Leachate treatment by direct capillary nanofiltration

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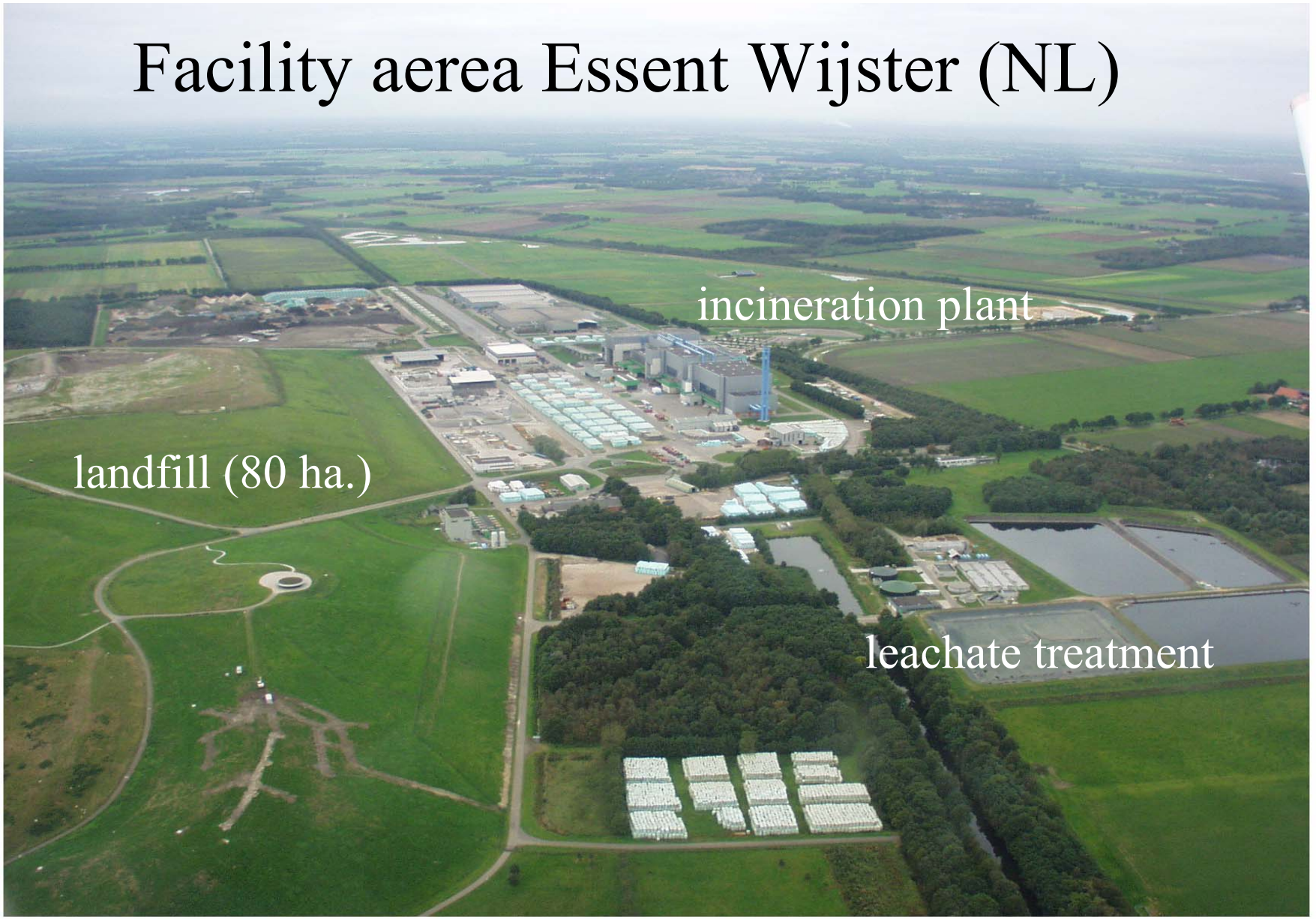
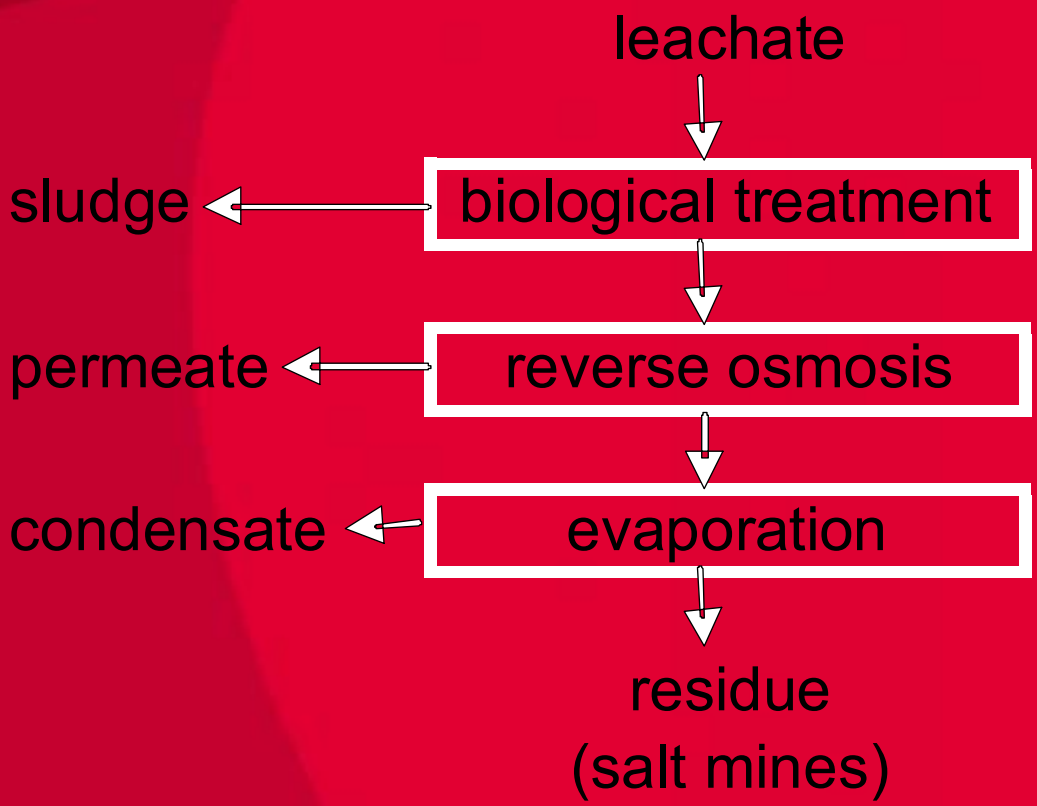
Presentation:

- Introduction; present leachate treatment
- Membrane filtration
- Pilot scale research with nanofiltration
- Proposed full scale plant
- Prospective of nanofiltration in leachate treatment.

Facility aerea Essent Wijster (NL)



Present system:

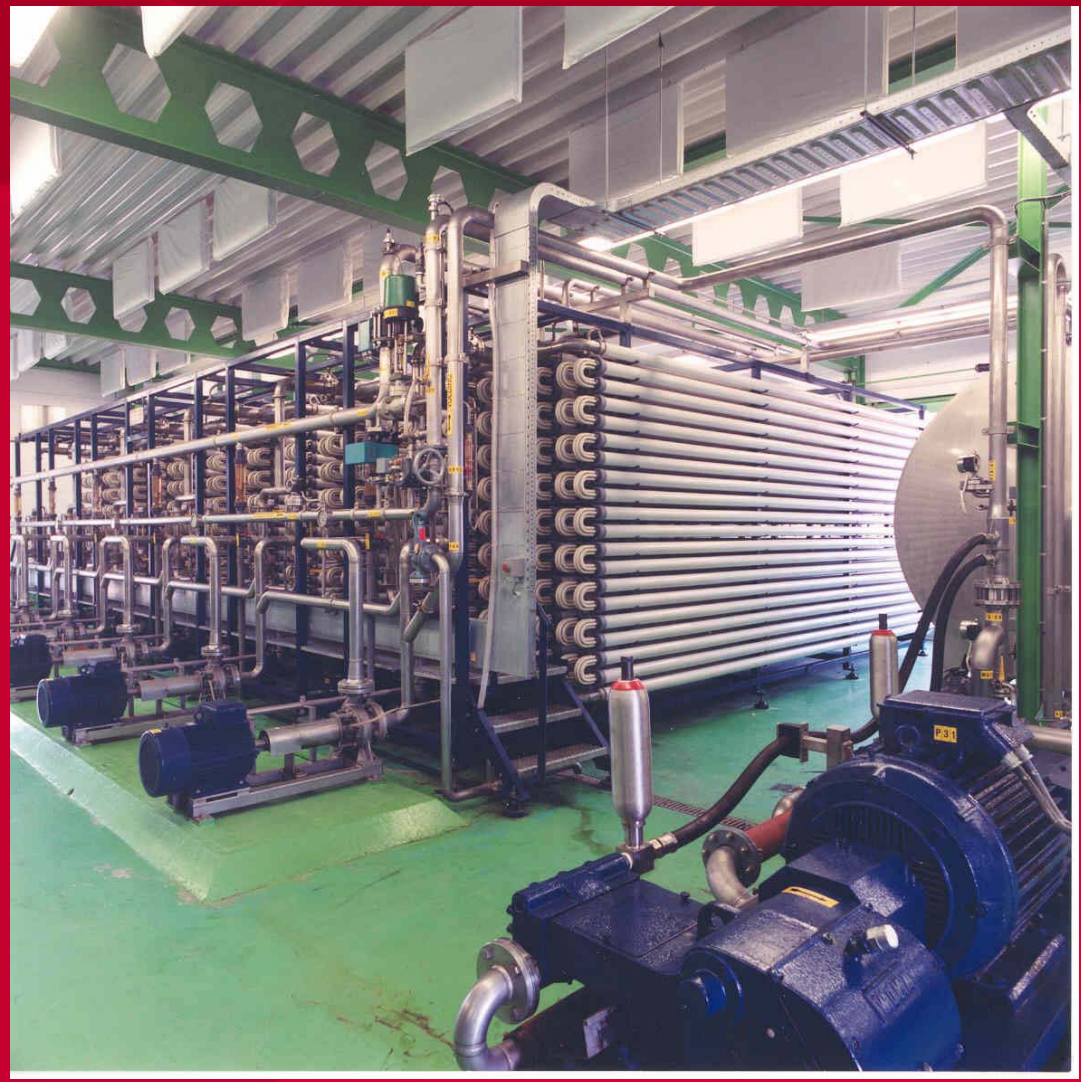


Effluent standards:

- COD 50 mg/l
- BOD 5 mg/l
- Total nitrogen 10 mg/l
- Chloride 200 mg/l

Biological pretreatment

Reverse-osmosis



Evaporation plant

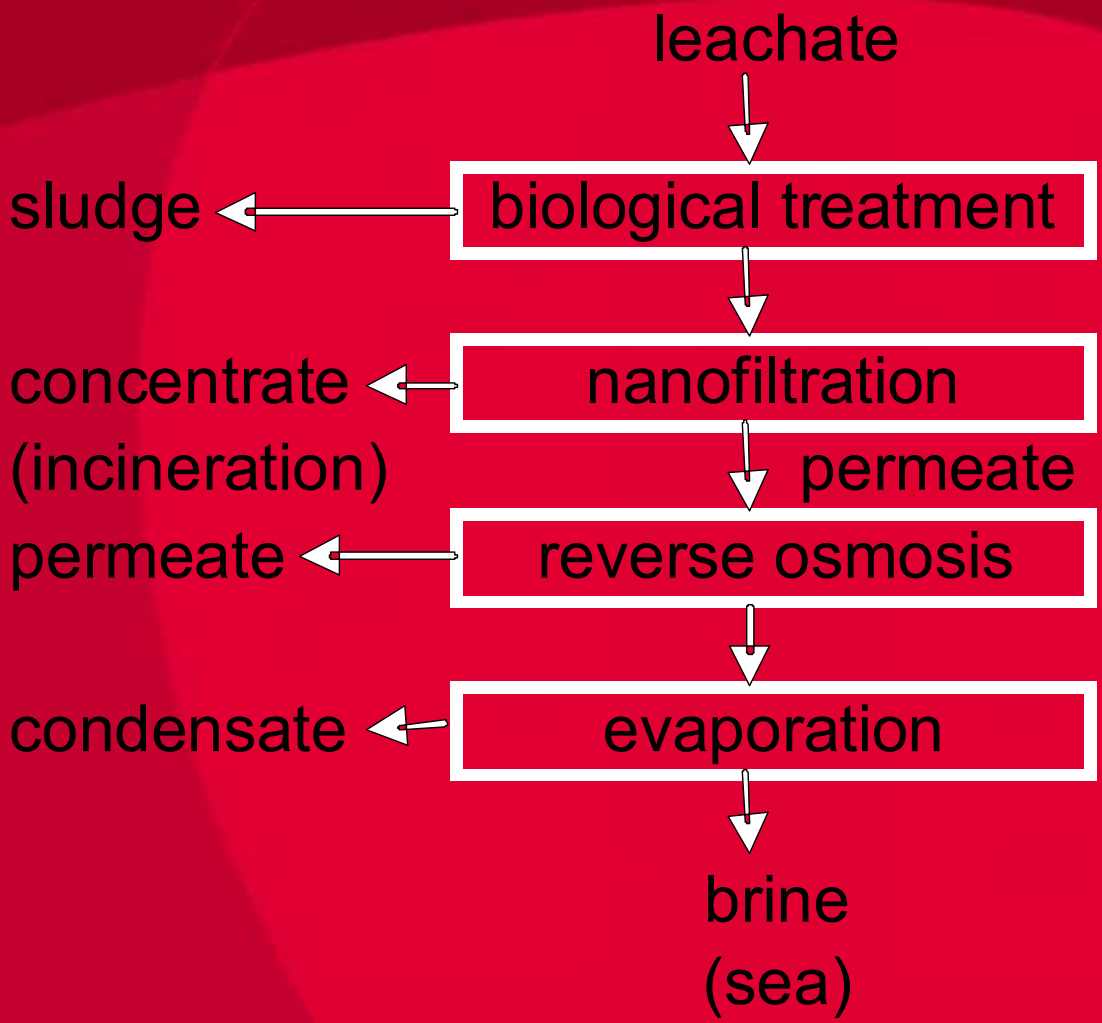
Why research?

- The existing system is expensive (all-in €18/ m^3 leachate)
- The tubular RO-system is technically spoken no more “state of the art”
- The high amount of residue (10,000 tons/a) makes the system not sustainable.

The objectives of nanofiltration are:

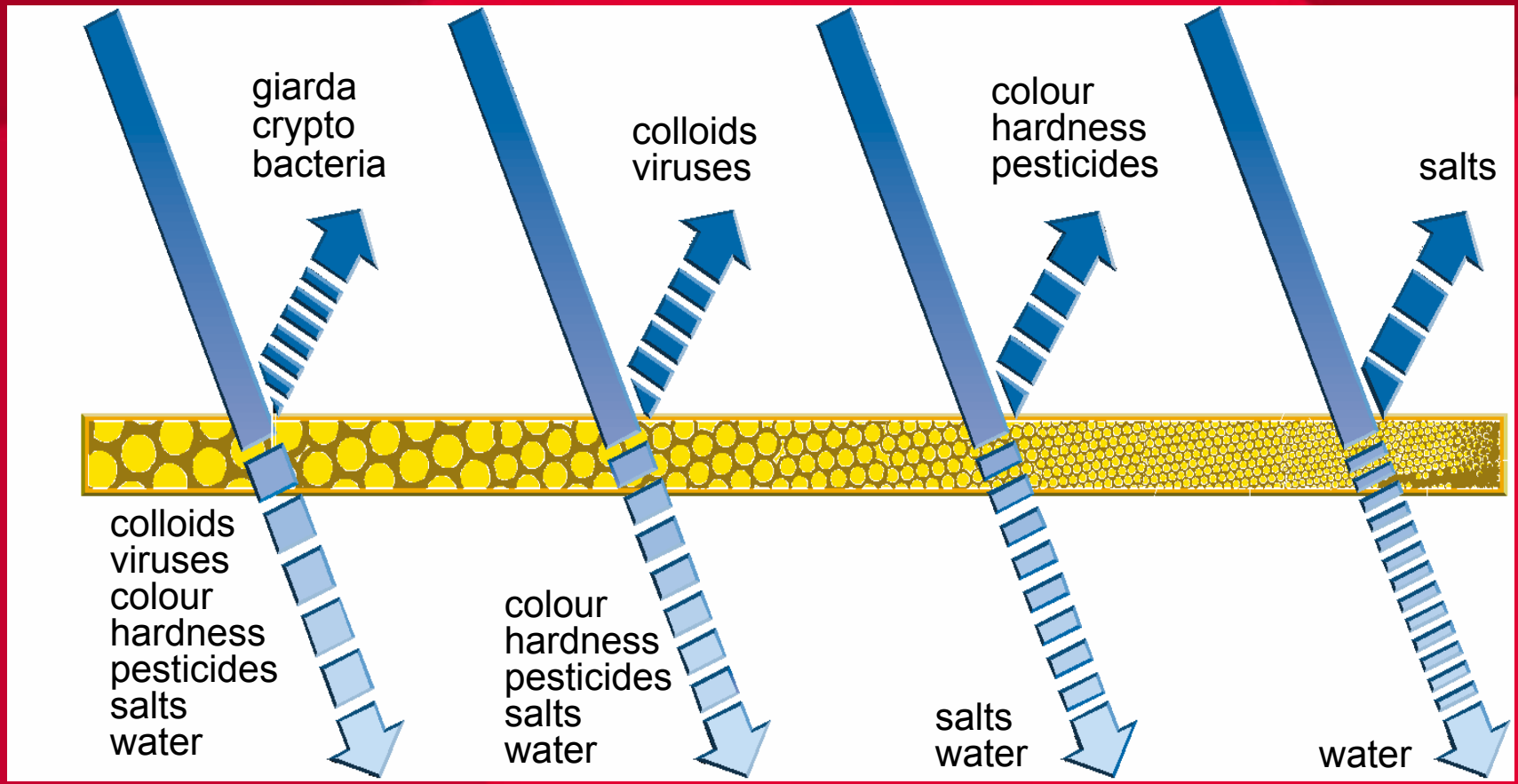
- Reducing the amount of residue by separating the monovalent salts (chloride, potassium and sodium) from the other components in the leachate and discharge of the brine to the sea
- Concentrating the organic compounds, heavy metals and organic micro pollutants.

Proposed future system:



Filtration techniques:

Micro Filtration	Ultra Filtration	Nano Filtration	Reverse Osmosis



100-1000 nm	10-100 nm	1-10 nm	< 1 nm

Nanofiltration modules:

- Tubular modules (d=15 mm, TMP=20 bar)
- Plate modules (TMP=20 ba)
- Spiral wound modules (TMP=20 bar, fouling!)
- Capillary modules (TMP=6 bar)

