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STUDIES ON WASTEWATER TREATMENT PLANT PERFORMANCE MEASUREMENTS

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Contents

- Objective, Rationale
- Introduction of the bleached kraft pulp mill effluent treatment
- Introduction of the refractometer measurements
- Methods
- Results of the controlling effluent quality using DDS and conductivity measurements.
- Results of the concentration profiles in a plug flow aeration biological reactor.
- Implications of process and mill levels
- Conclusions

Objective

- **Series of investigations to better understand the phenomena of WWTP;** Identify changes of concentration level in wastewater, Find a new way to measure wastewater parameters' limit values, Optimize the dynamics of the aeration basin.

Rationale

- There is a need to improve wastewater treatment process (WWTP) and its monitoring, for environmental and economic reasons.

- Conventional on-line and traditional lab sampling methods do not reveal all process variations.

→ Better real time monitoring tools are needed.

Wastewater treatment

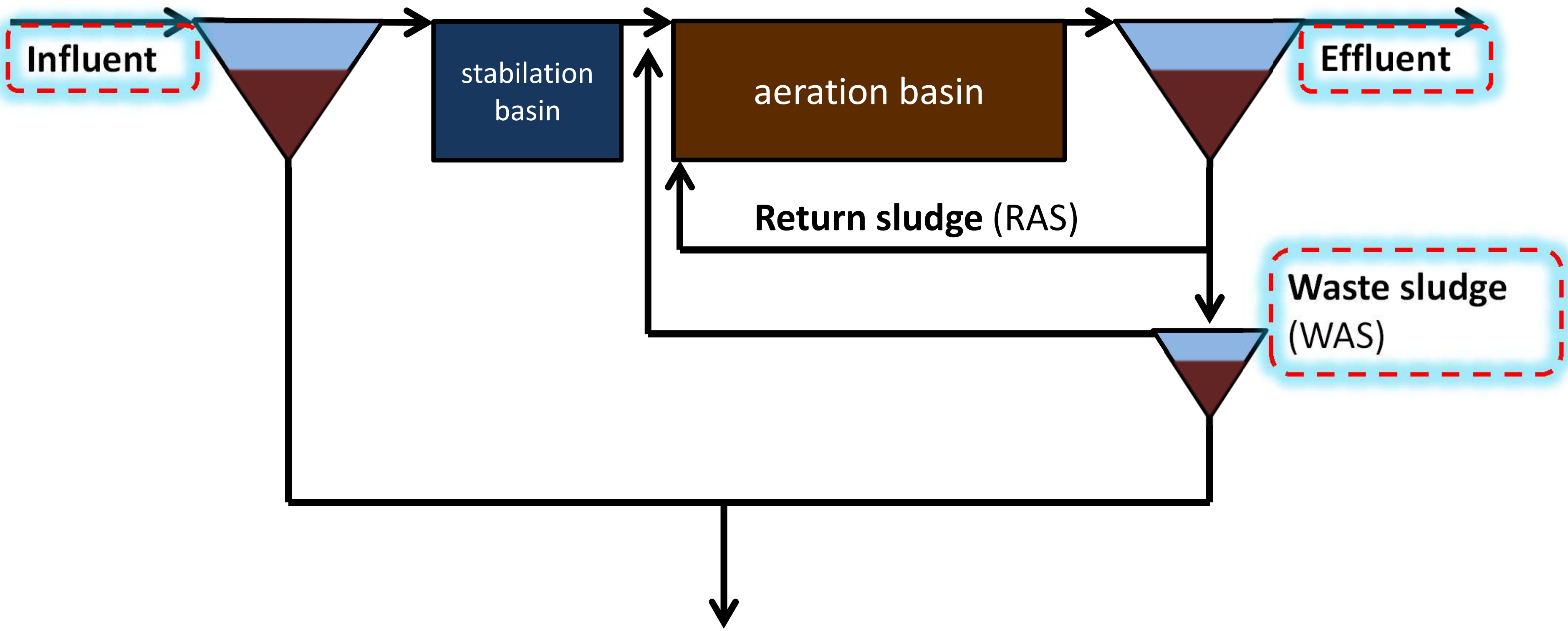
BLEACHED KRAFT PULP MILL EFFLUENT TREATMENT

- In general, amount of wastewater produced during the process varies between 19-40 m^3/Adt
  - Rapidly degradable organics
  - Slowly degradable organics
  - Non-degradable organics
  - Nutrients
  - Toxic compounds
- Wastewater quality is relatively steady when compared to municipal wastewaters
- Wastewater is commonly treated in activated sludge process
- Tertiarty treatment (optional)

Wastewater treatment

BLEACHED KRAFT PULP MILL EFFLUENT TREATMENT

- **BOD-reductions usually quite high** (up to 98 %)
- **COD-reductions varies between 40 - 80 %**
- **The excess of phosphorus to the biochemical need in an activated sludge process** (total P-reductions 40-60 %)



Refractometer

- Indicates total dissolved solids in solution, suitable for all concentrations
- Measures the washable liquid substances concentration exactly

- Detects organic materials with large molecular size, like lignin
- Not influenced by COD caused by methanol

