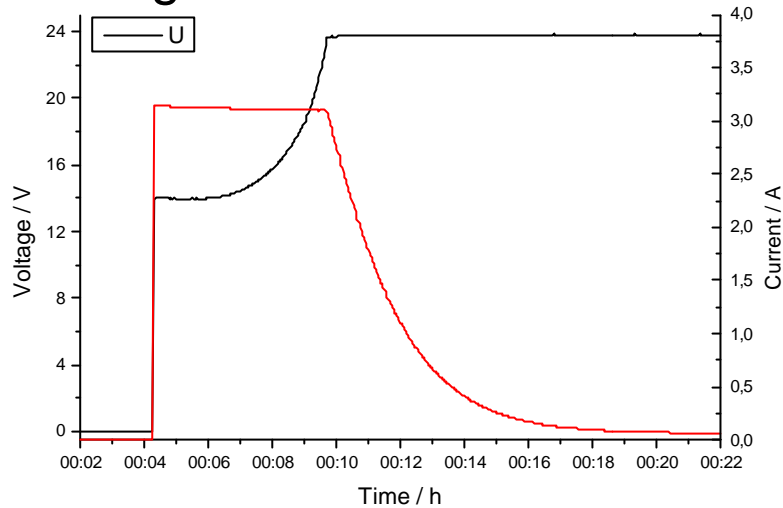
Minimum process requirements



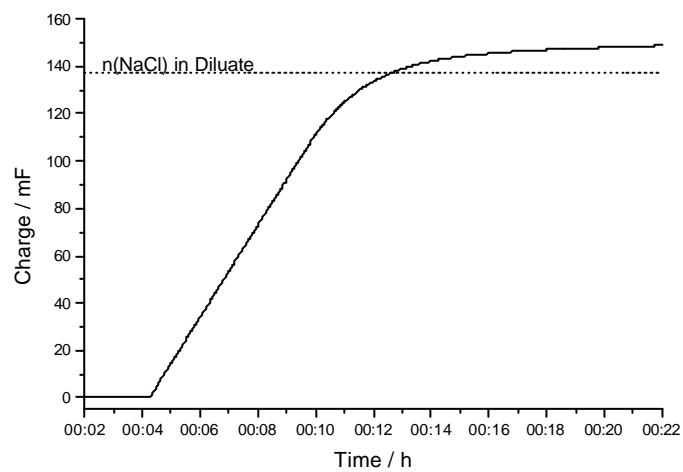
Batch desalination: conductivity of concentrate and diluate



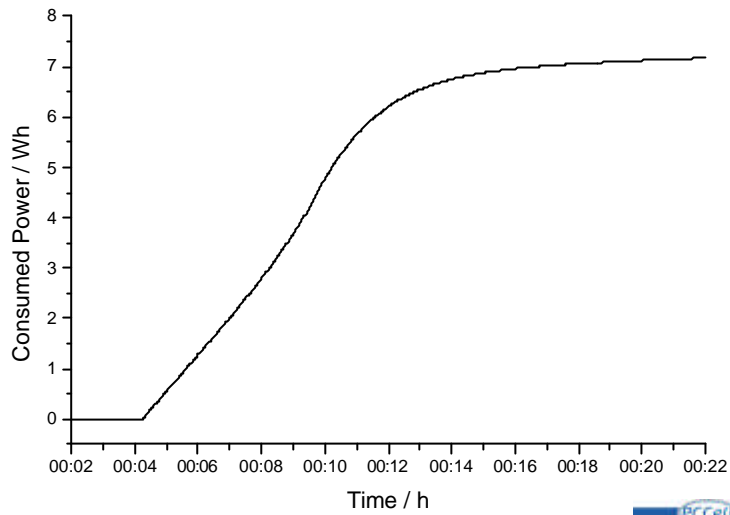
Batch desalination: voltage / current characteristic



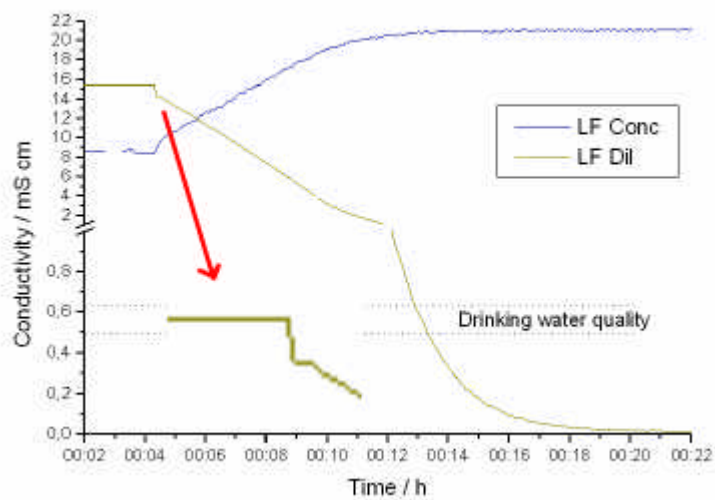
Batch desalination: The charge in course of the process



