

FRENCH-NORWEGIAN WORKSHOP
ON THE MANAGEMENT OF WATER QUALITY
November 2001

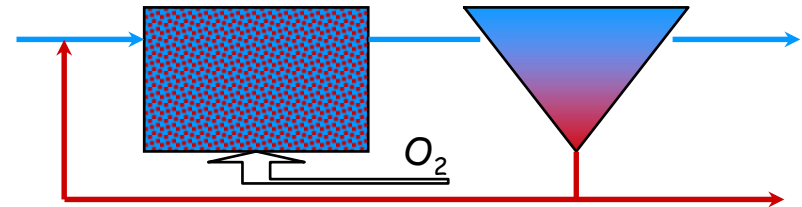
The potential of membrane bioreactors for special wastewater problems

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Terms and definitions

- Biological reactor.

- Suspended (AS)
- Fixed, Biofilm



- Membrane

- Mode of operation

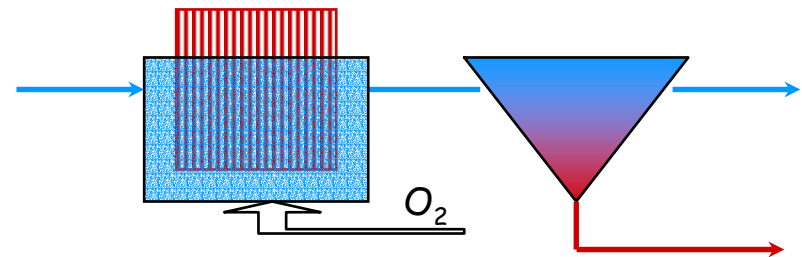
- Cross flow, dead-end

- Configuration

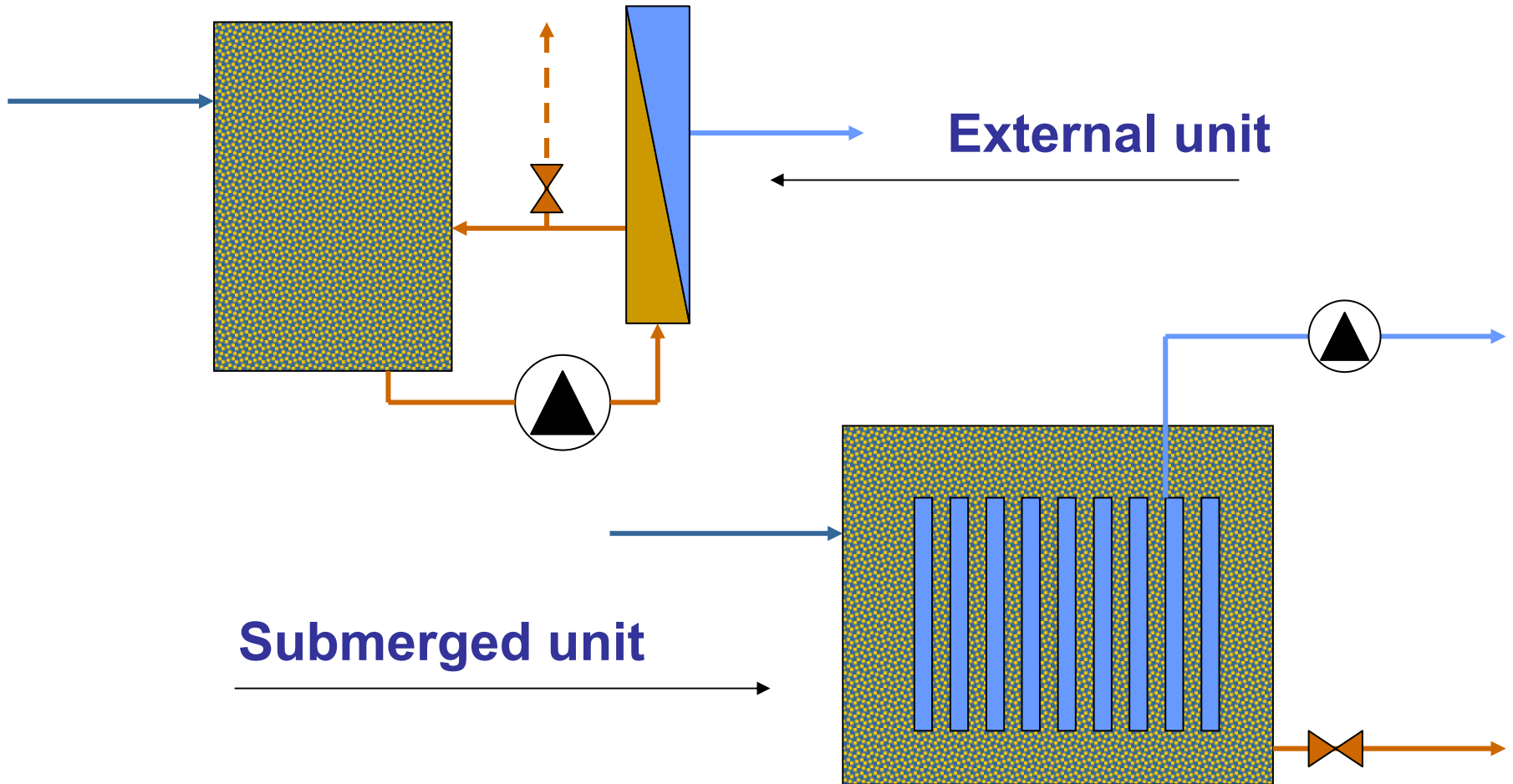
- Flat sheet, spiral wound, tubular, hollow fiber