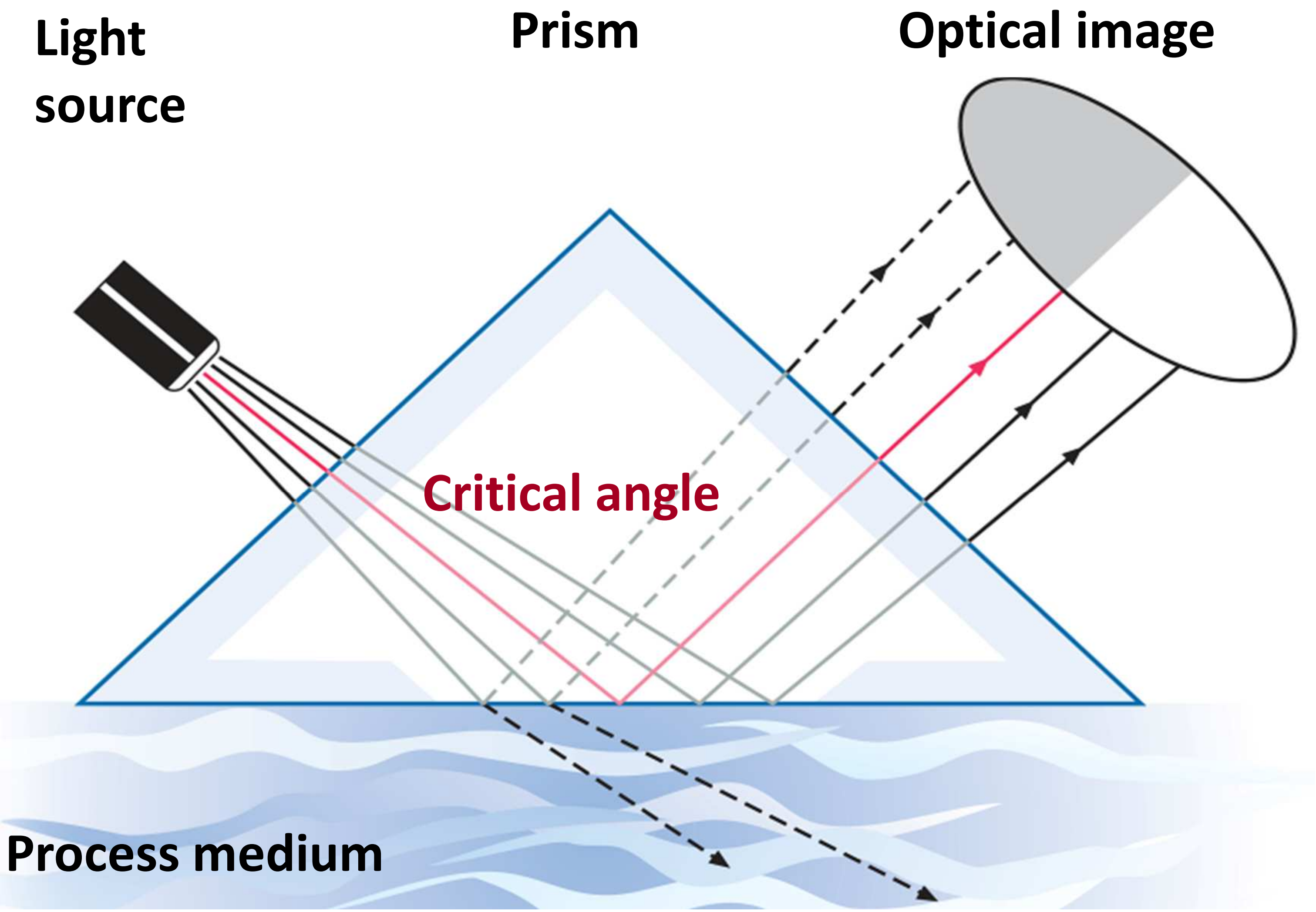
Refractometer

- **Not influenced by suspended solids, bubbles or fibres**

- **In-line real-time measurement**

- **Short response time → suitable for control**

Principle



Light source
Prism
Optical image
Critical angle
Process medium

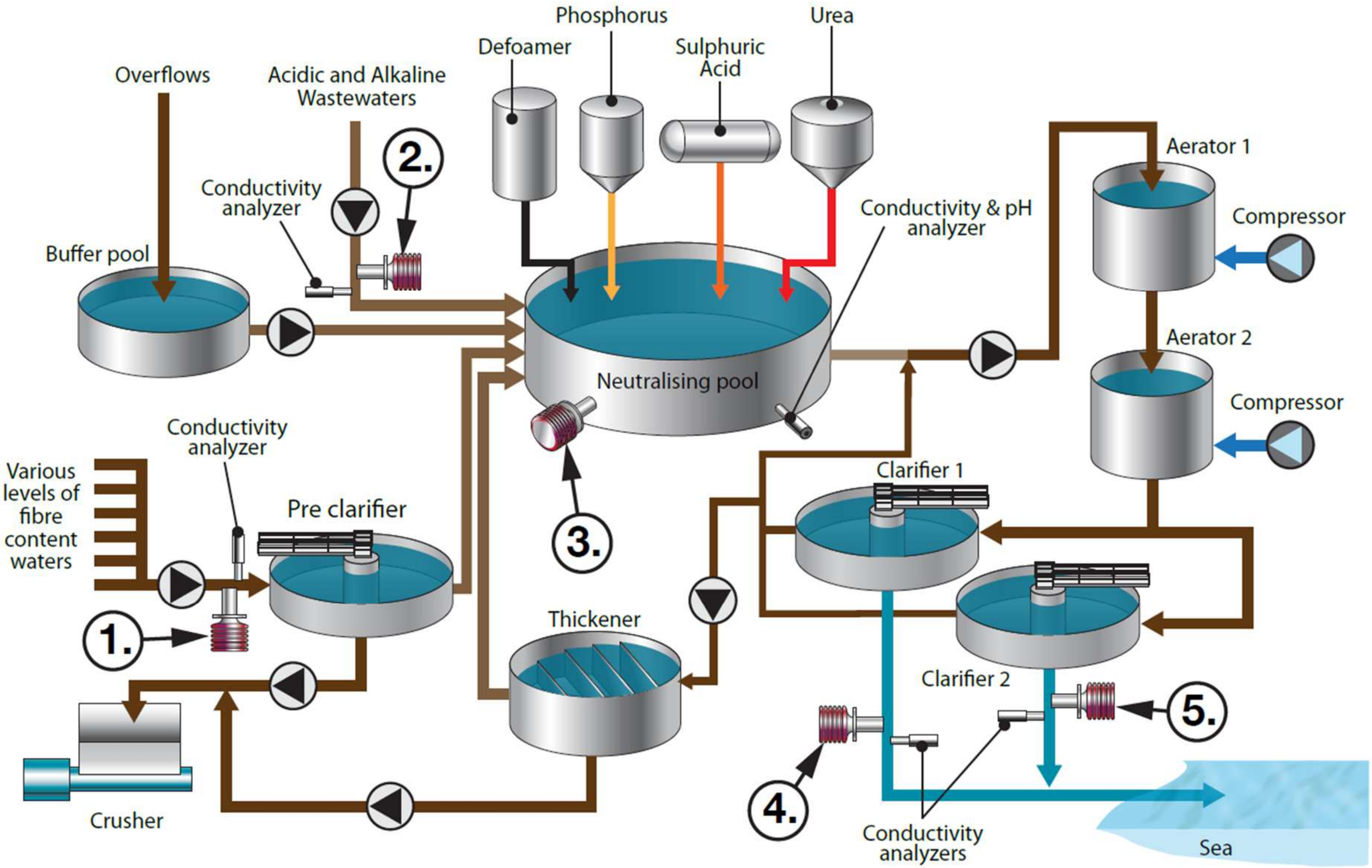
Experiments

Experiments were divided into two parts:

- The first part shows a novel method for controlling effluent quality using DDS and conductivity measurements.
- The second part deals with the dynamics of reactions in a plug flow aeration basin.