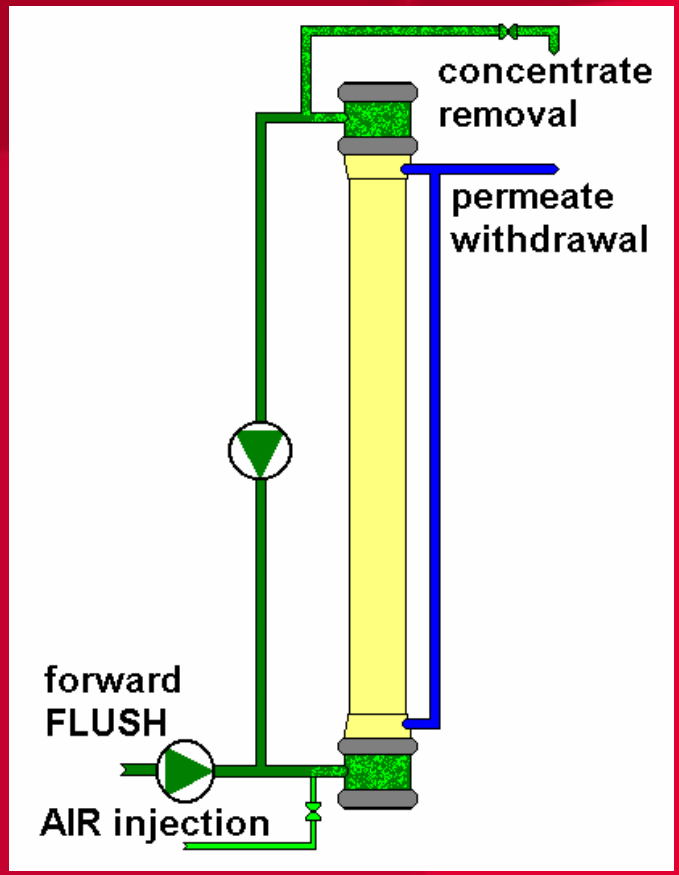
Capillary NF module:

- Capillary diameter
  1.5 mm
- Composite membrane
- Poly-ethersulfon carrier
- Polyamide-coating
- Module length 1.5 m
- Membrane surface
  20 m^2/module

Pilot plant:

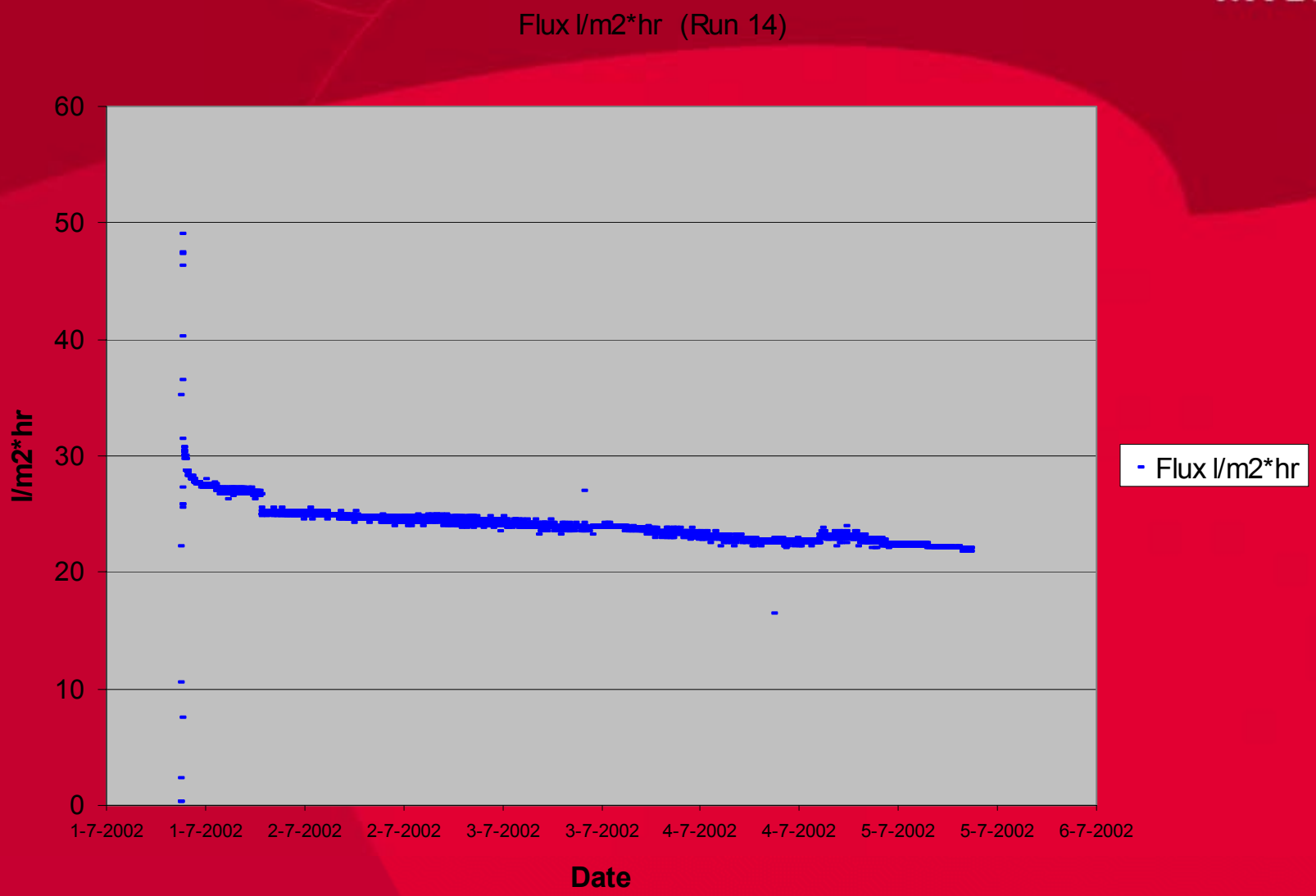
- Input is biologically pretreated leachate
- Micro sieve 200 µm
- pH adjustment (6.8-7.2)
- Anti-scalant supply
- Trans membrane pressure (max) 7 bar

