Sustainability in commercial laundering processes

Module 1
Usage of water

Chapter 5 b

Waste water treatment Various filtration methods for laundry effluent

Content

Education and Culture

Leonardo da Vinci

- Waste water treatment and water quality
- Waste water treatment methods
- Membrane filtration: how does it work?
- Membrane filtration: how to select the right technology?
- Reverse Osmosis
- Ultrafiltration
- Ceramic membranes
- Membrane filtration and filtration cost
- Prefiltration & Particle filtration
- Performance limiting parameters & Maintenance
- Simple filtration methods & Resources recovery concept
- Summary

Learning targets

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- You will learn about the basics of membrane filtration technology and how it can be used to treat laundry effluent.
- Be able to select the optimal filtration method according to both the quality of the water you are treating and the quality of the water you wish to obtain after filtration.
- Know about the importance of pretreatment steps to successfully use membrane filtration.
- Learn why and how to correctly maintain membrane filtration systems.
- Know how considerable water savings can be obtained by combining simple filtration and appropriate washing processes.

Waste water treatment

Education and Culture

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- Do you want to improve the quality of your laundry effluent or reuse the water in your laundry? …and save money?

Waste water treatment - IN

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- The composition of waste water can vary significantly and influences the choice of effluent treatment method.

	COD	BOD	pH	P_{tot}	N_{tot}	TSS
	mg/l	mg/l		mg/l	mg/l	mg/l
normal	1000	400	10	20	2-16	60
heavy	3500	1250	10	30	5-30	150

Source: Vercaemst & Dijkmans, 'BBT-studie, 1999'.

- Heavy metals ions
- Hydrocarbons
- AOX
- Lint

Waste water treatment - OUT

Education and Culture

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- When you define the target quality of your laundry effluent or the quality of your reuse water then consider the following parameters:
  - Low COD content
  - Low salt content
  - No metals
  - No dyes – colour
  - No biological activity

Waste water treatment methods

Education and Culture

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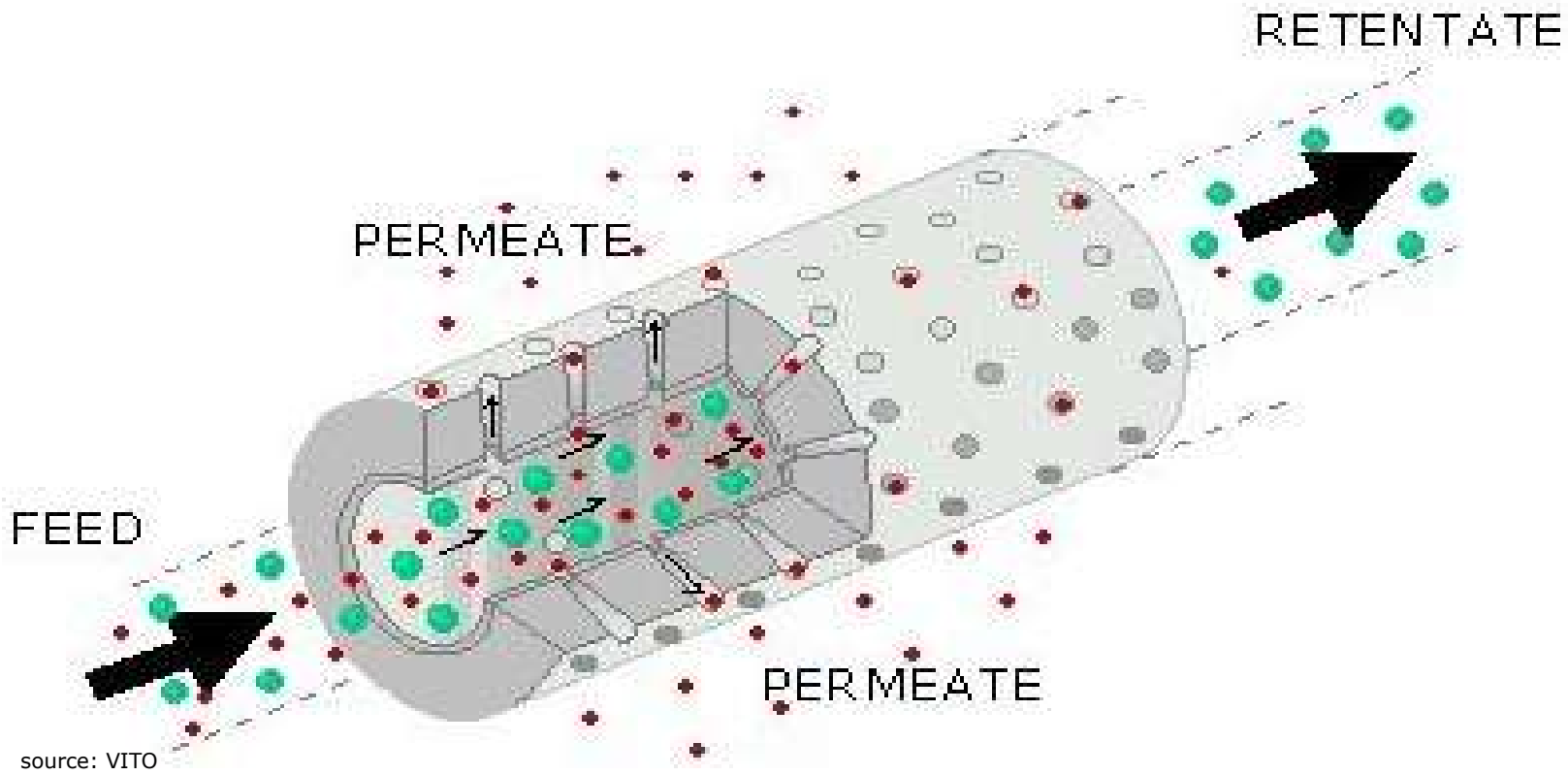
- You may already know about classical waste water treatment methods as
  - Coagulation & flocculation (& sedimentation, flotation)
    - Aim: Remove suspended solids, colloids, natural organic materials.
  - Active coal filtration
    - Aim: Remove natural organic materials, microcontaminants.
  - Oxidation (ozon, UV, chlorine, hydrogen peroxide)
    - Aim: Degradation of organic materials, disinfection.
  - Biological methods
    - Aim: Degradation of organic materials, nitrogen, iron.
  - Ion exchange
    - Aim: Water softeners to remove water hardness.
  - Destillation & evaporation
    - Aim: Removal of solvents, oils.
- In this module you will learn about Membrane Filtration.

Membrane filtration: how does it work?

Education and Culture

Leonardo da Vinci

- A simple view on how membranes function in removing contaminants:



source: VITO

Membrane filtration: how to select?

Education and Culture

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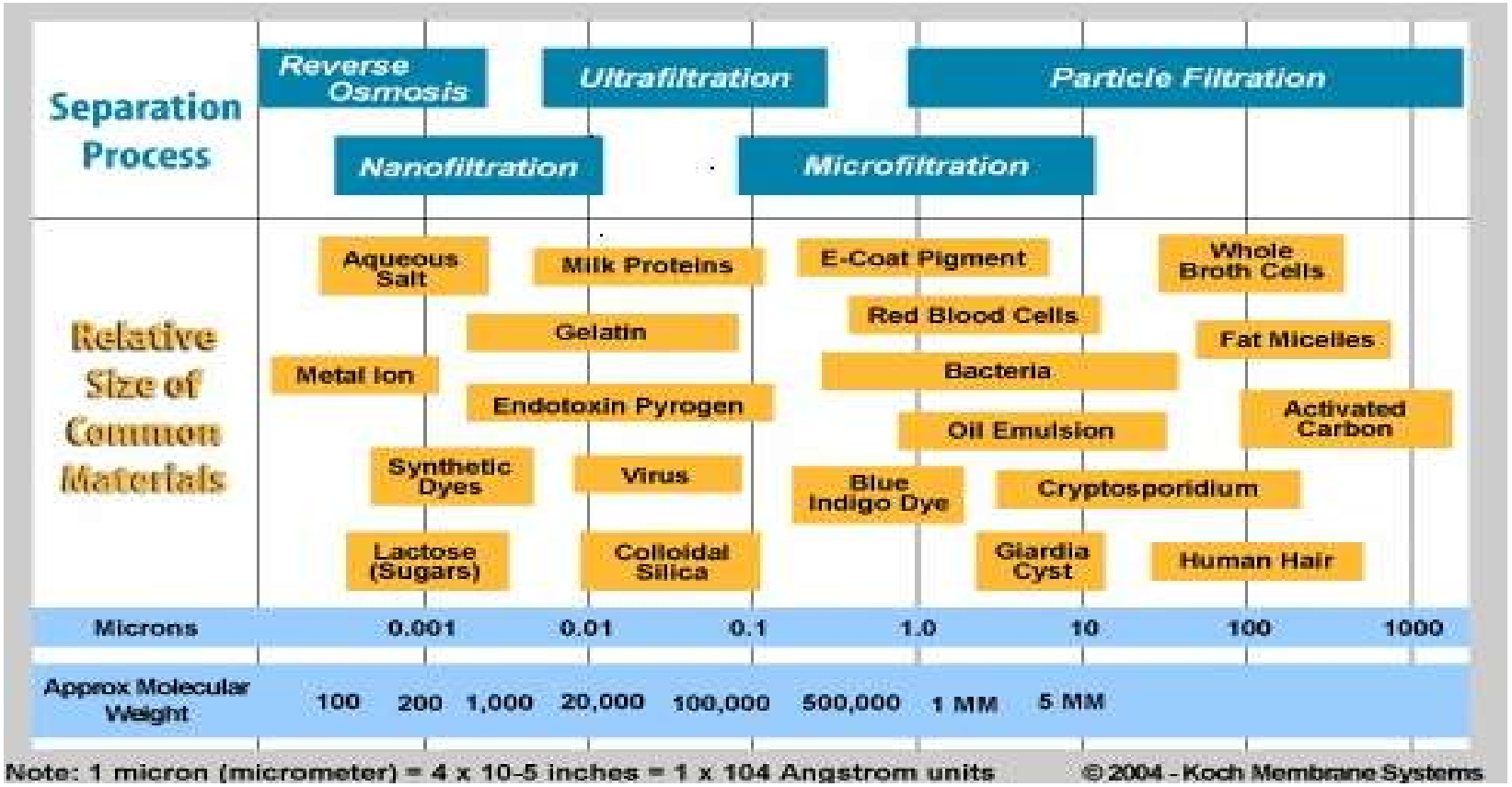
- This overview shows how you can select the separation process according to the size of the contaminants in waste water.