Experimental installations

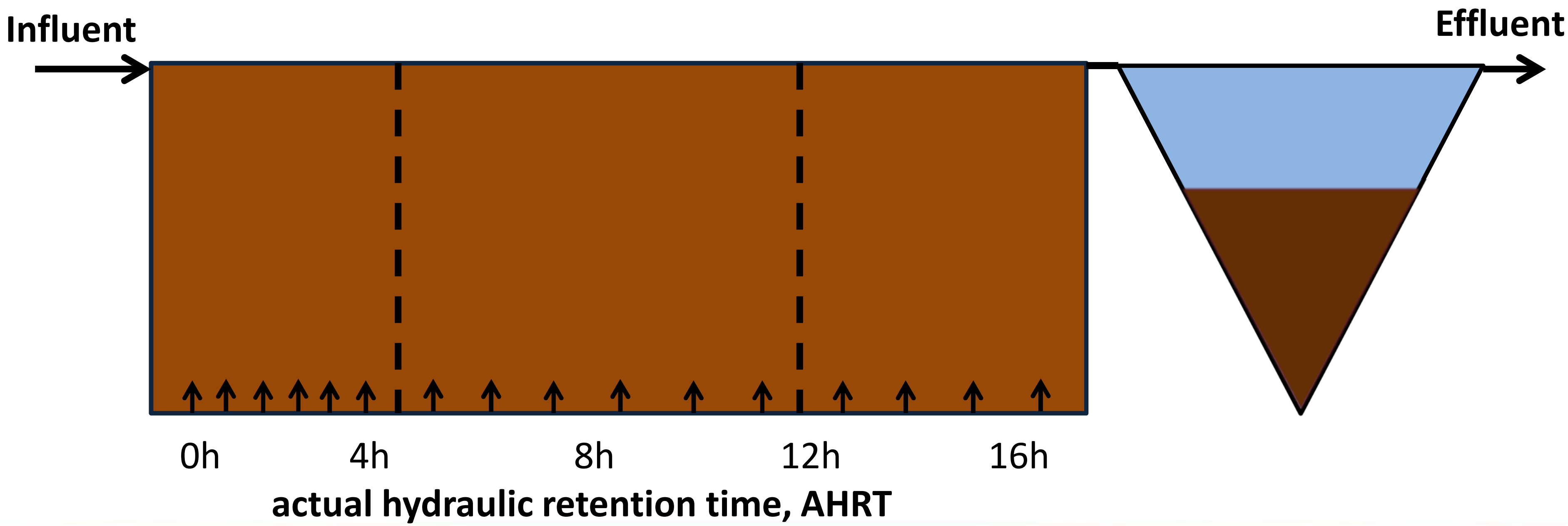
MONITORING WWTP'S INFLUENT AND EFFLUENTS QUALITY



Experiments

DYNAMICS IN THE AERATION BASIN

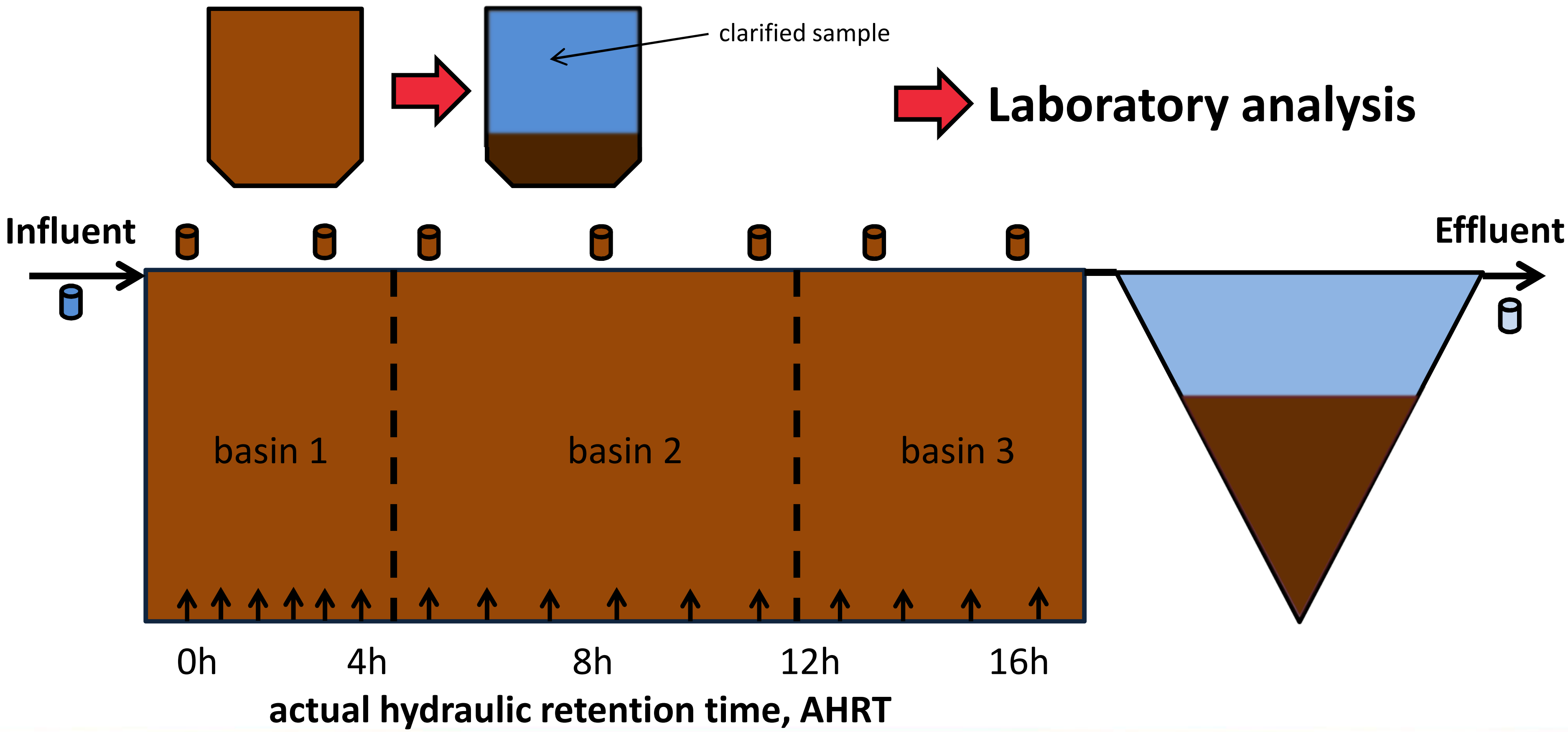
- On-site measurements ( ) in function of time
  - Dissolved oxygen
  - Specific Oxygen Uptake Rate (SOUR=OUR/MLSS)
- AHRT = aeration volume / (wastewater flow + RAS)



