

# Sustainable Water Use in Industry

Osnabrück, 24.Juni 2010

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Innovative Technologien für industrielle Wasserkonzepte-Trend und Perspektiven, 24.Juni 2010, Osnabrück

# Content

- Introduction AquaFit4Use
- Role of technology
- Examples from AquaFit4Use
- Conclusions



# Vision Statement (SRA WssTP 2005, update June 2010)

..... water is not a **consumable**, but a  
**highly valuable asset**

## Industries want to:

- be **independent** of the supply and further treatment of this critical factor,
- and demand **water qualities** up to their specifications, which are carefully tailored to **suit product demands and quality standards.**



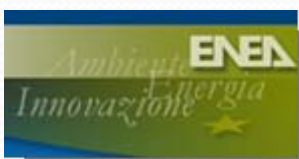
## AquaFit4Use: Facts and Figures

- Integrated Project, 1<sup>st</sup> call FP7
- 1<sup>st</sup> ' WssTP' project
- 14.5 M€, 9.65 M€ EC funding
- 1 June 2008 – 31 May 2012
- 34 partners
- 65 % Industrial participation
  - 13 End-users: Paper, Food, Chemistry, Textile
  - 9 Suppliers (water, equipment, chemicals, services)
- 22 Work packages, 39 Deliverables
- Sc. Officer: Dr. Balabanis





# Consortium



Innovationskonferenz für die Textilindustrie und  
Perspektiven, 24. Juni 2010, Goslar

## Overall objectives - AquaFit4Use

Development of new reliable cost-effective technologies, tools and methods for

**sustainable water supply, use and discharge**

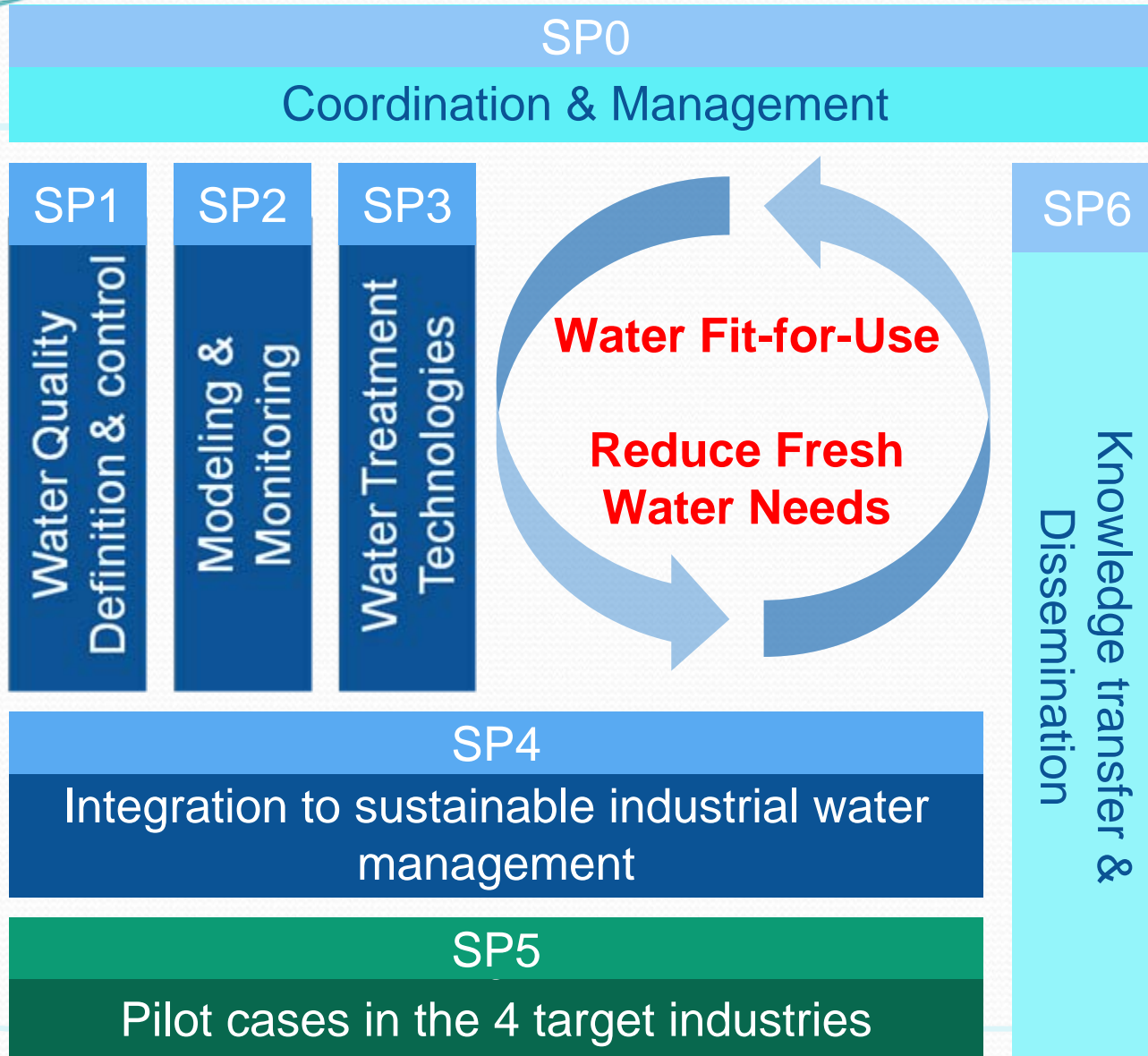
in the main Water consuming industries:

- Reduction of fresh water needs (30 %)
- Less environmental impact (energy, emissions, sludge)
- Water fit-for-use (increasing productivity, safety, health)
- Closing the water cycle

## AquaFit4Use gives clear answers to the questions

- What are the right water qualities in the various processes in the target industries?
- How can these water qualities be produced and maintained?
- How can these water qualities be monitored and controlled?
- What are the effects of using a different water quality?

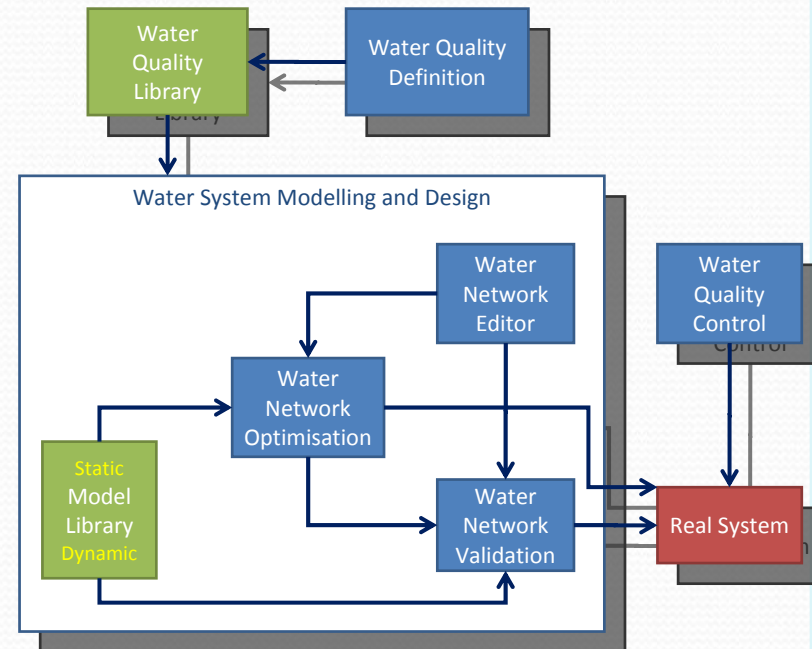






# Water Management (tool)

- Water Quality Definition
- Integrated modeling and control strategies
- Uncertainty Propagation
- Risk analyses
- Process unit modeling
- Water Network optimization



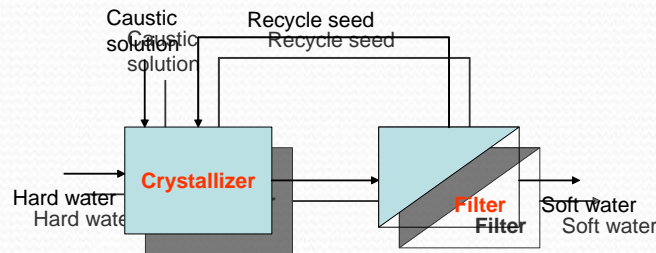
# Water treatment technologies in AquaFit4Use

## Tailor made combined systems



Membrane bioreactor (MBR)  
 Membrane filtration (NF, 3 FM)  
 AOP Process  
 Evapo-concentration  
 Controlled precipitation  
 Electrodialysis