Membrane filtration: how to select?

Education and Culture

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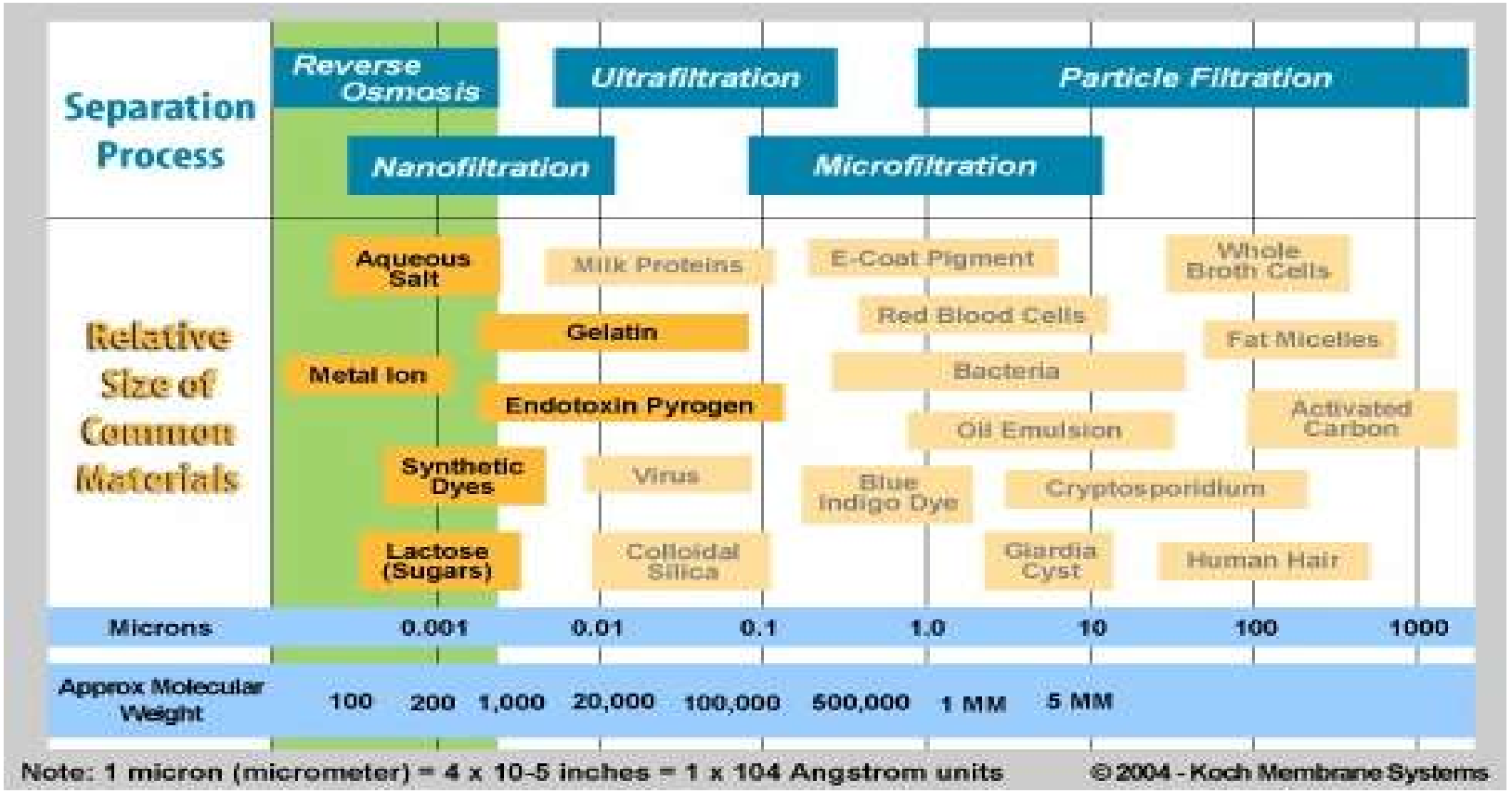
- Permeate quality highly depends on the filtration method used.
- Here below you can see from left to right samples of waste water feed, ultrafiltration permeate and reverse osmosis permeate.

source: Wehrle

source: VITO

Reverse osmosis (RO)

- Smallest materials (incl. salts) can be removed by reverse osmosis resulting in permeate of highest quality.



Spiral RO membranes

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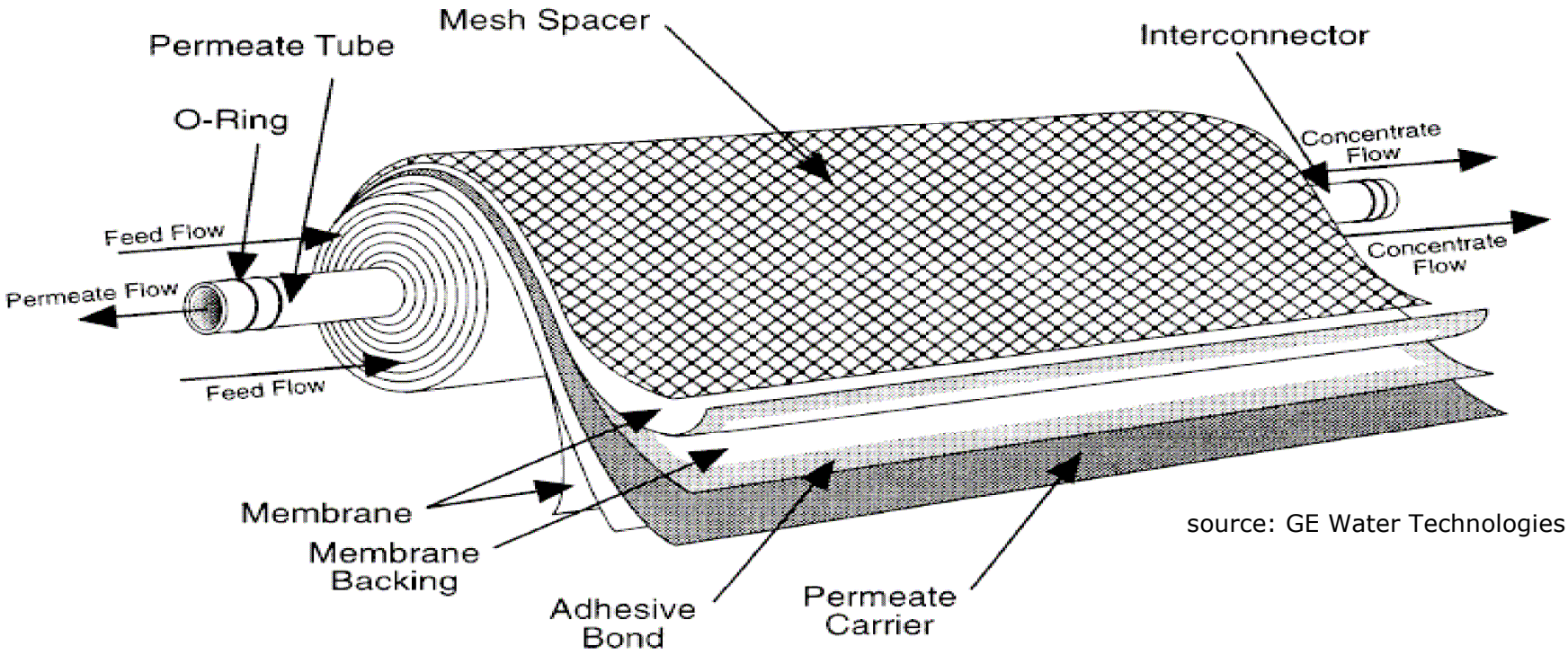
- The spiral wound membrane element is constructed of one or more membrane envelopes wound around a perforated central tube. The permeate passes through the membrane into the envelope and spirals inward to the central tube.