Experiments

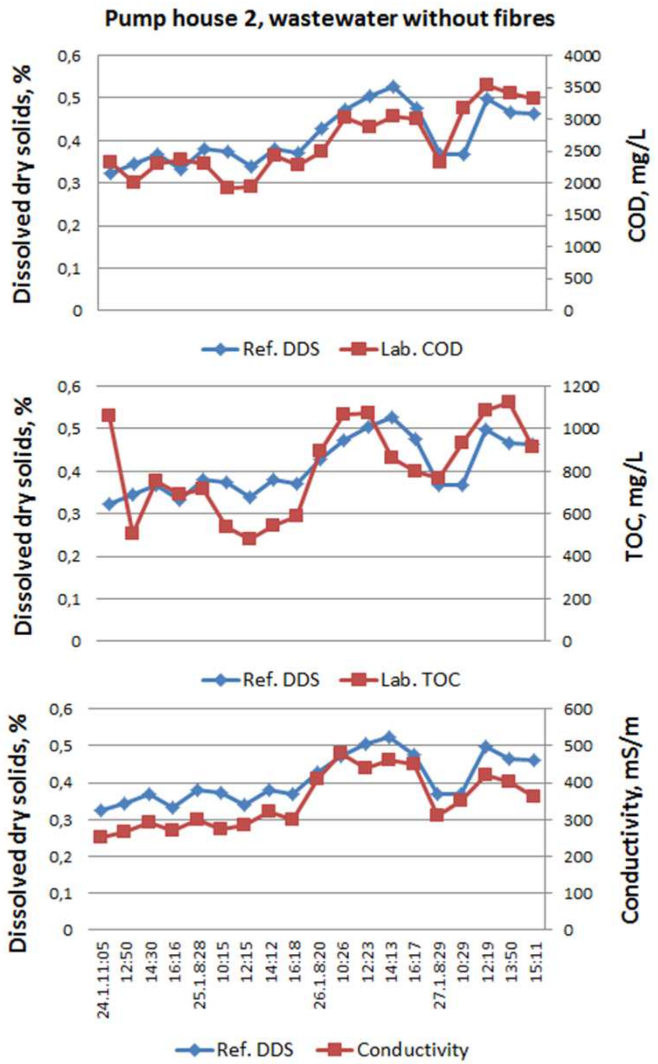
DYNAMICS IN THE AERATION BASIN

- Collecting samples ( ) during the aeration phase in function of time
- Decanting the samples
- Filtering (5 µm) the samples to minimize further degradation of residue organic matter



Results

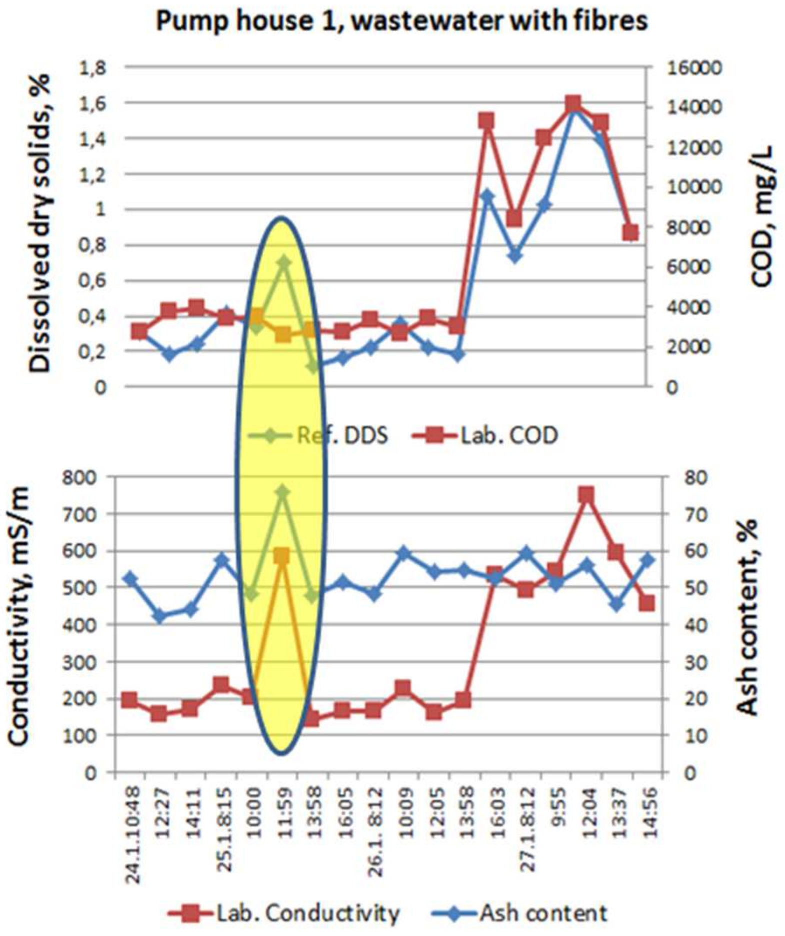
MONITORING WWTP’S INFLUENT AND EFFLUENTS QUALITY



- All of the measurements had almost the same behaviour.
- Dissolved material was pretty evenly polarised into organic (40–45%) and inorganic (55–60%) matter.