## Biofouling and scaling prevention



Denutritor  
 Filtration assisted crystallization (FACT)  
 Nano-scaled Silver

## Water treatment technologies (2)

Selective removal of substances	Zerovalent ion Destabilization agents
Disinfection	Membrane filtration Ultrasound technology
Saline streams	Flow through capacitor (FTC) Membrane distillation-crystallization (MDC) Evapo-concentration

## MBR process stability

### 1 year of parallel pilot trials

- Selection and comparison of 3 MBR technologies
  - Flat sheet <> hollow fiber
  - PVDF <> PES
- Waste water constituents, not sludge quality caused irreversible and irrecoverable fouling



## Total effluent reuse

# 5 treatment trains run at pilot scale for production of low and high quality reuse water

- Tested membrane technologies
  - MBR
  - RO
- Complemented with
  - Denitrifier to reduce biofouling
  - AOP for enhanced biodegradability
- Evaluation pending



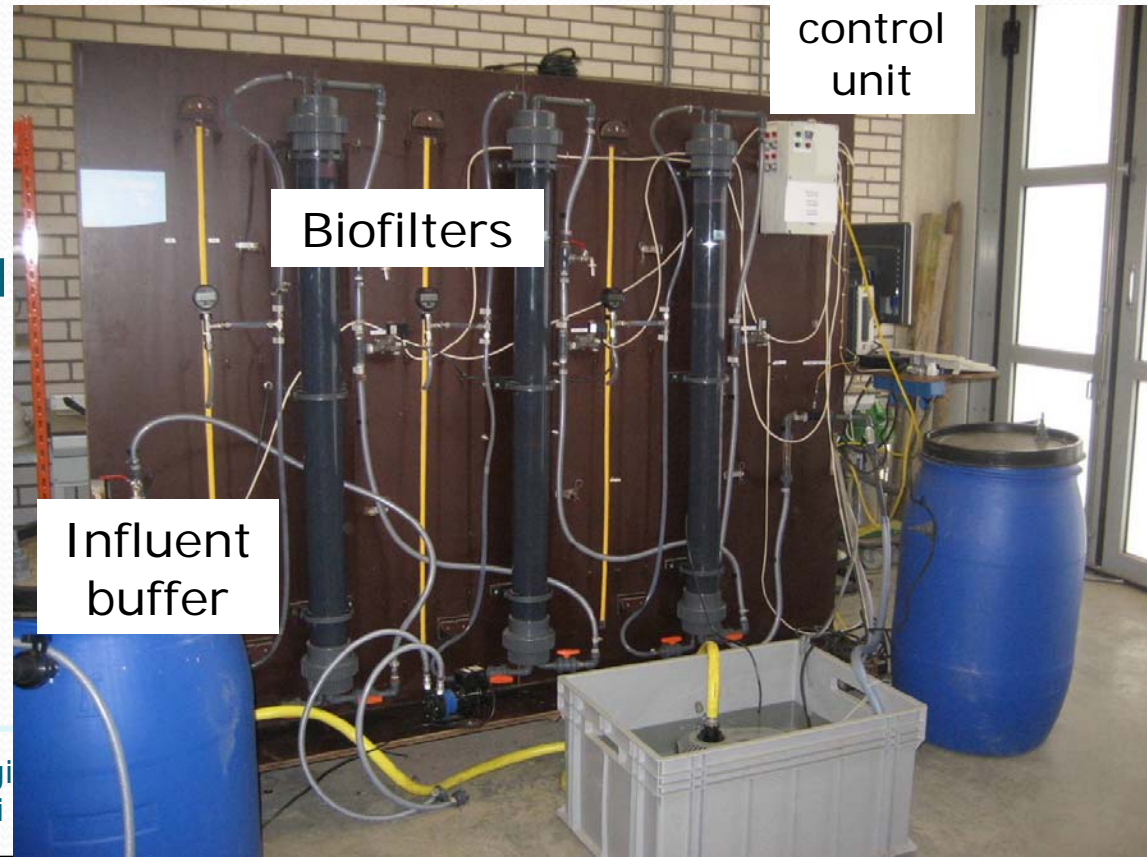
## Biofouling prevention by Denutritor

- Denutritor is a biofilter which removes substrates for microbial growth from water (from mg to  $\mu\text{g}$  range)
  - Microorganisms grow preferentially in the filter and biofilm growth downstream Denutritor is prevented
- ➔ The source of biofouling is removed