source: GE Water Technologies

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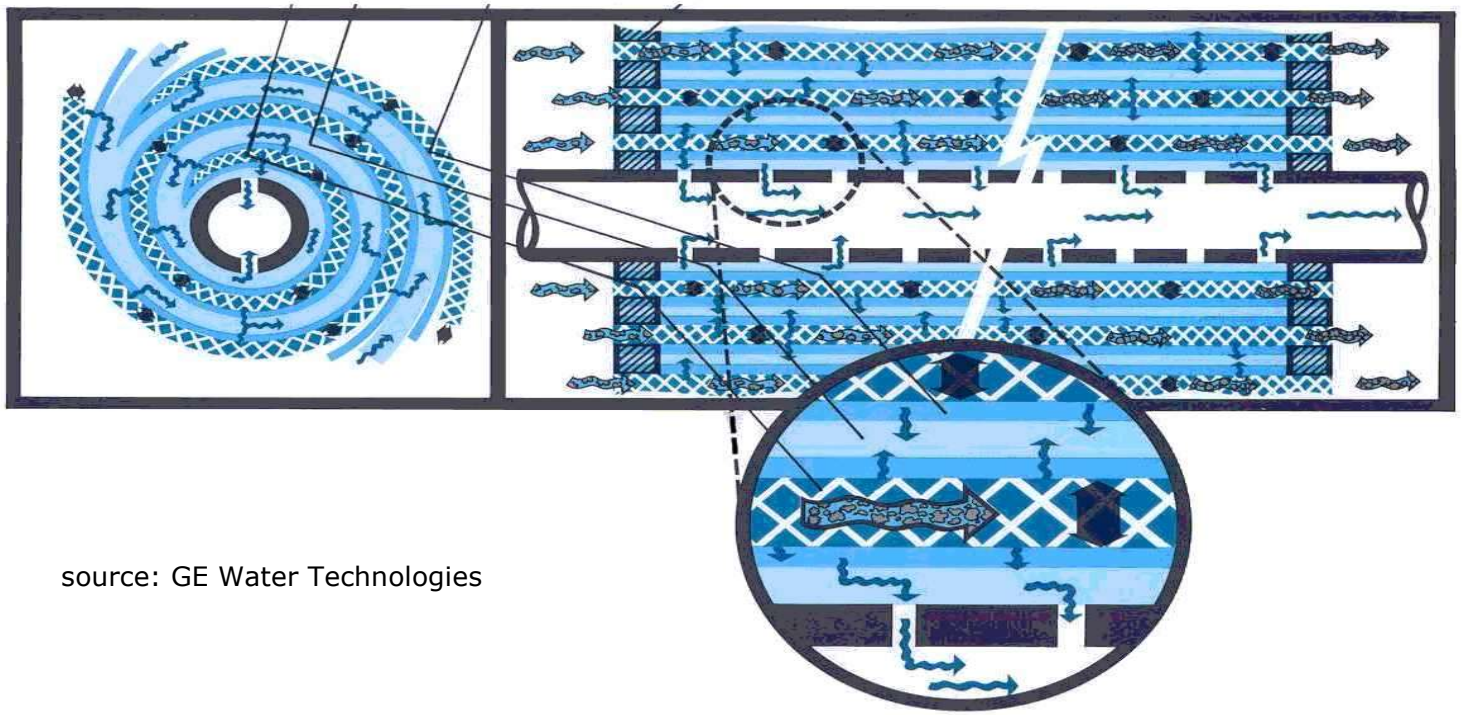
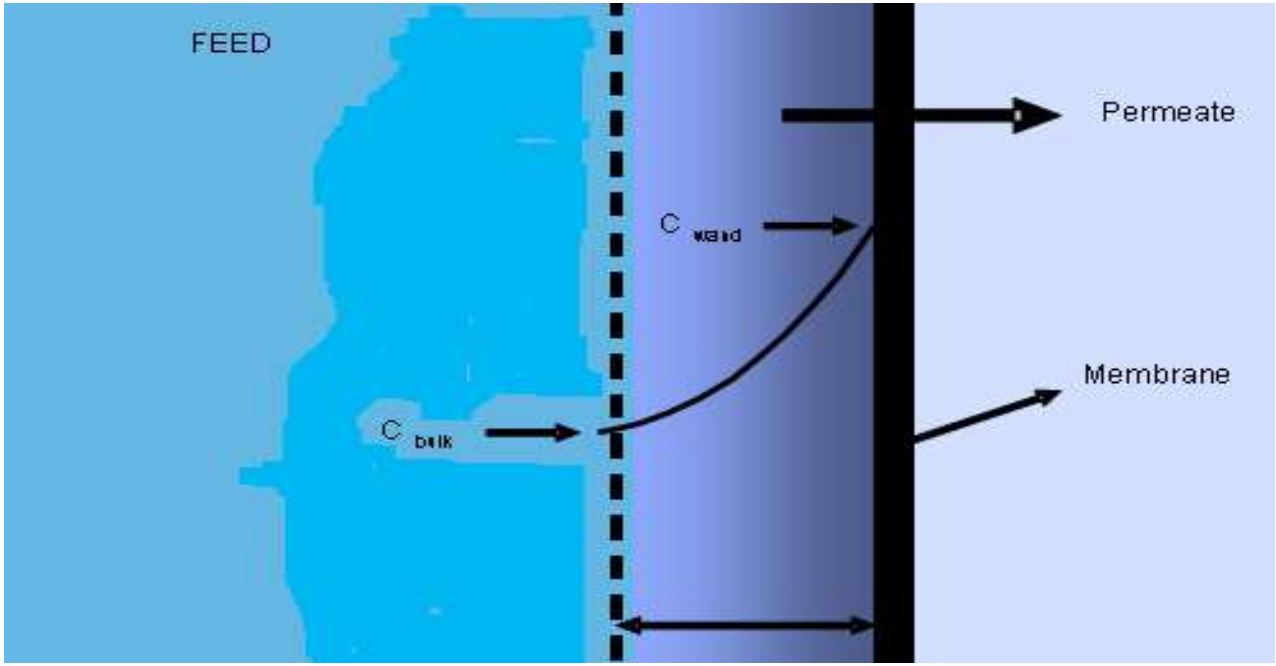


source: GE Water Technologies

Cross-flow principle

- Concentration polarisation is a phenomenon whereby in the vicinity of the membrane surface an increased concentration of waste water materials is found.



source: VITO

Cross-flow principle

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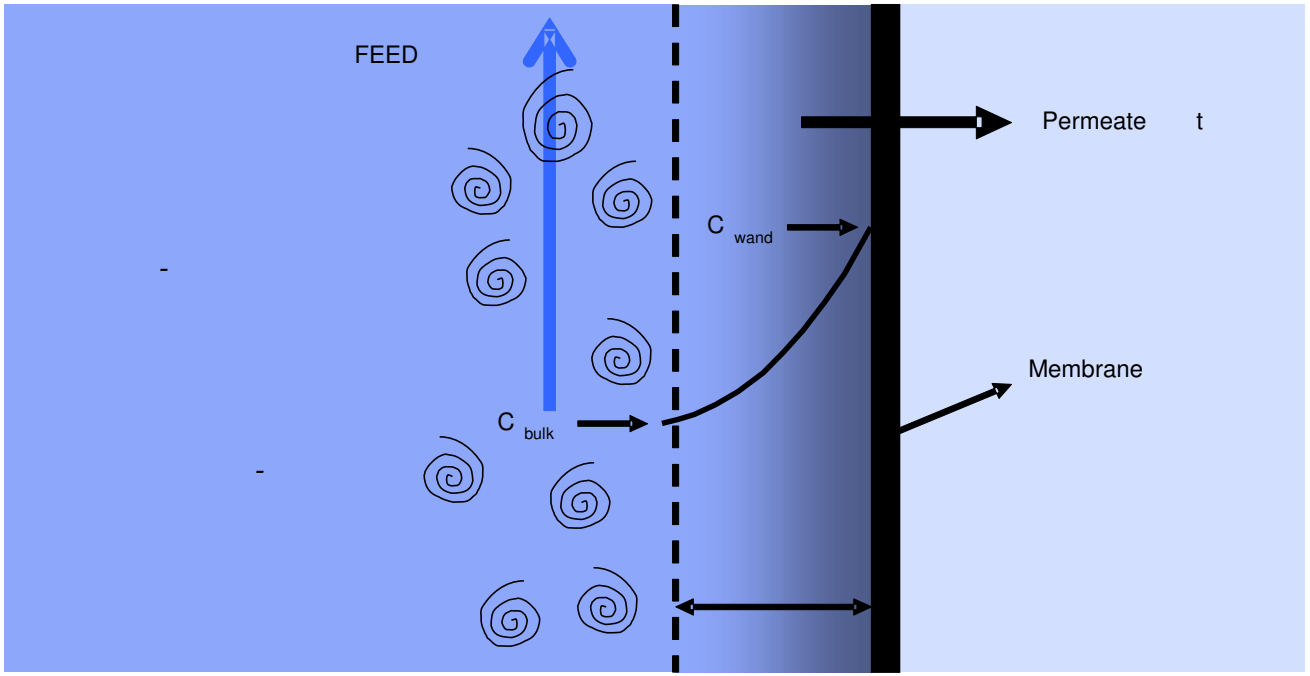
- High concentration polarisation results in
  i) Strongly reduced permeate flow
  ii) Diffusion of salts through the membrane
  iii) Precipitation of salts or 'scaling'