Results

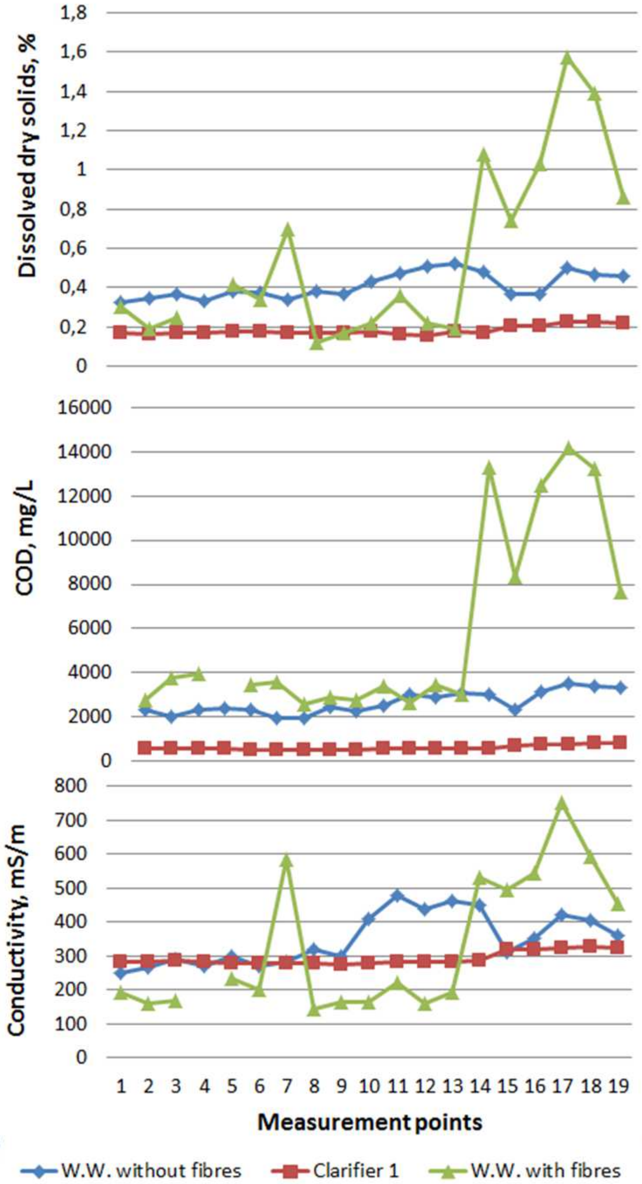
MONITORING WWTP'S INFLUENT AND EFFLUENTS QUALITY



- A momentary spike in the amount of inorganic matter very clearly showed as an increased conductivity and on the refractometer values, while no effect on the COD value was observed.
- These results support the theory that conductivity tells us mainly about the inorganic materials, the COD tells us mainly about the organic materials and the refractometer measurement emphasizes both with the measuring all dissolved material.

Results

MONITORING WWTP'S INFLUENT AND EFFLUENTS QUALITY



- The activated sludge plant where the samples were collected operated normally, reducing the COD by approximately 75%, while there was no significant effect on concentrations of inorganic matter.
- Therefore, the conductivity measurement, which correlated to the inorganic measurements, was not a very good indicator of the effluent load from the ASP into the local water system.