# Biofouling prevention by Denutritor

Biofilter which  
removes substrates

→ The source of  
biofouling is removed



Biofilters

Influent  
buffer

Valve  
control  
unit

# Results: biofouling potential reduction

→ protein formation on PE biofouling monitors

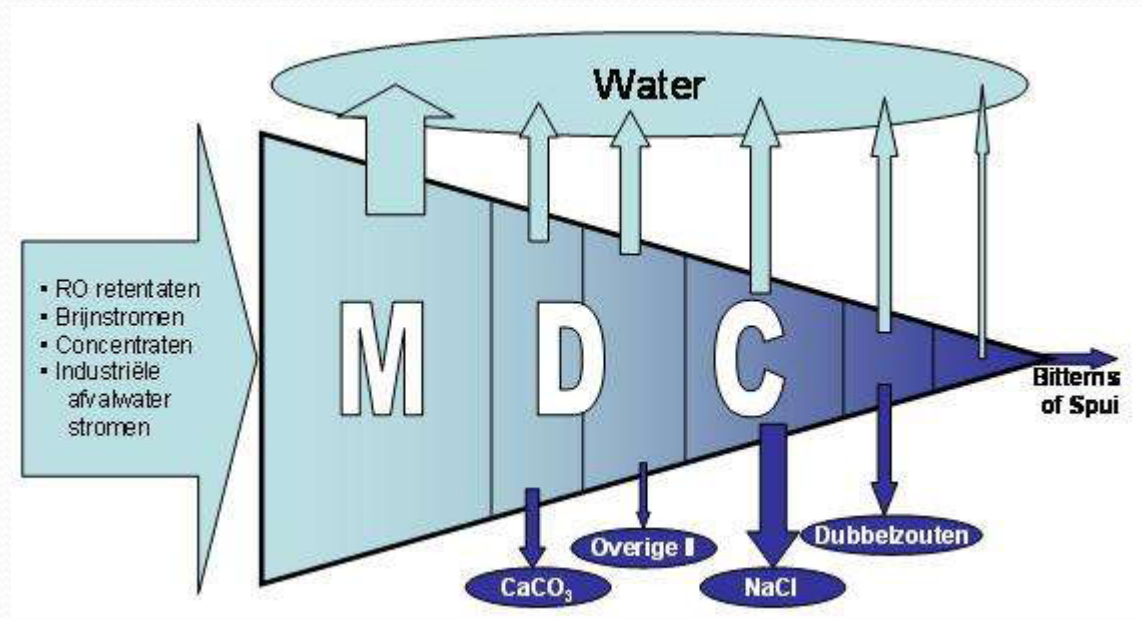


Test run	Biofouling potential (mg protein/m <sup>2</sup> /day)				Biofouling potential reduction (%)
	Influent	Effluent Filter 1	Effluent Filter 2	Effluent Filter 3	
1 (1 day)	45	19	12	9	<b>80</b>
2 (19 days)	5.0	2.4	2.4	0.4	<b>92</b>
3 (12 days)	5.3	3.0	3.3	1.5	<b>71</b>
4 (13 days)	5.8	4.4	3.3	0.7	<b>88</b>
5 (6 days)	8.4	2.9	1.4	1.1	<b>87</b>