source: VITO

Cross-flow principle

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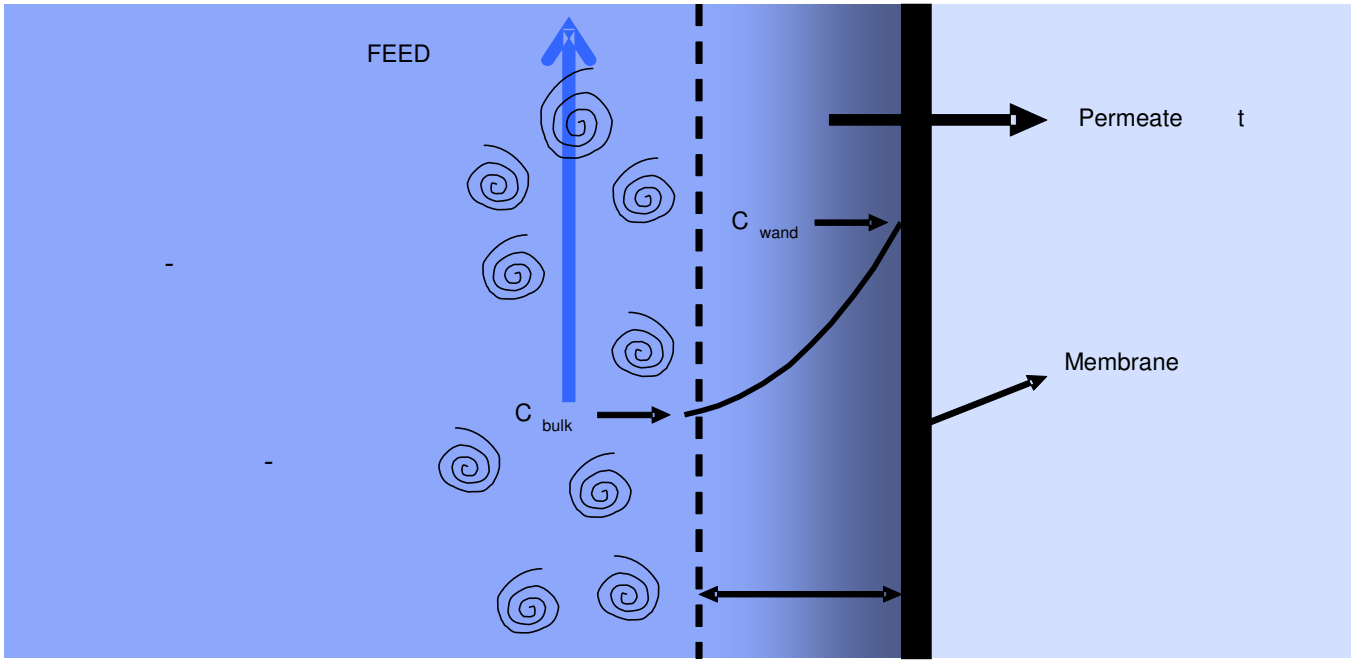
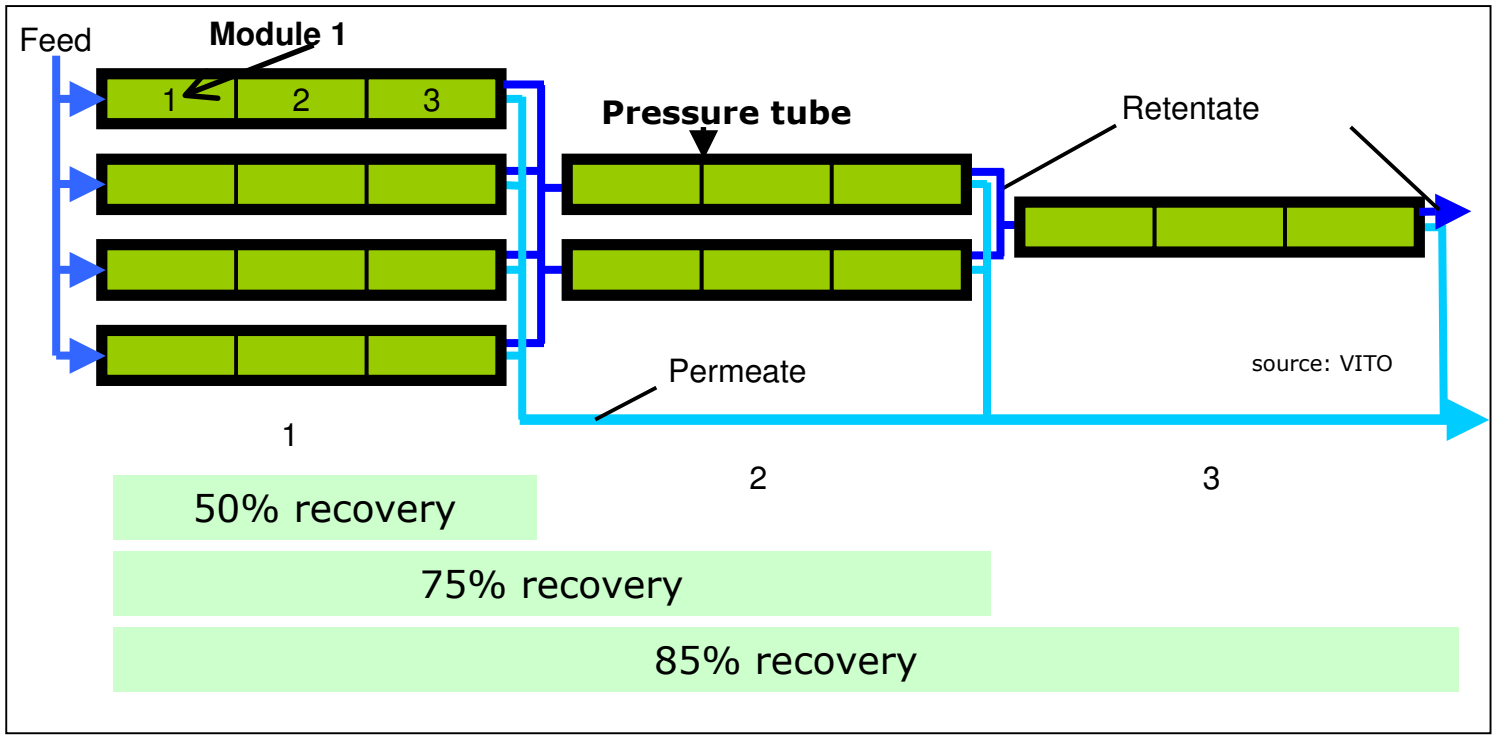
- Cross-flow is required to minimize concentration polarisation through turbulence.



source: VITO

Reverse osmosis

- Concentration polarisation impacts the set-up of an RO installation:



Reverse osmosis

- An example of an RO installation:

source: See:Water

Reverse osmosis

Education and Culture

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- An example of an RO installation:

source: See:Water

Ultrafiltration

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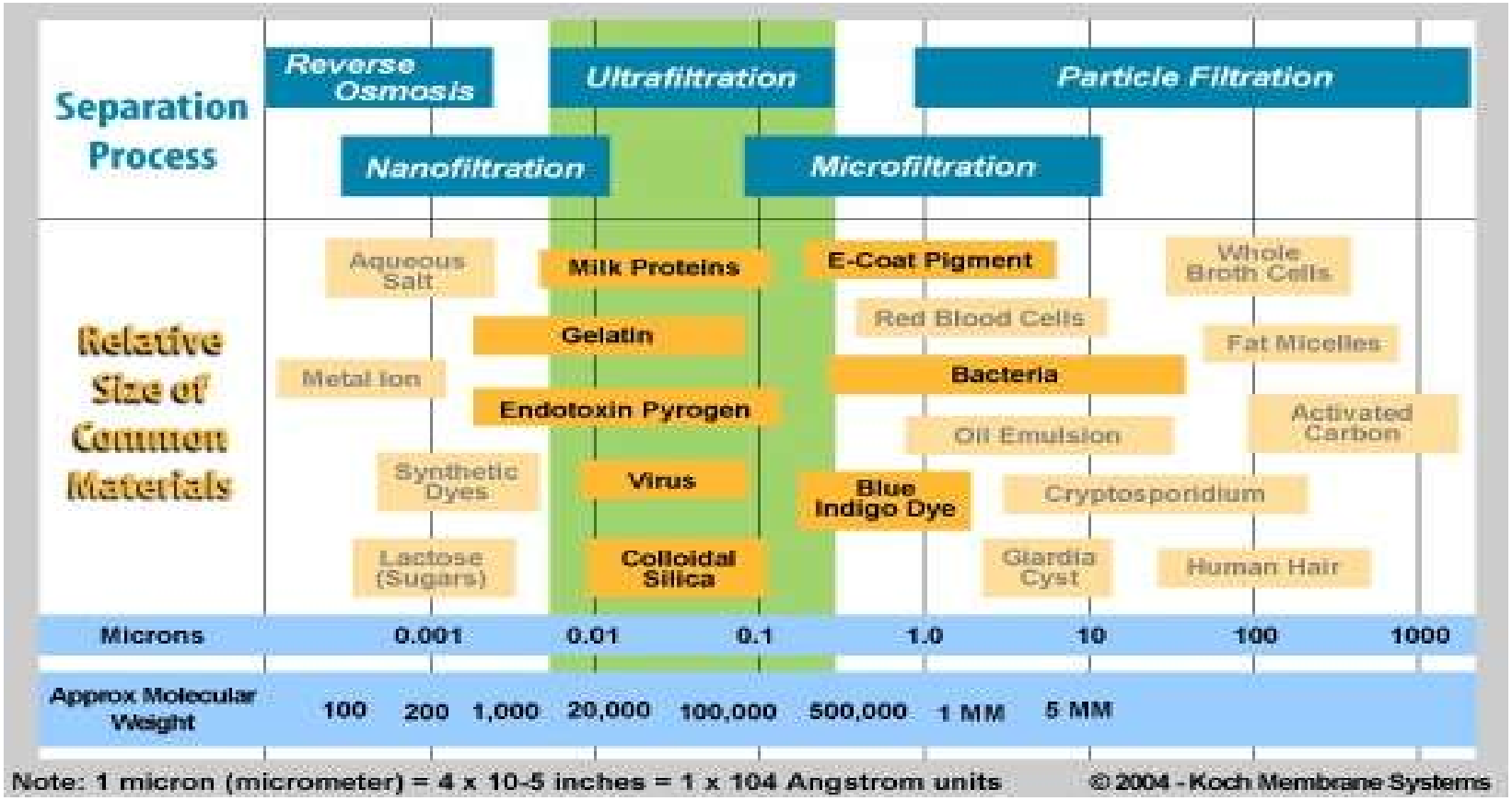
- Workwear soils as oil emulsions and bacteria can be removed by ultrafiltration.