Results

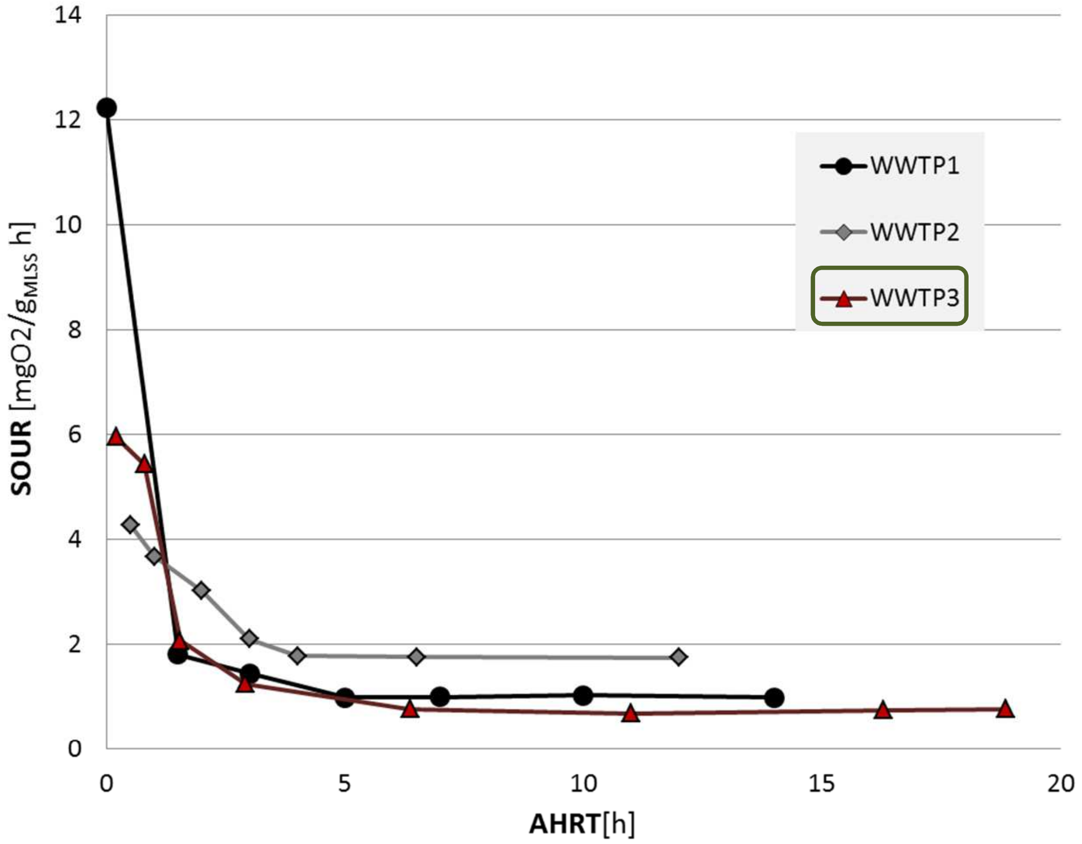
DYNAMICS IN THE AERATION BASIN

Quantity	WWTP1	WWTP2	WWTP3	WWTP4
Aeration volume (m^3)	55 000	108 000	90 000	103 000
Flow rate (m^3/d)	43 000	85 000	58 000	86 000
HRT (h)	31	30	37	29
AHRT (h)	15	12	18	14
Influent BOD_7/COD	0.20	0.29	0.31	0.56
MLSS (g/l)	5.1	4.8	5.8	5.4
Sludge load ($BOD_7 kg\ MLSSkg^{-1}\ d^{-1}$)	0.04	0.05	0.08	0.15
Volumetric load ($kgBOD_7\ m^{-3}d^{-1}$)	0.19	0.24	0.48	0.83
SRT (d)	32	25	38	17
Temperature (°C)	35-37	34-36	37-39	32-34

	pulp mill (%)	paper mill (%)	municipal (%)
WWTP1	100%	-	-
WWTP2	70%	30%	-
WWTP3	75%	25%	-
WWTP4	40%	30%	30%