Batch desalination Power consumption



Starting point of a batch desalination



Sizing an ED unit



Key parameters for ED cell layout

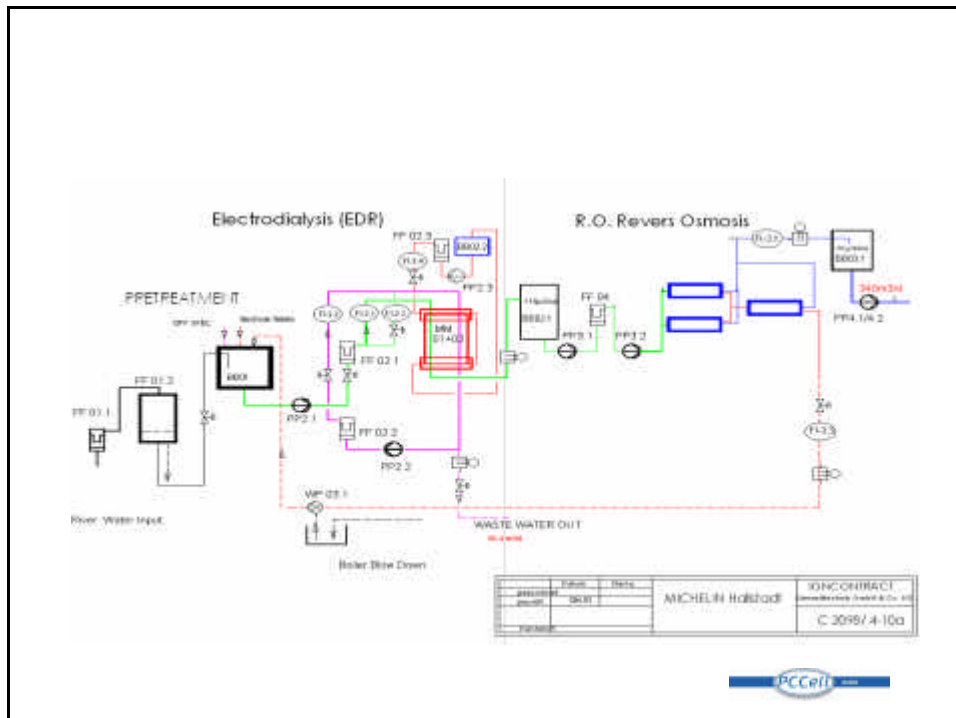
- Membrane area need (How much salt at what current density)?
- What is the conductivity level of diluate?
- How much desalination per single pass (What charge has to be taken up)?
- What is the Amperage and flow per cell?
- What is the final layout?
- 20.000 l / h from 6 mmol/l to 3 mmol/l = about 60 moles = about 1600 Ah
- $10 \text{ A} / \text{m}^2 = 160 \text{ m}^2$ anion membrane area (=460 cell pairs)
- $3 \text{ mmol/l} = \text{about } 290 \text{ As/l}$
- => At a cell with 3,5 A, a minimum flow of 42 l/h is needed minimum.
- The cell needs 50 l/h minimum.
- As EDR is used, some time interrupts are not available:
- Two cells with 400 cell pairs in series have to be set up.



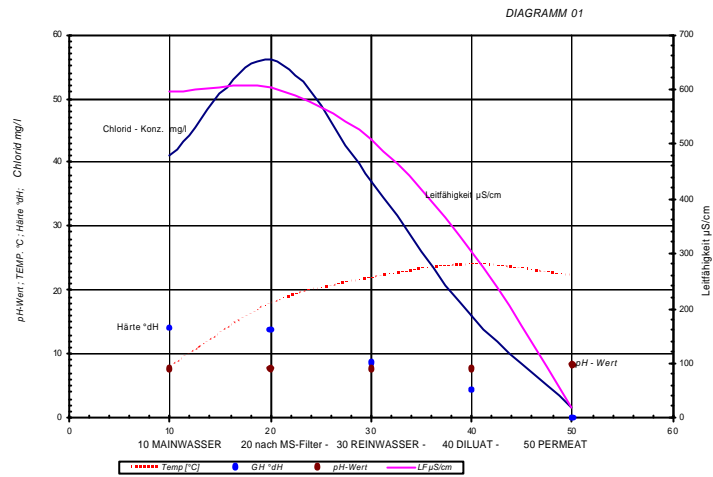
The Setup of a 20 m³/h ED/RO plant to produce pure water from river water.

Task:

- Produce a pure water <20 μ S cm with a maximum recovery rate
- Use also boiler outlet water for recycling



Water quality at the different processing steps



Pump unit of the 20 m² plant with sample valve battery at the right side and ED Stack



RO modules + pretreatment tanks



RO pretreatment
to prevent scaling.

The pretreatment chemicals
remain in the RO
concentrate.

RO concentrate recycling
need a proper adaption of
the pretreatment
chemicals.



10 square meter pilot production unit for pharmaceutical applications