Ultrafiltration

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- Application:
  - Treatment of waste water of workwear plants
  - Pretreatment before RO installation
- Feed water quality:
  - TSS < 50 mg/l
  - prefiltration ± 200 µm
- Permeate water quality:
  - SDI < 2 (“Silt Density Index”)
  - Turbidity < 0.1 NTU
  - Microorganisms – log 4 (virus) to log 6 (bacteria) reduction
- Permeate recovery: 85-95 %

Ultrafiltration

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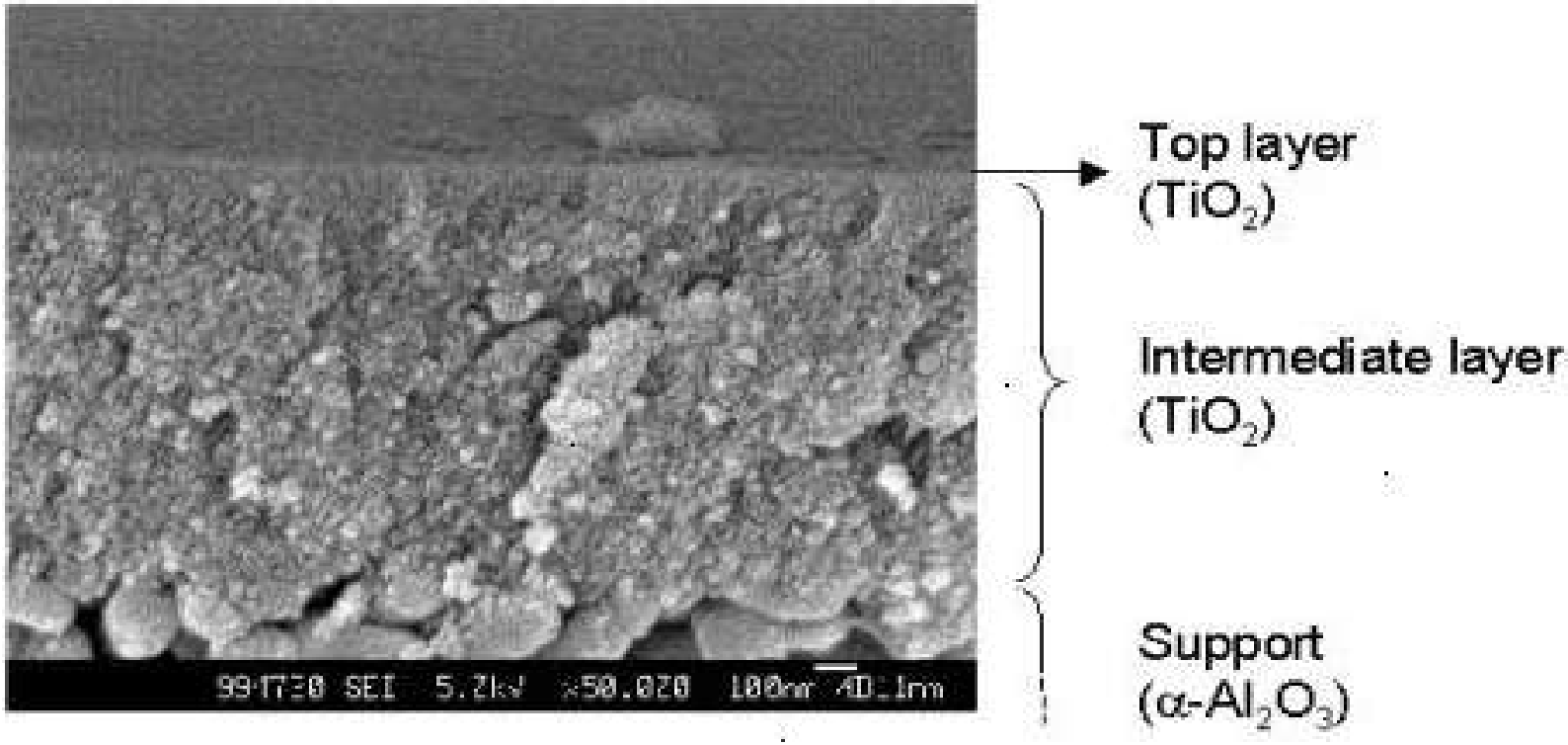
- An example of an UF installation:

Ceramic membranes

- Ceramic membranes are very robust membranes (acidity, alkalinity, temperature).
- Miscropic view and structure of a ceramic UF membrane:



Membrane filtration

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- **A higher permeate quality results in a higher filtration cost.**
- Microfiltration & Ultrafiltration:
  - Process flow : 80-100 l/h.m²
  - Pressure < 1.5 bar, energy consumption of 0,1 kWh/m³
  - Operational cost : 0.15 - 0.20 EURO/m³
- Nanofiltration:
  - Process flow : 20 l/h.m²
  - Pressure < 10 bar, energy consumption of ≤ 0.5 kWh/m³
  - Operational cost : 0.25 - 0.35 EURO/m³
- Reverse Osmosis:
  - Process flow : 15 l/h.m²
  - Pressure < 10 bar, energy consumption of ~ 0.5 kWh/m³
  - Operational cost < 0.4 EURO/m³

- **PREFILTRATION IS ESSENTIAL !!!!!**
- Use of prefiltration methods such as particle filtration are essential in ensuring that membranes do not get immediately blocked and therefore allow membrane filtration to function as intended.
- For example, particle filtration can preceed Ultrafiltration, which can preceed Reverse Osmosis or Nanofiltration.

Particle filtration

- A whole range of particle filtration equipment is available:

PRESSURE FILTRATION

* cartridge filters
* bag filters
* strainers
* automatic filters
* sandfilter
* filterpress
* rotating drumfilters

VACUUMFILTRATION

* rotating drumfilter with precoat
* rotating filter

GRAVITARY FILTRATION

* static sieve
* rotating sieve
* vibrating sieve

CENTRIFUGAL FILTRATION

* centrifuge
* decanter

Particle filtration

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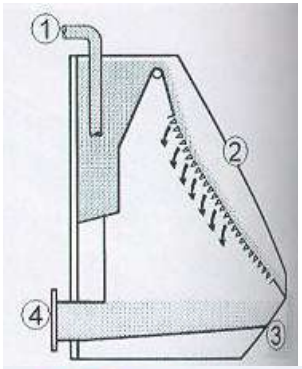
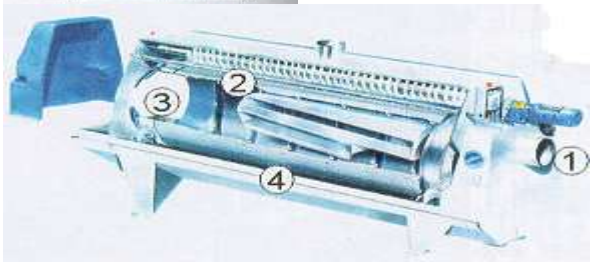
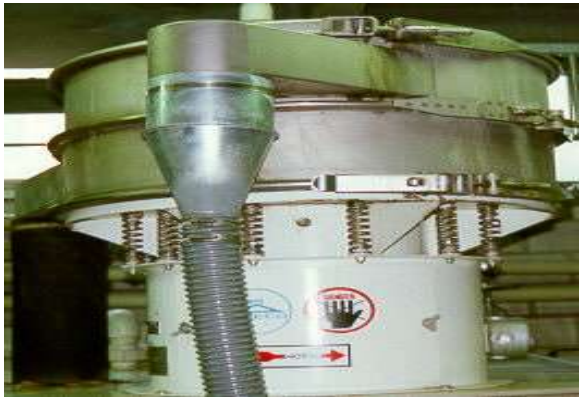
- Sieves (0.2 - 0.25 mm)
  - Static Sieve
    - no moving parts
    - clogging potential
    - selfcleaning is expensive
  - Rotating Sieve
    - almost no clogging
    - reliable
    - expensive
  - Vibrating Sieve
    - maintenance
    - energy
    - noise
    - very efficient



1) Raw waste wate inlet
2) Sieve
3) Screen matter discharge
4) Sieved water discharge