Flow scheme:

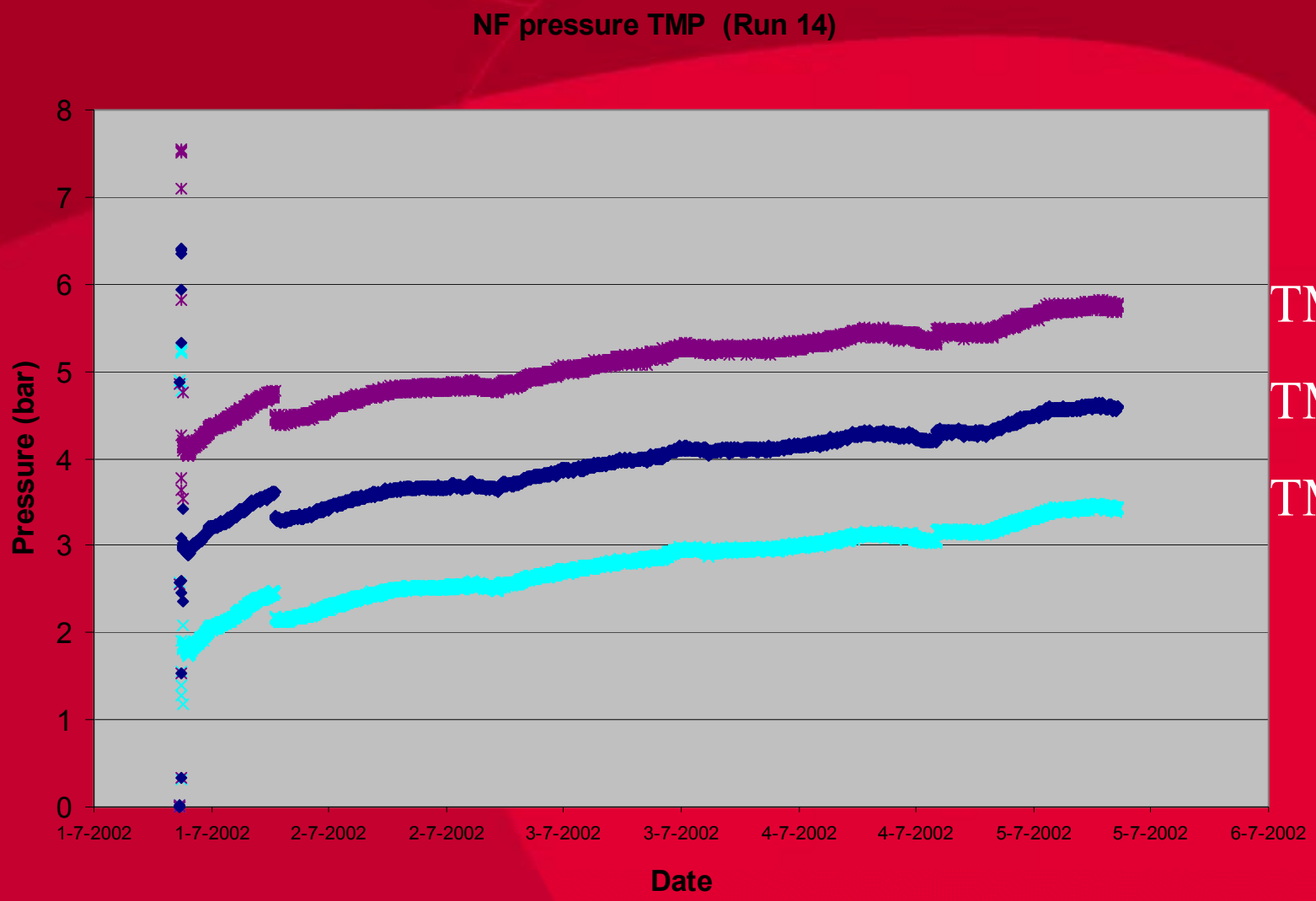


- Horizontal velocity approx. 2 m/sec
- Cross-flow operation; continuous feed and bleed
- Different concentration factors (CF 2 till 20)
- $CF = V_{input}/V_{concentrate}$
- Different pretreatment methods
- Different cleaning policies
- Main “problem” is fouling of membranes

Flux:


Flux l/m2*hr (Run 14)
60
50
40
30
20
10
0
l/m2*hr
1-7-2002
1-7-2002
2-7-2002
2-7-2002
3-7-2002
3-7-2002
4-7-2002
4-7-2002
5-7-2002
5-7-2002
6-7-2002
Date
Flux l/m2*hr

Trans membrane pressure:



TMP-high

TMP-average

TMP-low

Results:

CF	Temperature (^{0}C)	TMP (bar)	Flux (l/m^2 hr)
2	15-17	2.8-4.2	31-35
4	32-35	2.7-5.0	26-22
10	32-38	2.2-6.0	21-18

Qualities (CF = 10):

influent NF = effluent bio-treatment

parameter	unit	raw leachate	influent NF	permeate NF
COD	mg/l	2500	1500	105
BOD	mg/l	150	5	1
NKj	mg/l	1200	60	4
Cl	mg/l	3000	3000	3050
SO_4	mg/l	240	220	60
Cd	µg/l	5	2	0.2
Hg	µg/l	0.15	0.10	0.01
PAH(16)	µg/l	0.50	0.09	0.025
EOX	µg/l	0.6	0.4	0.1

Colors:

essent MILIEU

influent NF

effluent NF

Pretreatment tests:

- Biocides; intermediate supply of chloramines!!!
- Biological treatment by a biofilm-system?
- Fiberfitration (3 µm)?
- Anti-fouling additives? (dispersion chemicals)

Cleaning of the membranes:

- Alkaline cleaning (pH 11) with good results
- periodically extra cleaning by:
  - acid cleaning agents
  - oxidation by peroxide
  - enzymatic (detergents) agents.

Proposed full scale plant:

- 30 m^3/h permeate
- 8 stacks of 10 modules
- automatic CIP

  (“cleaning in place”)
- modules of 20 m^2

Costs:

- Investment: 900,000 €
  (mechanical-electrical equipment)

- Operation costs: 1.70 €/m^3 permeate
  including:
  - depreciation 10 years
  - membrane replacement 3 years
  - interest 6%
  - maintenance and operator
  - electricity and chemicals

Prospective of nanofiltration in leachate treatment (1):

- Step 1: biological treatment (reducing O_2-consumption)
- Step 2: nutrient removal (N and P)
- Step 3: removal of color (COD), heavy metals, organic micro pollutants by activated carbon or ***nanofiltration***
- Step 4: desalination by reverse-osmosis.

Prospective of nanofiltration in leachate treatment (2):

- Find a solution for the NF-concentrate:
  - incineration
  - recycling to the landfill
  - adsorption to…
- Research into feasibility in respect to landfill charge and skilled operators.