- Material

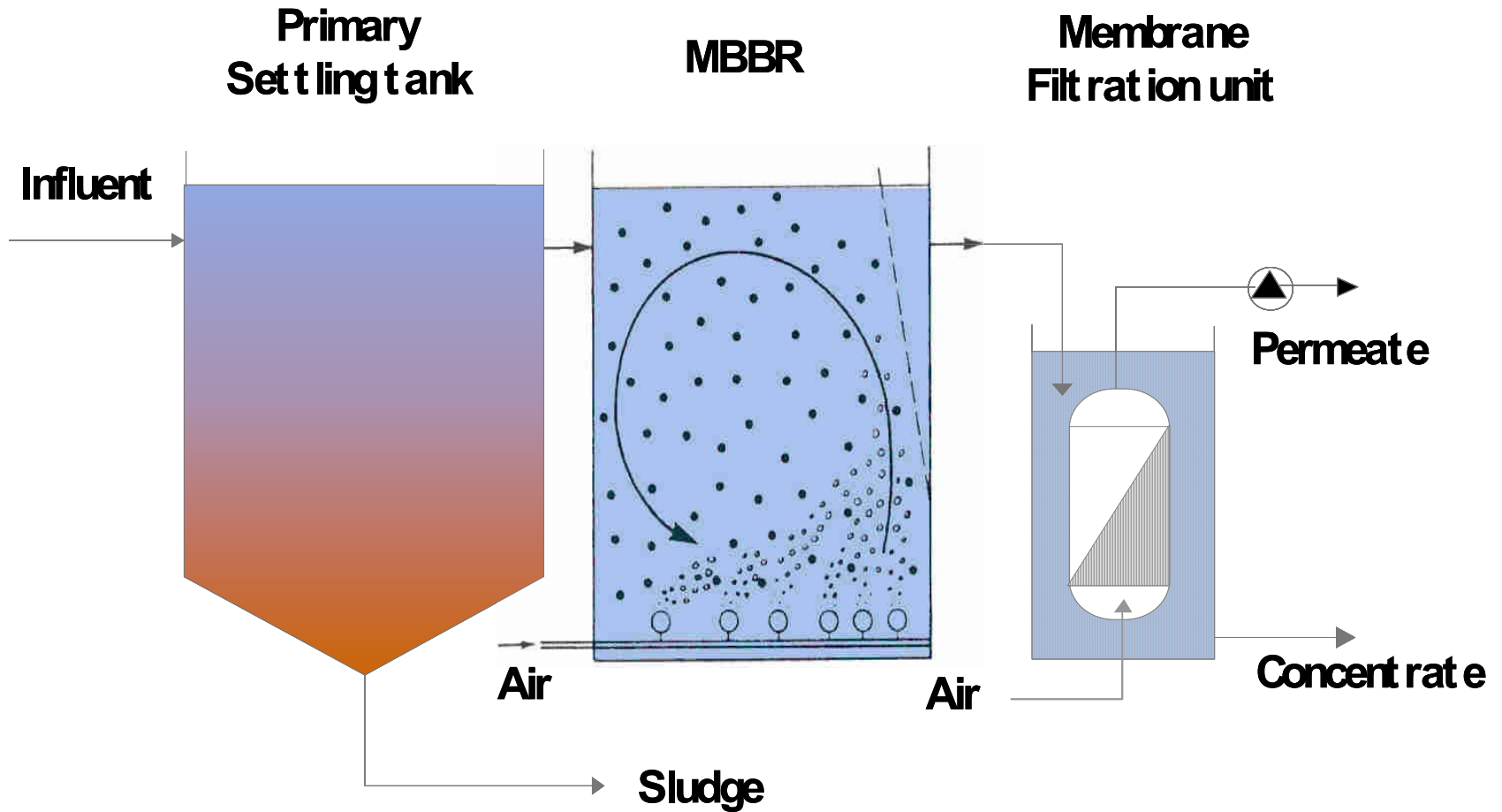
- Hydrophobic/hydrophilic, porous/dense, asymmetric etc.