Other performance limiting parameters

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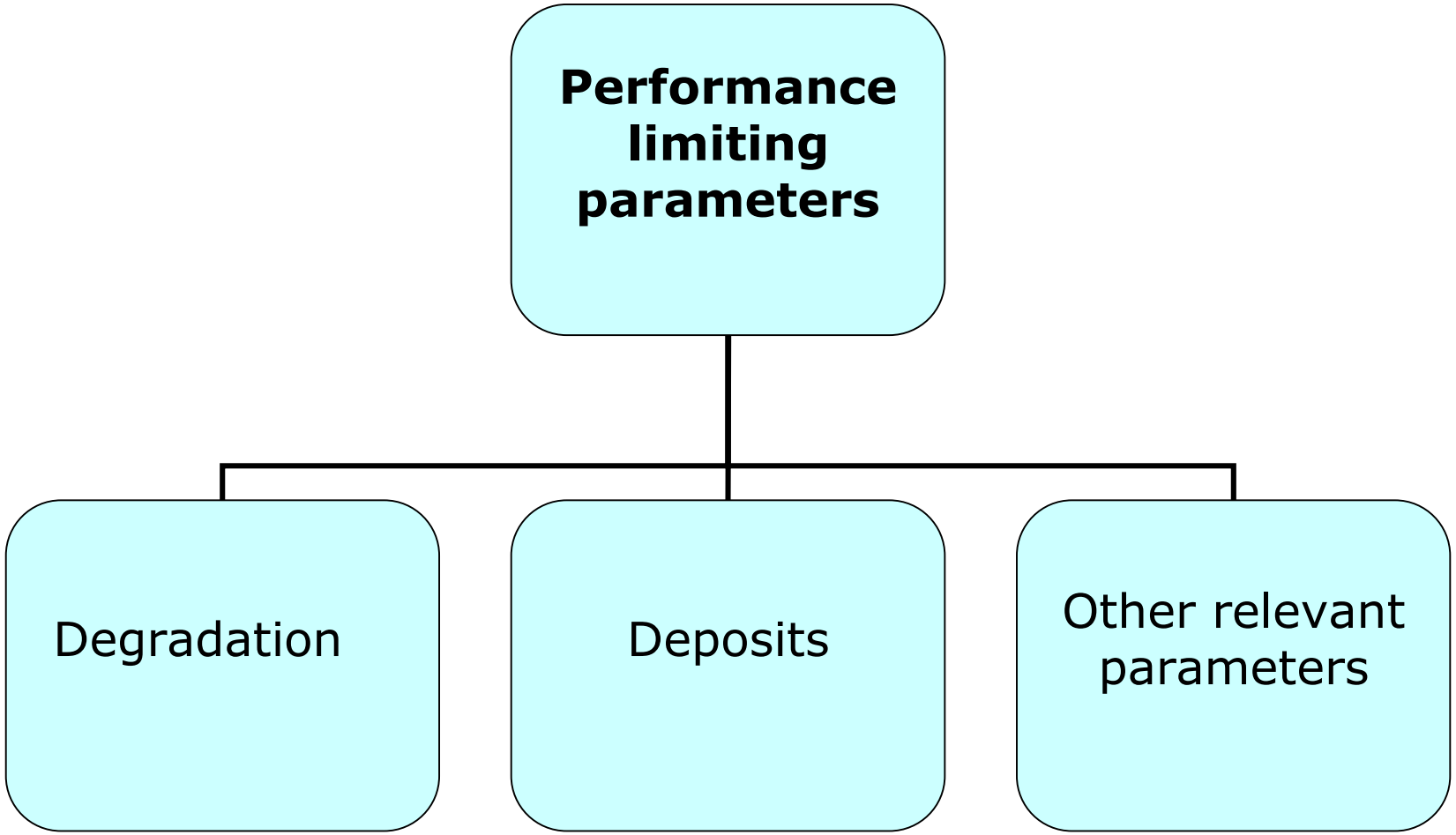
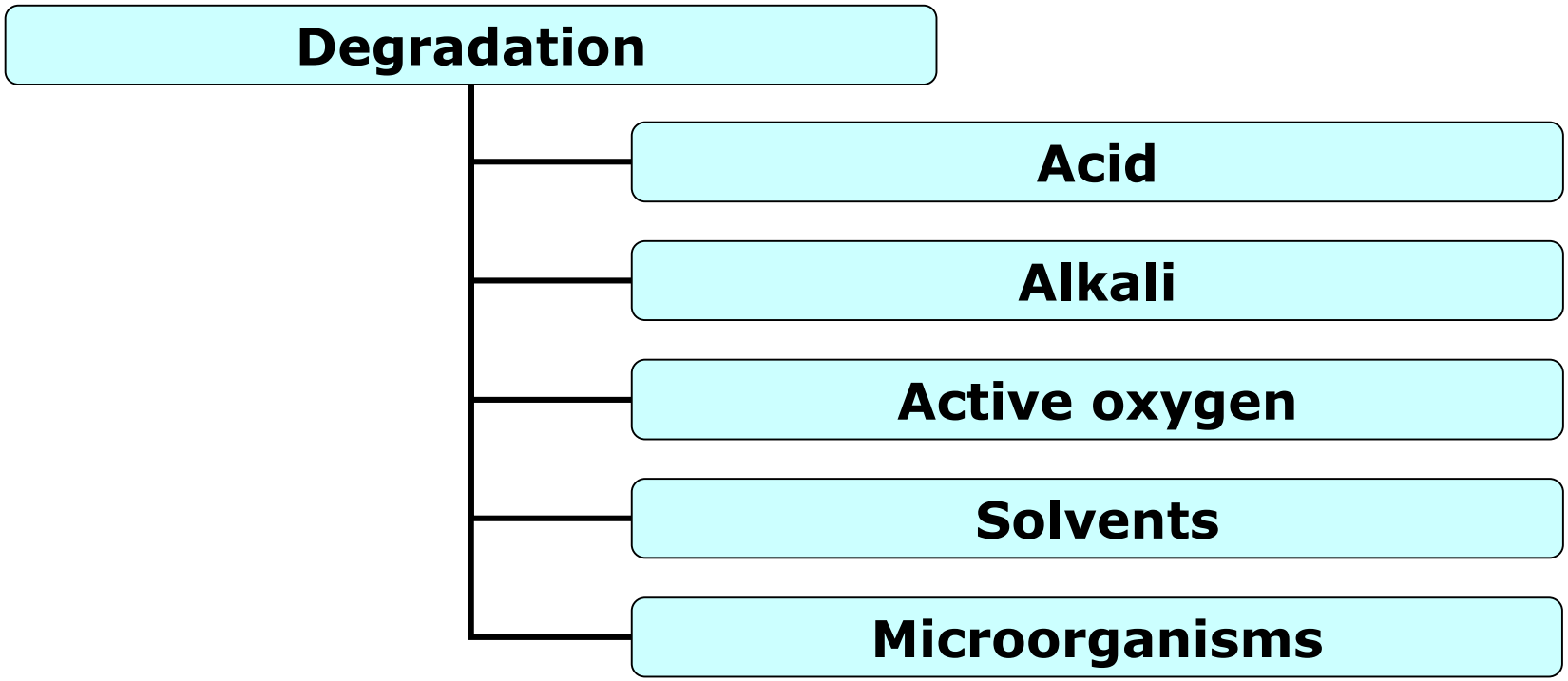


Other performance limiting parameters



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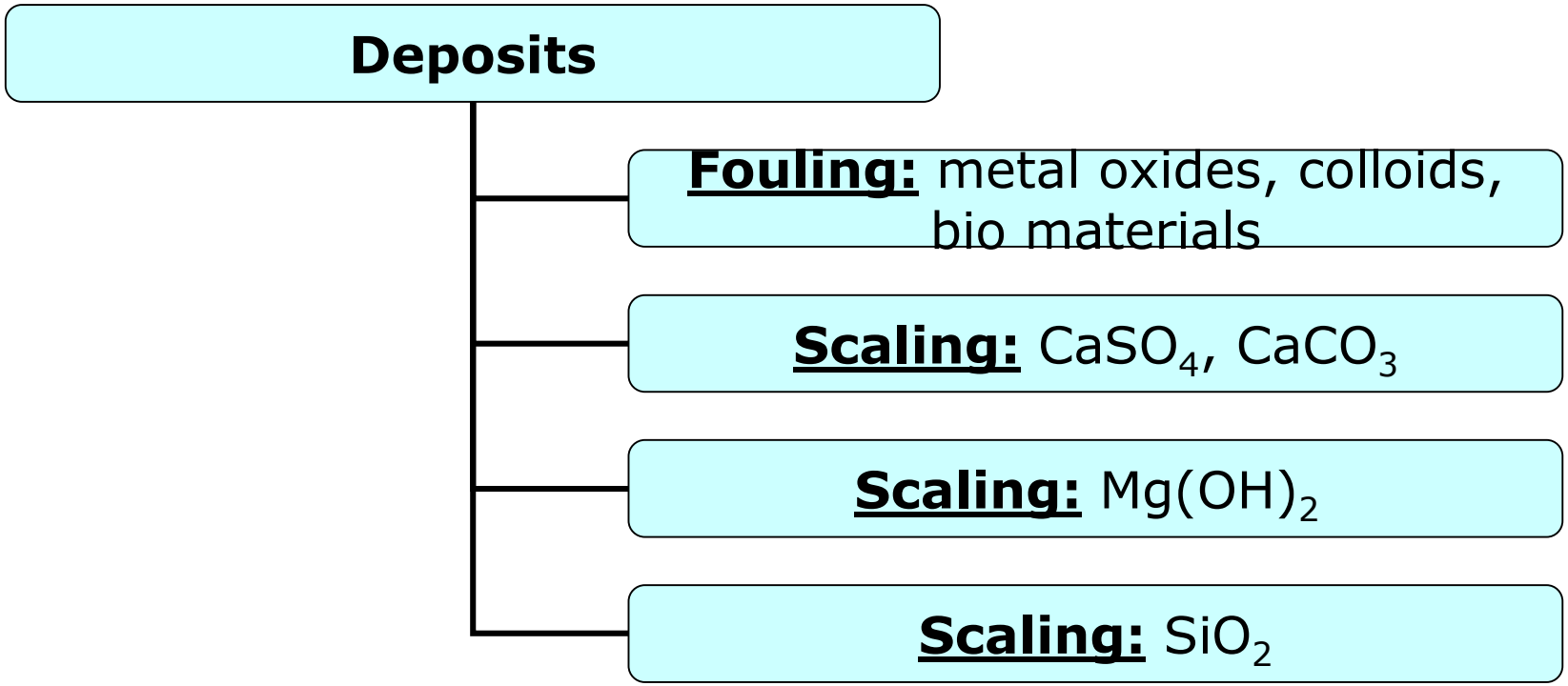

Fouling

Education and Culture

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source: VITO

Fouling

Education and Culture

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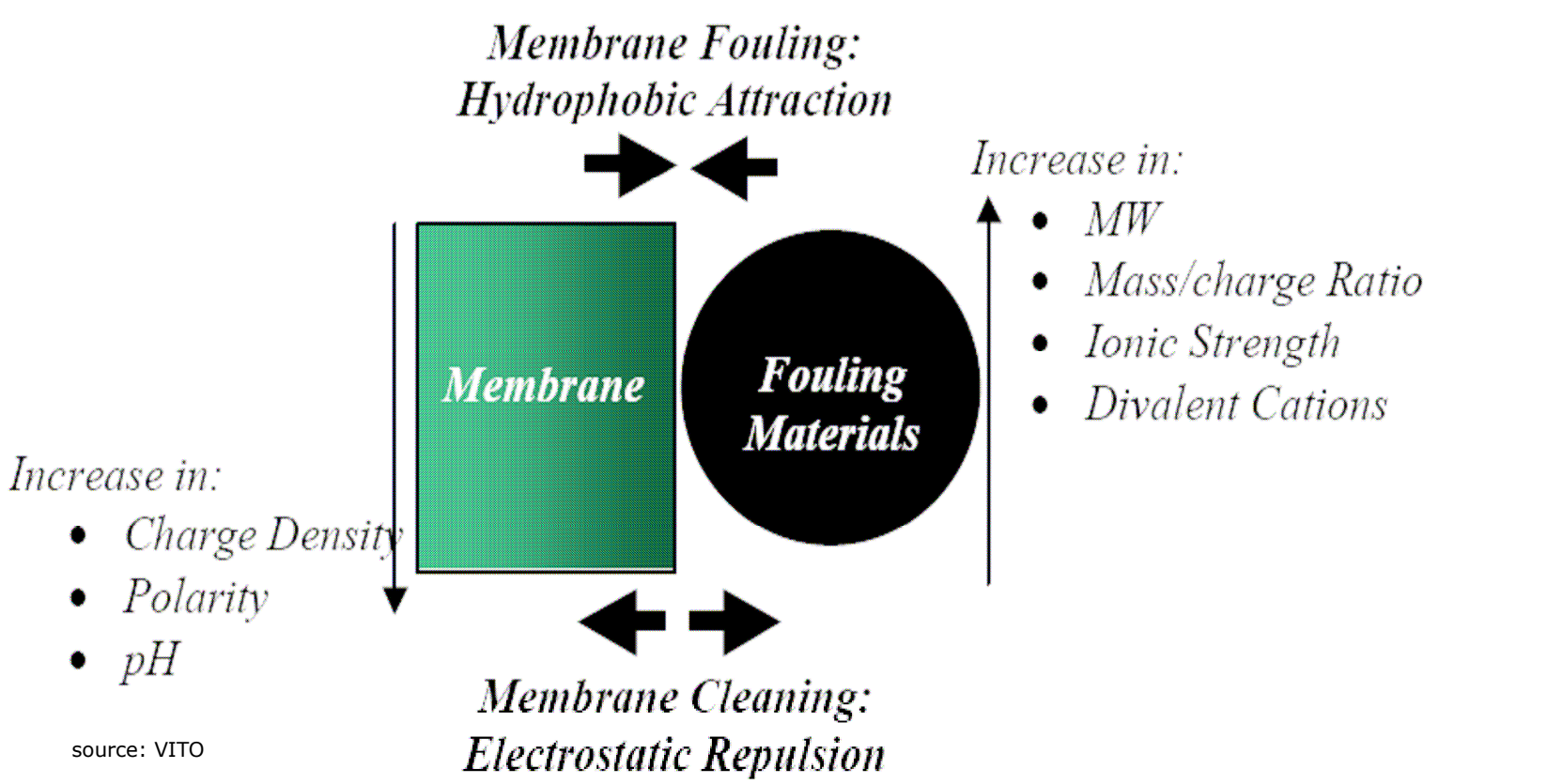
- Regular cleaning with special detergents increases membrane lifetime:



source: VITO

Scaling & Silica solubility

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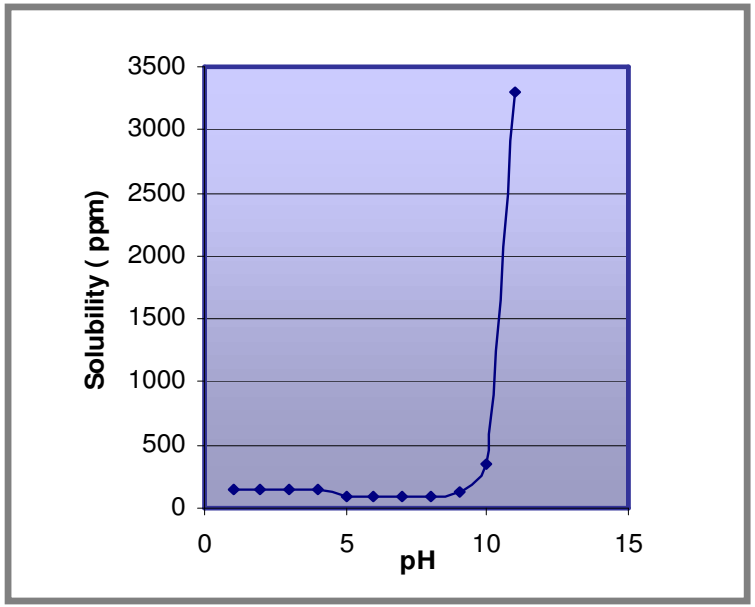
- Use of suitable detergents is a key requirements when using membrane filtration based waste water treatment.
- Use an anti-scalant product.



source: AKZO PQ

Simple filtration methods

- By using simple filtration methods water can be reused resulting in considerable reduction of water consumption.

- Consider using simple filtration systems before introducing the more efficient but more costly membrane systems.

Microfilter

Filtermodule incl. Tubing + Touch-Screen Control

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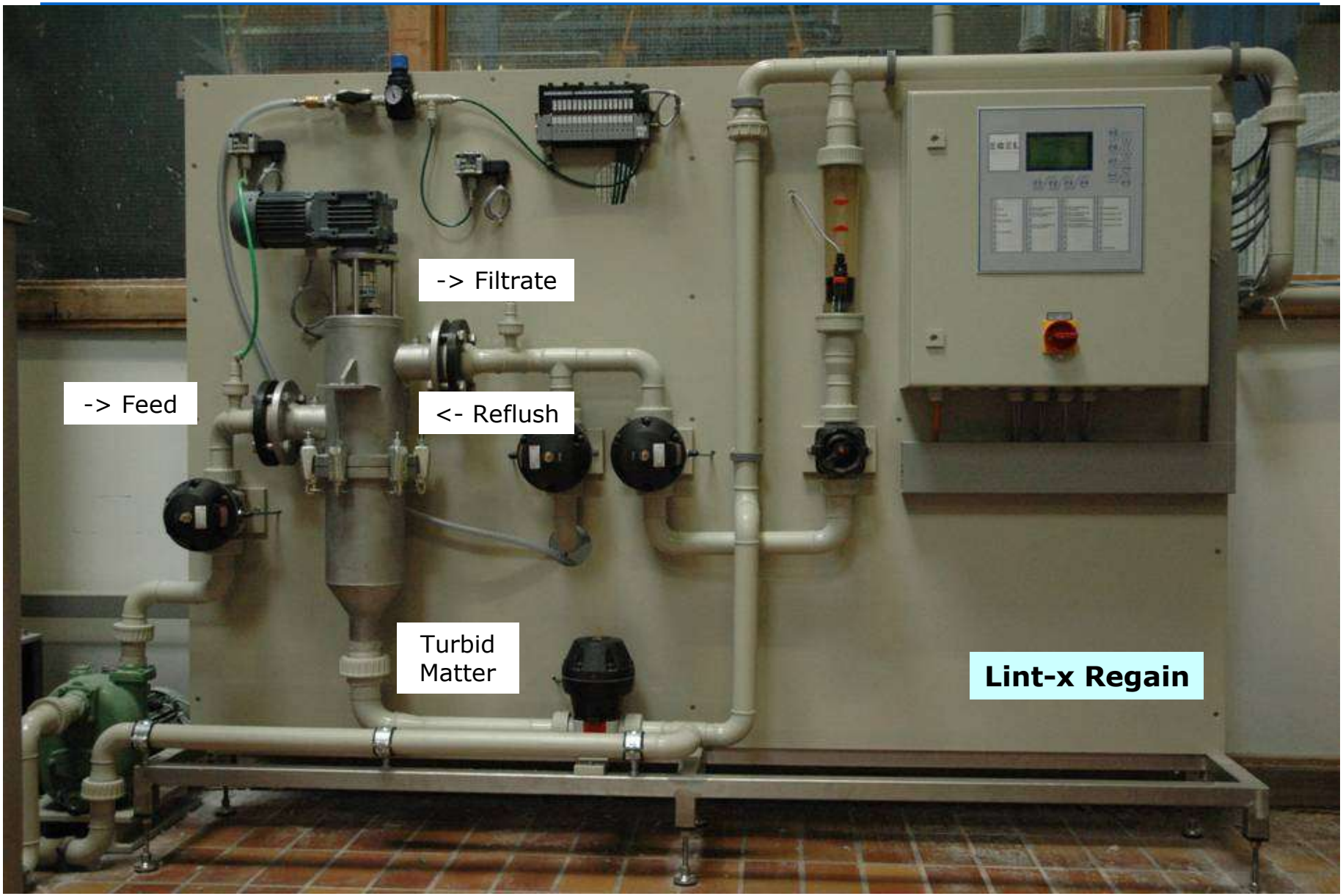

Microfilter

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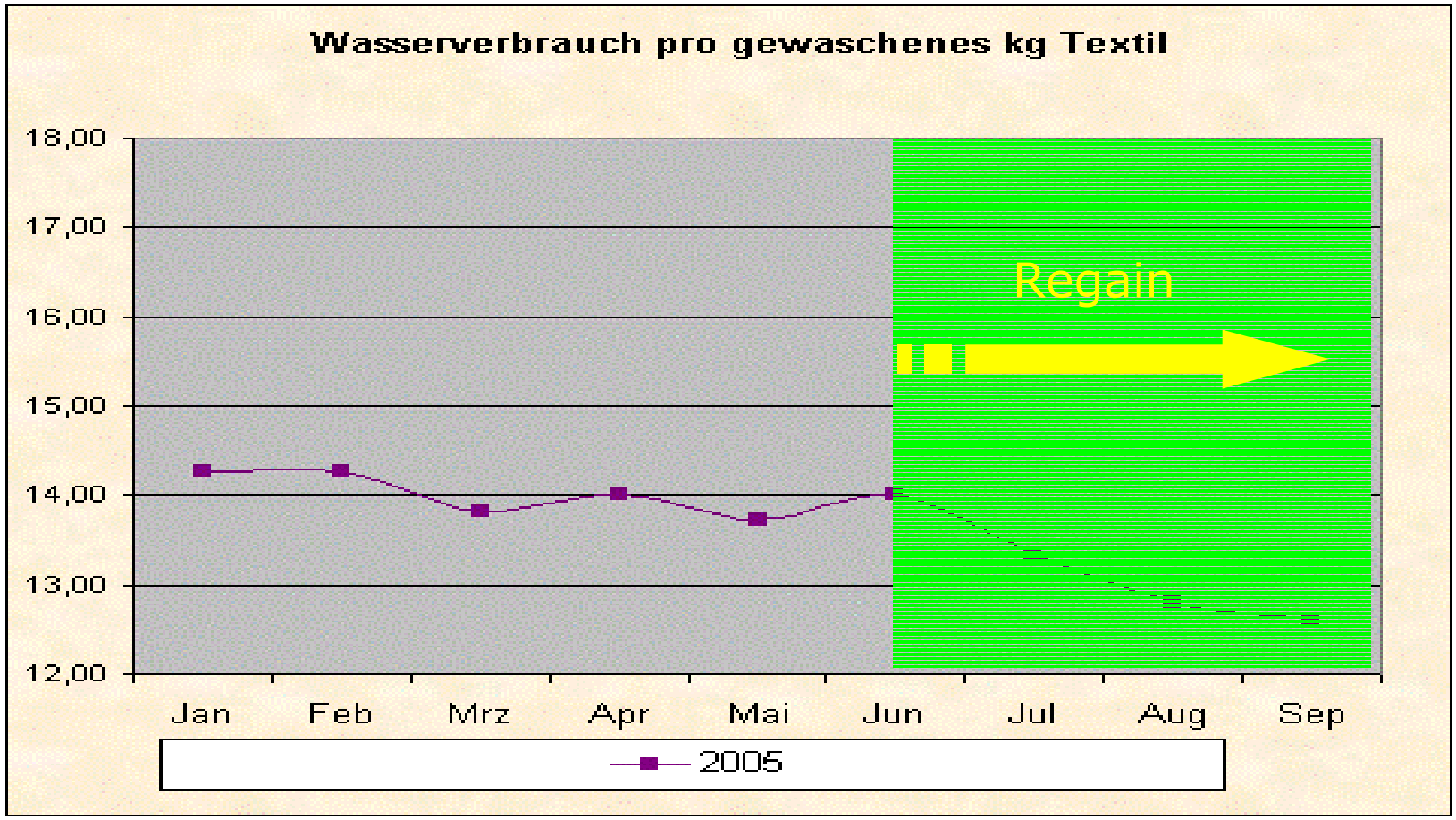
Water Savings in L/kg Textile, Total Laundry