Results

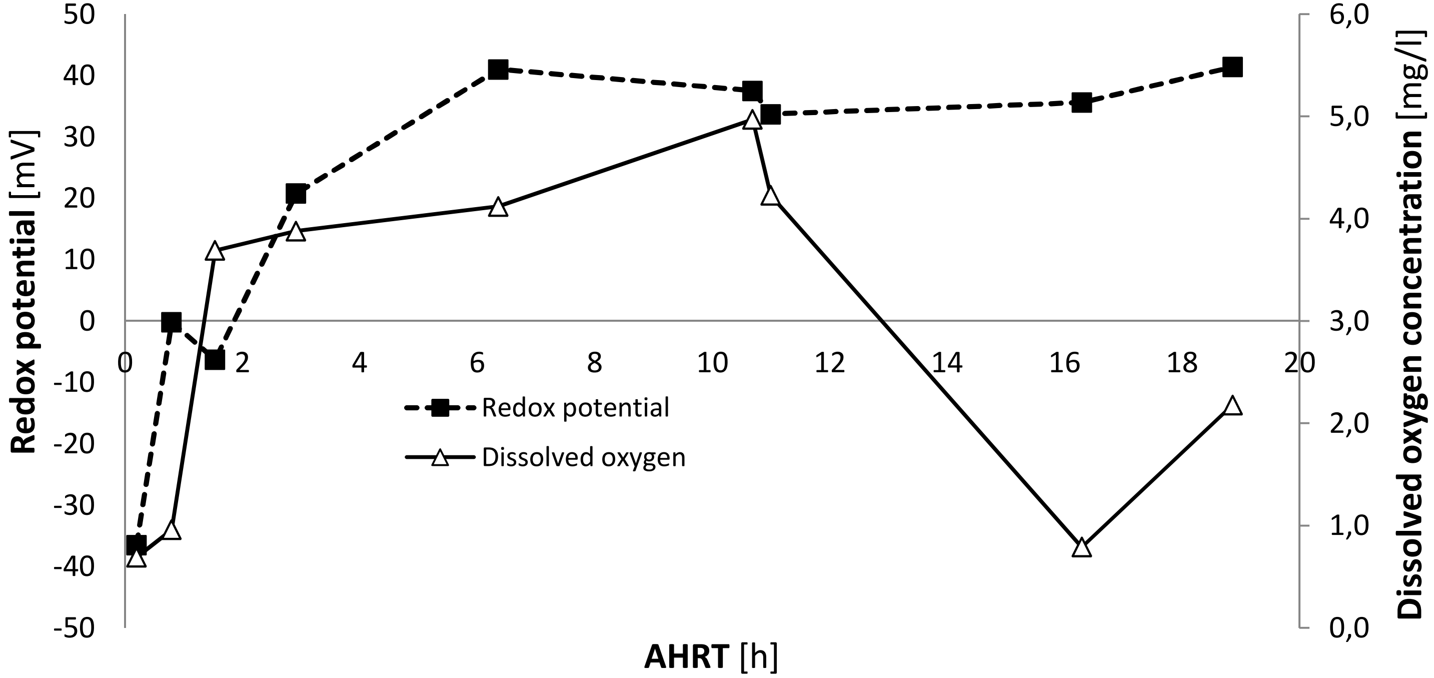
DYNAMICS IN THE AERATION BASIN



Results

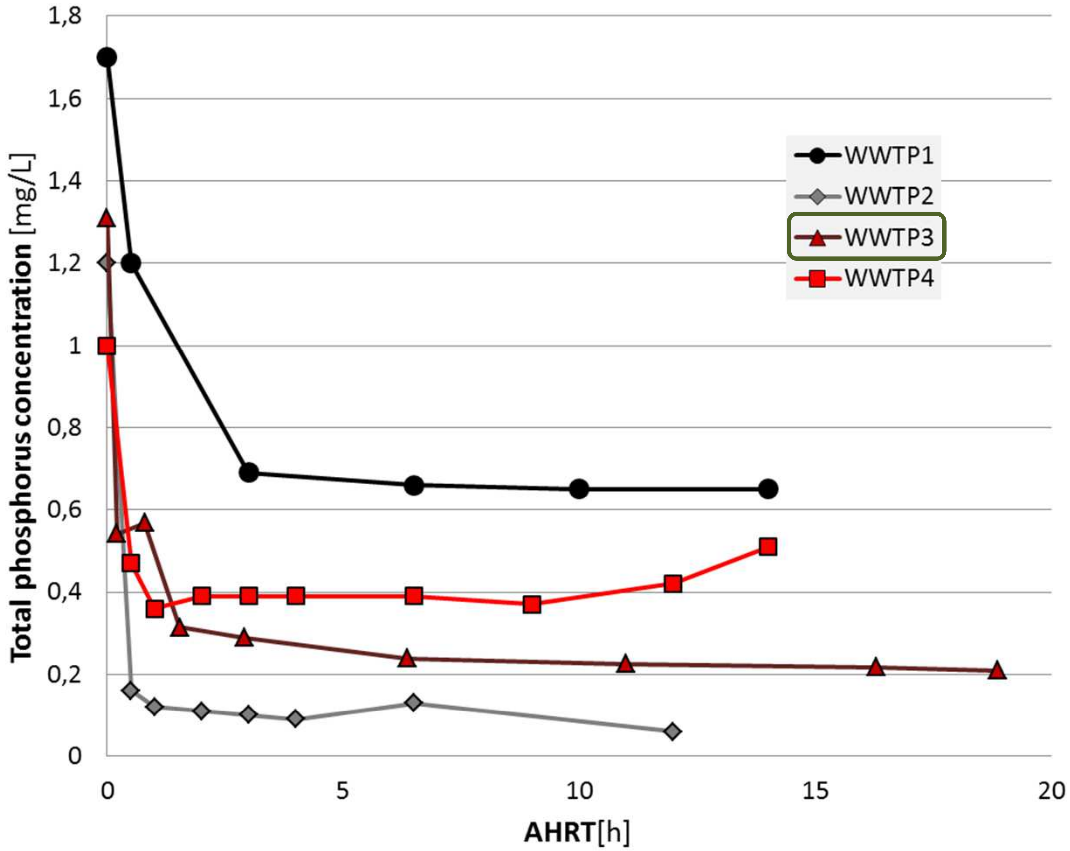