"standard" configurations

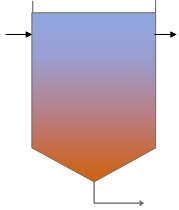


MBB-M-R studies: Moving-bed-biofilm-membrane-reactor



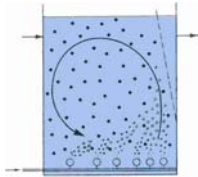
Pilot plant components

Primary settling tank:



- wastewater from a municipal sewer pipe
- volume $\sim 9 \text{ m}^3$
- mechanical separation – no chemicals added

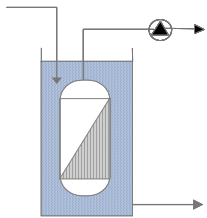
MBBR:



- KMT biofilm reactor
- volume: $\sim 200 \text{ l}$
- flow: $\sim 2 \text{ l/min}$

Load: $120 \pm 20 \text{ mgCOD/l}$
 $\sim 40\% \text{ SCOD}$
HRT $\sim 100 \text{ min}$

Membrane filtration unit:



- model: ZW-10, Submersible module
- configuration: Outside/ in hollow fiber
- nominal surface area: $0,93 \text{ m}^2$
- process tank working volume: 190 l
- flow extracted from MBBR: $\sim 1 \text{ l/min}$