….water usage of 2,5 l/kg*

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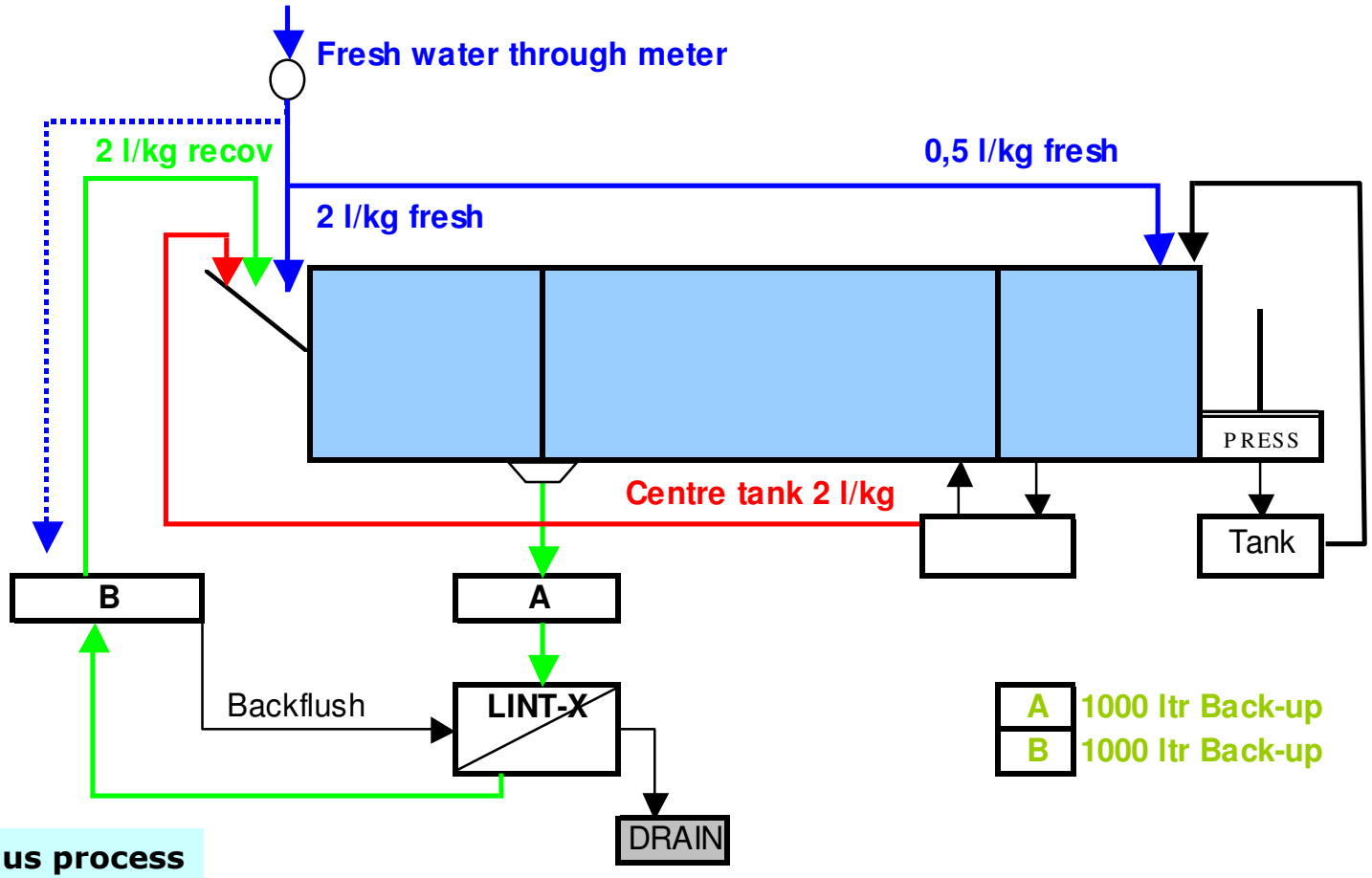

*Sanoxy Plus process

Resources Recovery Concept

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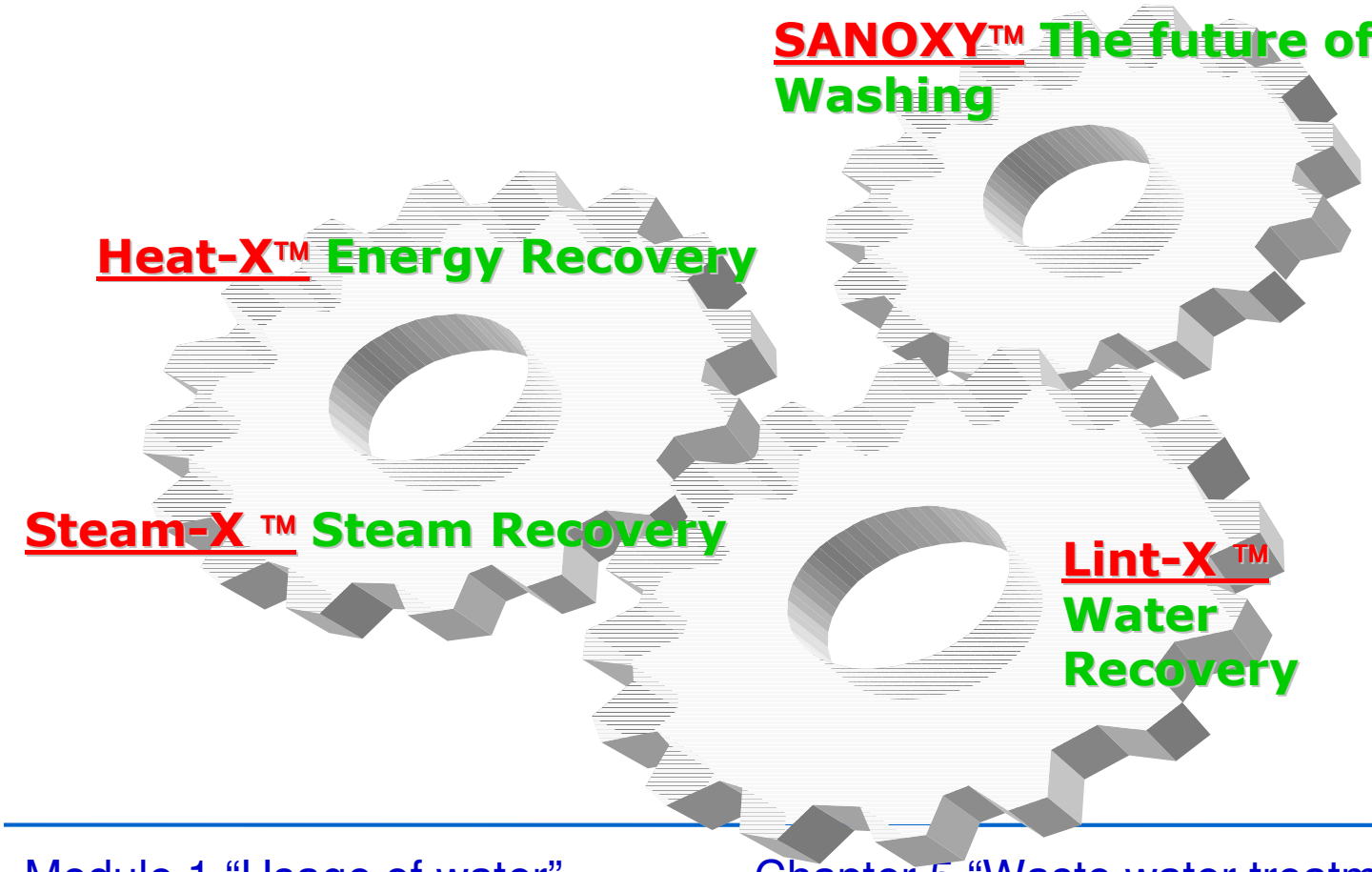
Implementing in your laundry plant a fully integrated solution leads to maximal water and cost savings



Membrane filtration - Summary

Education and Culture
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- Use is highly dependent on the price of water
- Membrane technology is expensive, however membrane price is dropping:
  - Price/m²: MF/UF: \$80 → 10\$ NF/RO: 15 \$ → 10\$
  - Energy: Pressure NF: 7 → 3 bar RO: 12 → 6 bar
- Investment cost becomes relatively more important
- Feed water pretreatment is important
- Use detergents that are compatible with membrane filtration

Thank you for your attention