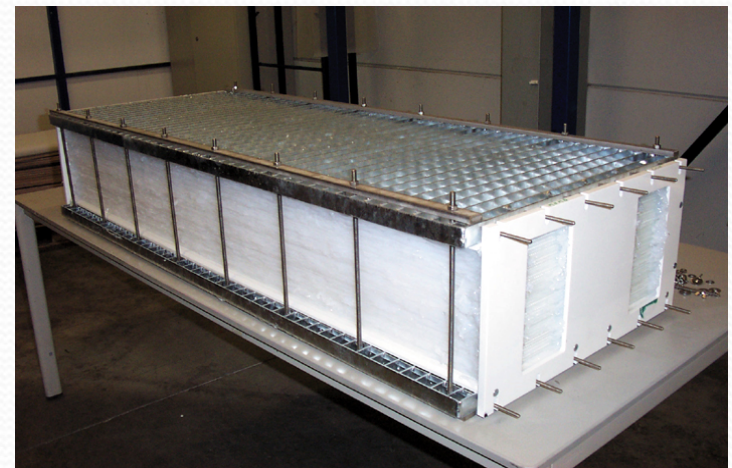
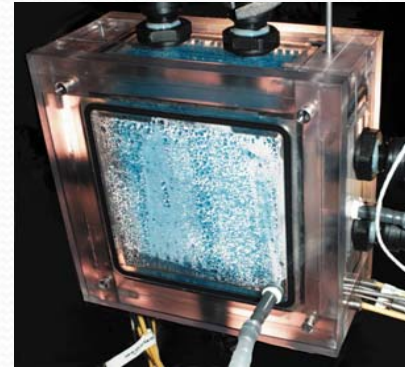
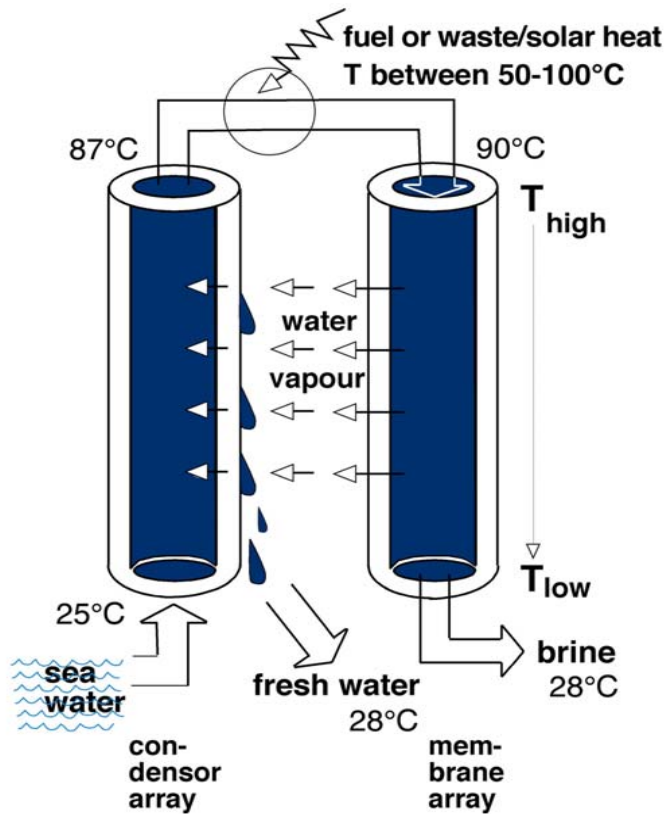