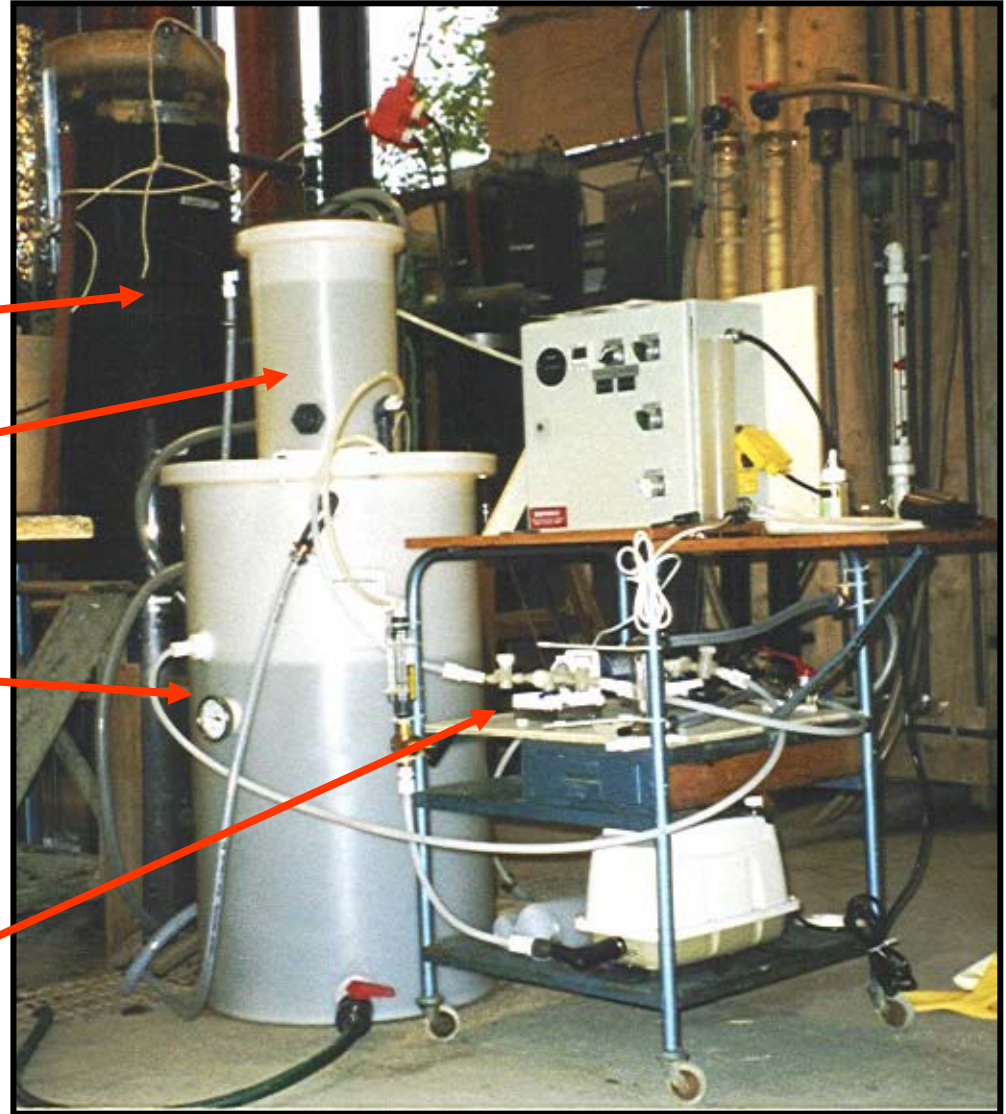
Photo of pilot plant components

MBBR unit

Permeate tank

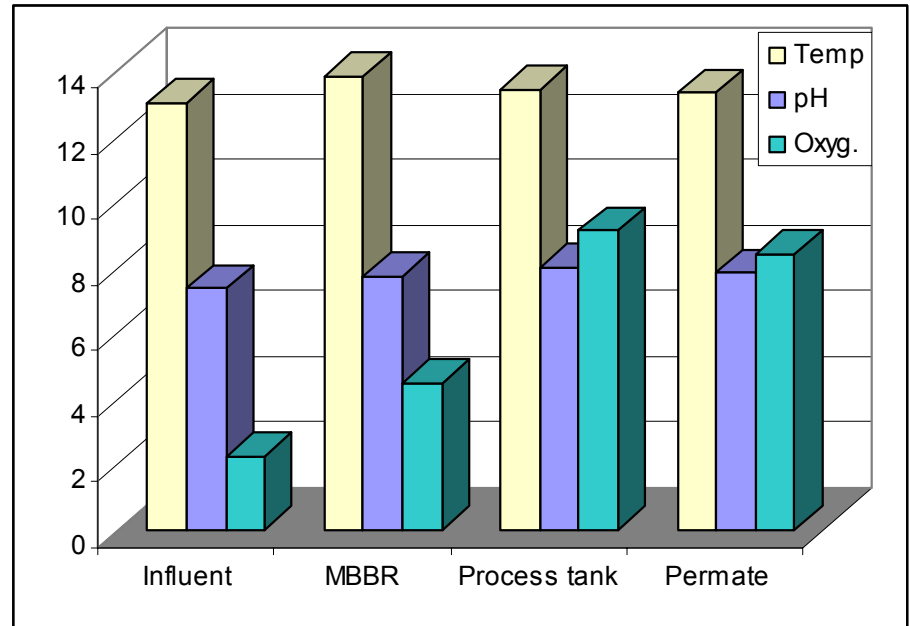
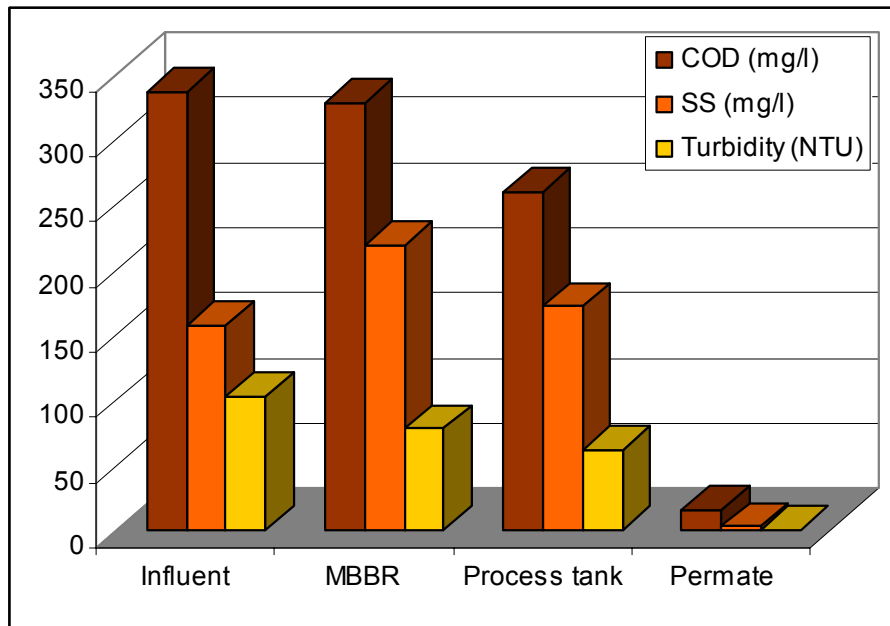
Membrane process tank with submerged module

Pumps, blower, control unit



Water qualities

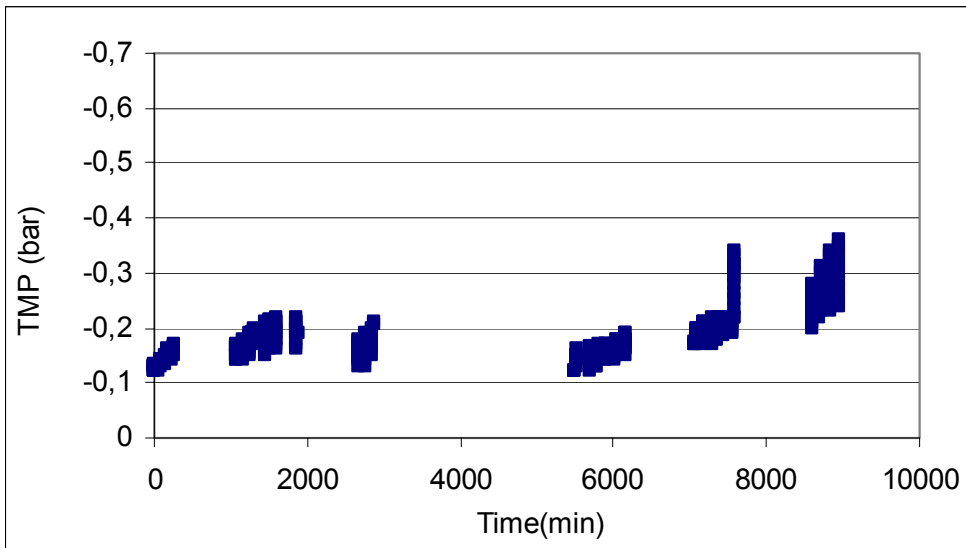
SS	COD	SCOD	NH ₄ -N	DO	pH	T°C
79±45	204±100	56±11	21±5	2.0	7.4±0.2	14