## MDC (Hybride Membrane Destillation/ Crystallisation Process)



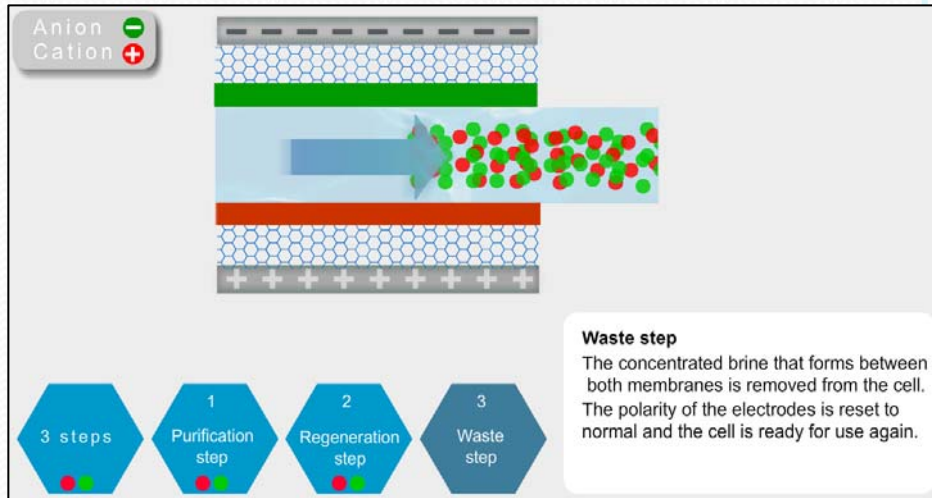
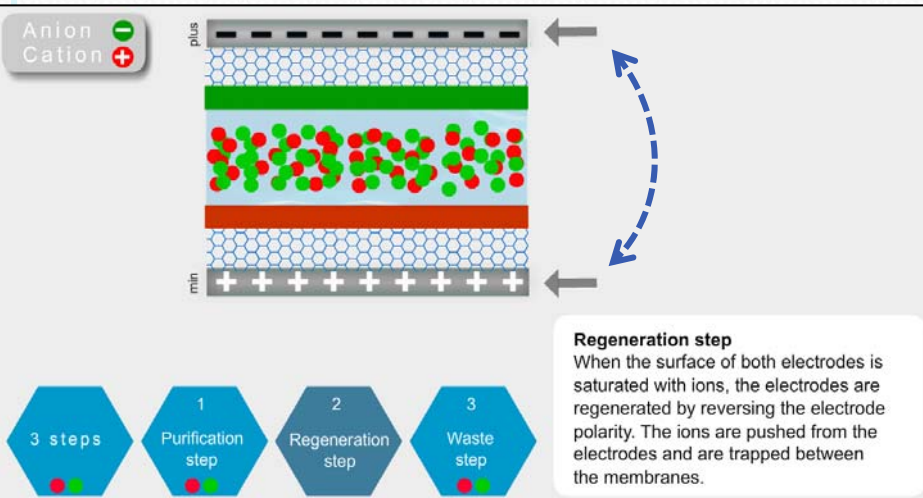
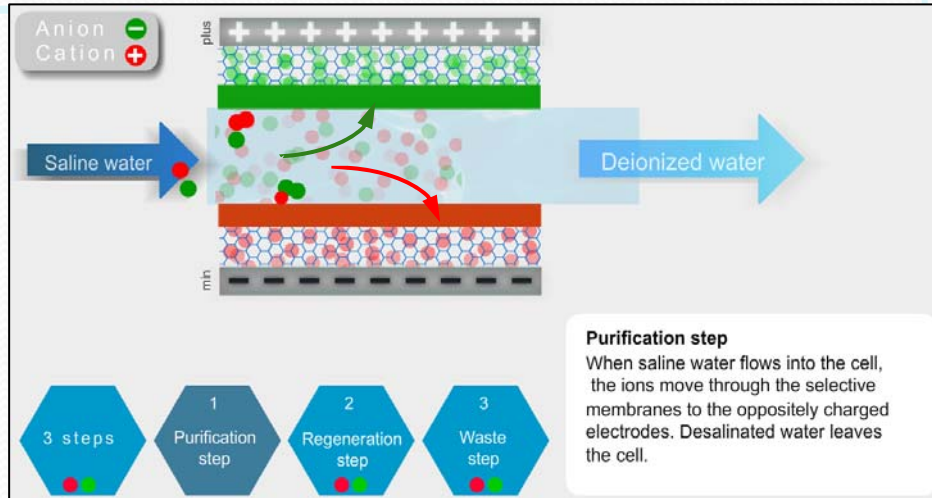
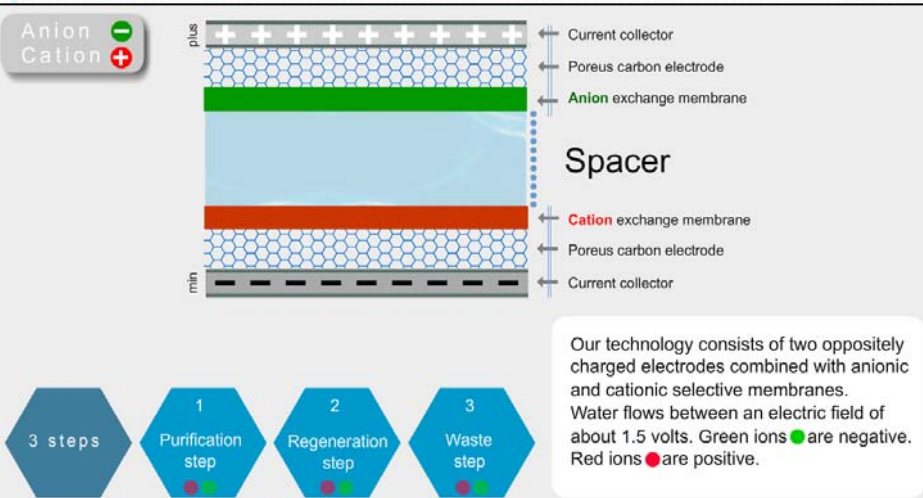
# Memstill® Basic principle

## Principle of Memstill-process



# Flow Through Capacitor

## Removing salt, not water



# Scaling prevention by Filtration Assisted Crystallization Technology (FACT)



Aim: realize re-use/recycling of water (and  $\text{CaCO}_3$ ) in paper industry by softening of process and/or waste water

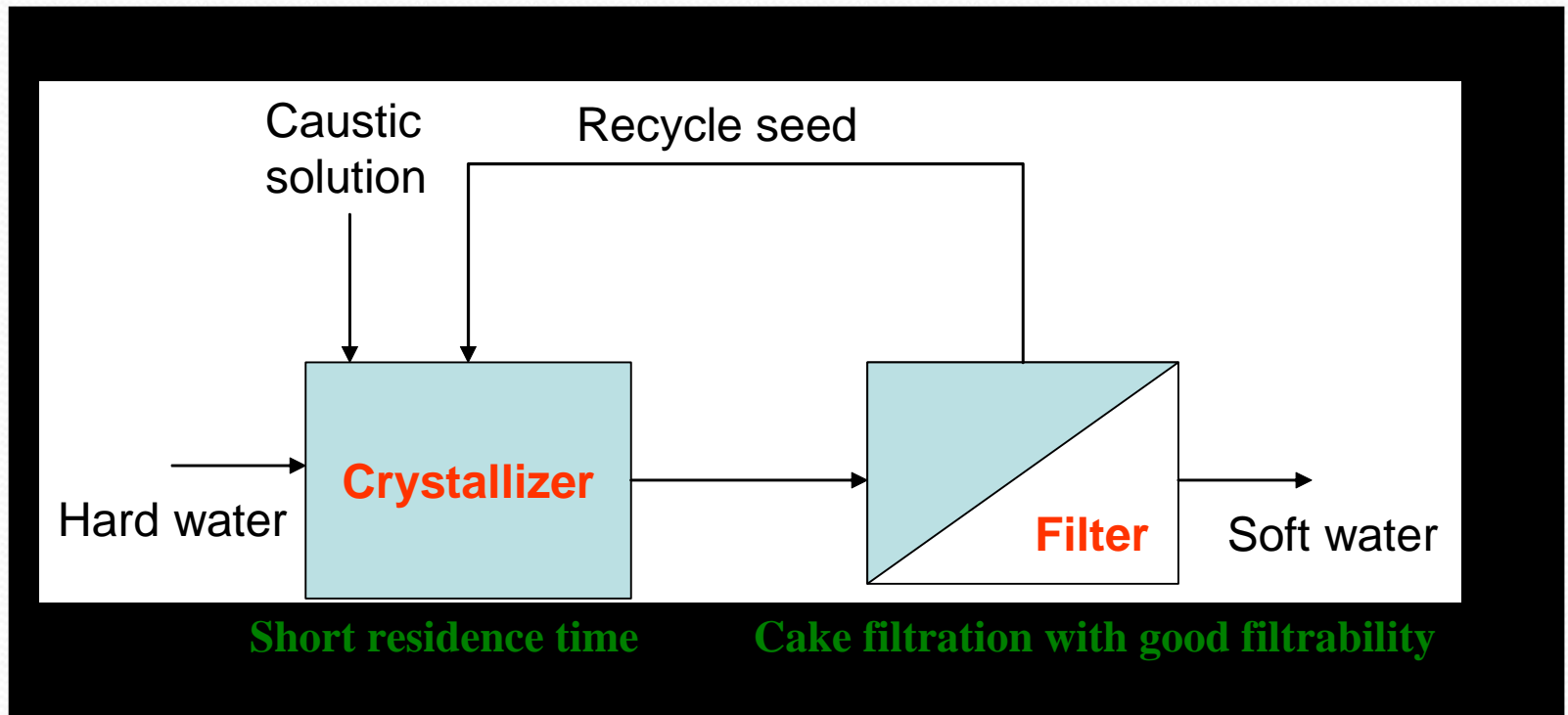
## Method:

Remove  $\text{Ca}^{2+}$ -ions by means of the crystallization of  $\text{CaCO}_3$  on heterogeneous seeds. The seeds make the crystallization faster and the filtration easier