- No nitrification/denitrification: average NH₄-N: 20 mg/l throughout system.
- No detectable biological activity in the process tank

Performance

SS mg/l	99,5% (<5 mg/l)
Turbidity NTU	99,5% (<1)
COD mg/l	84,0%



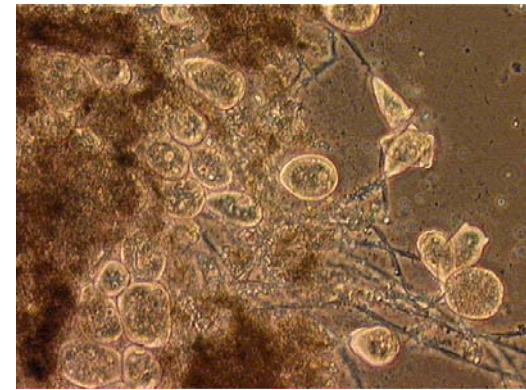
Operating conditions:

- Flux: 60 LMH, >150 hrs
- HRT: 20-60 minutes
- Volumetric loading rate: 30-45 kg COD/m³·d

Why MBB-M-R?

Biofilms:

- biofilm fairly "constant"
- production = loss at steady state
- mass transport limiting step
- surface area / volume essential
- biomass is more "specialized"



Can target "special" wastewaters, conditions of the biofilm process.

Membrane technology:

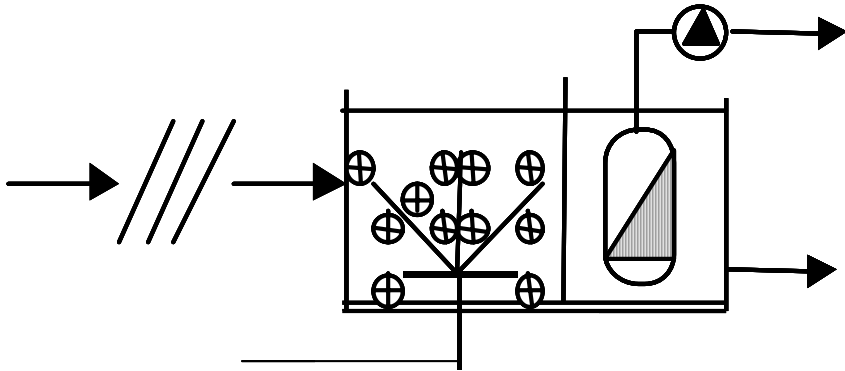
- Efficient removal of COD
- 85-90 % TCOD removal
- No particulates
- No chemicals

Treatment demands:

- high quality effluent (secondary/tertiary treatment)
- Water reuse / recycling
- compact process design
- good control of operating criteria

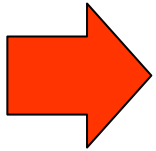
"Conclusion"

Concept:



Hybrid solution:

- Optimizing the biofilm process for special wastewater sources
- Efficient particle separation



- "on-site" treatment, targeting specific discharges
- treatment of recalcitrant substances
- high quality effluent, water recycling/reuse potential
- compact process design
- energy efficient and "sustainable" solutions