## Potential advantages:

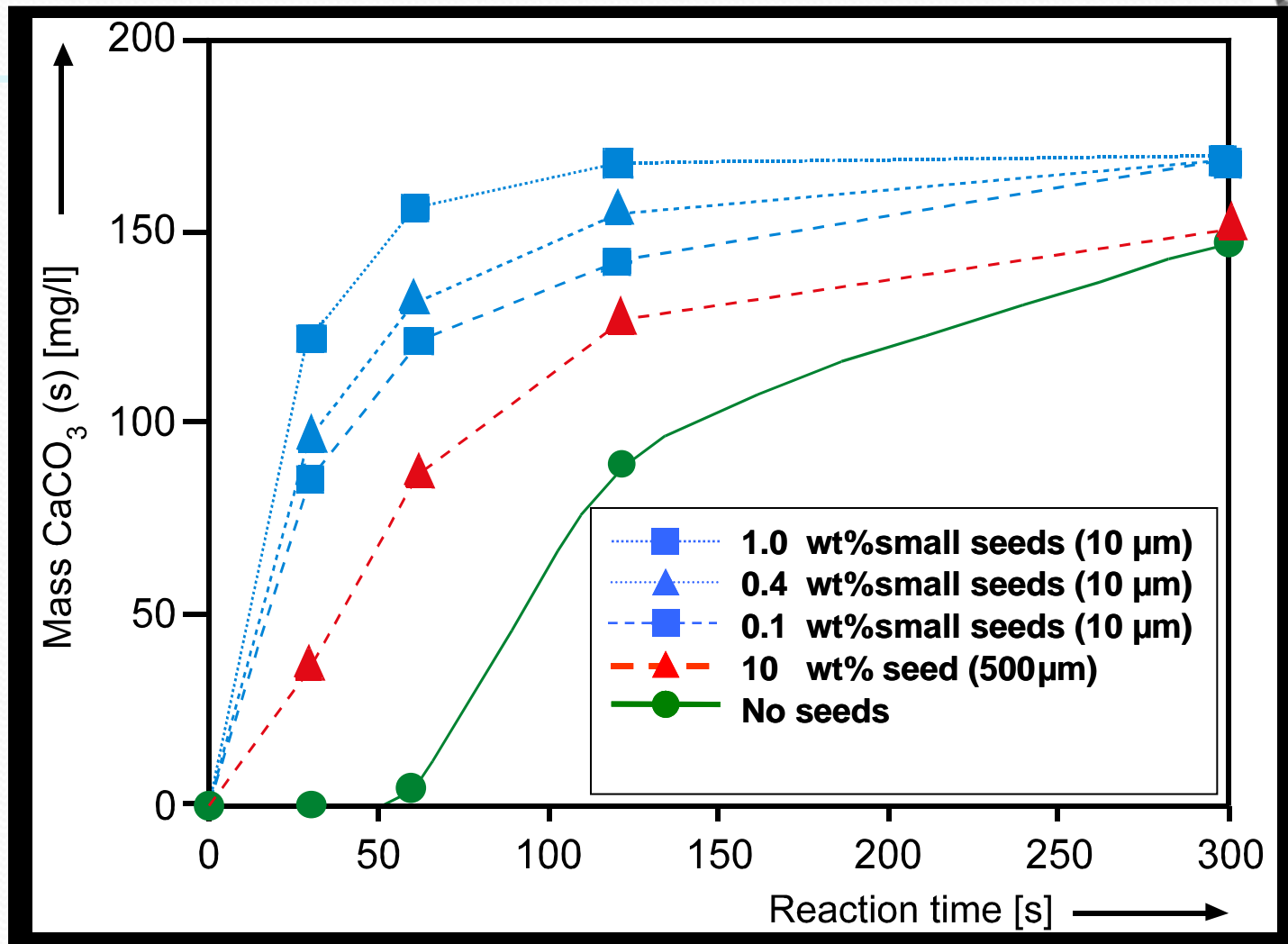
- (1) Closing of water cycles i.e. savings on water consumption (and maybe energy when warm, soft water is recycled);
- (2) To use the seeds +  $\text{CaCO}_3$  as filler ( $\pm$  10-20% reduction raw material (filler));

# FACT: optimal crystallization combined with optimal filtration process



Filtration assisted crystallization technology (FACT)

# Comparison of the effects of heterogeneous seeds for the Pellet Reactor and the FACT



**FACT: Small seeds faster than big seeds leads to small and compact apparatus**

## Industrial Examples from AquaFit4Use

- Re-use of effluent at Holmen paper Industry
- Water and Energy optimisation at Perstorp
  - Improve insights
- Application of Denutritor at Ben and Jerry's
  - Reduction of chemical use
- Application of FACT and FTC at ALPRO
  - Future closure of water cycle
- Treatment trains in Chemical and Textiles Industry

## 'New challenges'

- Sustainable water system as part of sustainable production (factory of the future): small scale dedicated installations
- Sustainable use of all resources in industrial water use (water, energy production, high added value products)
- Water in Industry as part of the total water system
- Far going cooperation with urban and agricultural sectors



## Conclusions

- Sustainable industrial water use ask for more than technological innovations
- There is still a need for new sustainable solutions, also closer to the processes (small scale)
- Technology can and will play an important role, also in combined systems
- Concentrates / Brines ask for real innovations



# Thank you

On behalf of The AquaFit4Use Team



# SP 6: Knowledge transfer and dissemination



[www.AquaFit4Use.eu](http://www.AquaFit4Use.eu)