DYNAMICS IN THE AERATION BASIN

WWTP3



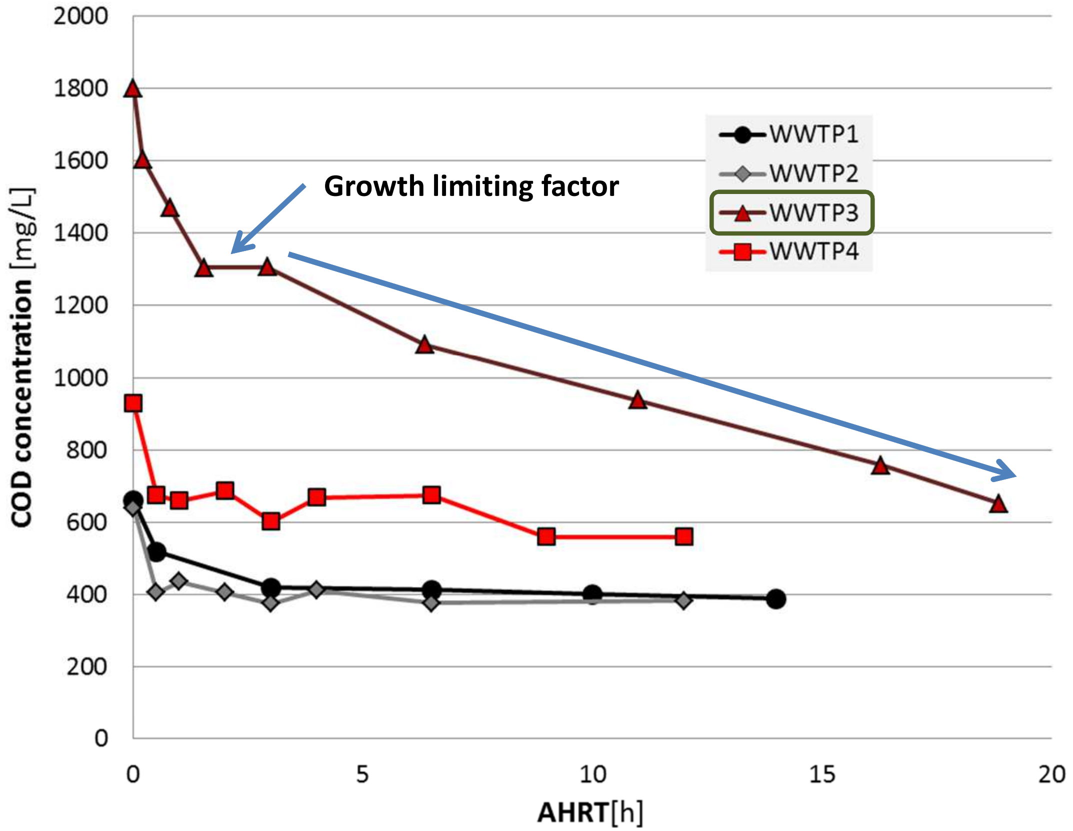
Results

DYNAMICS IN THE AERATION BASIN



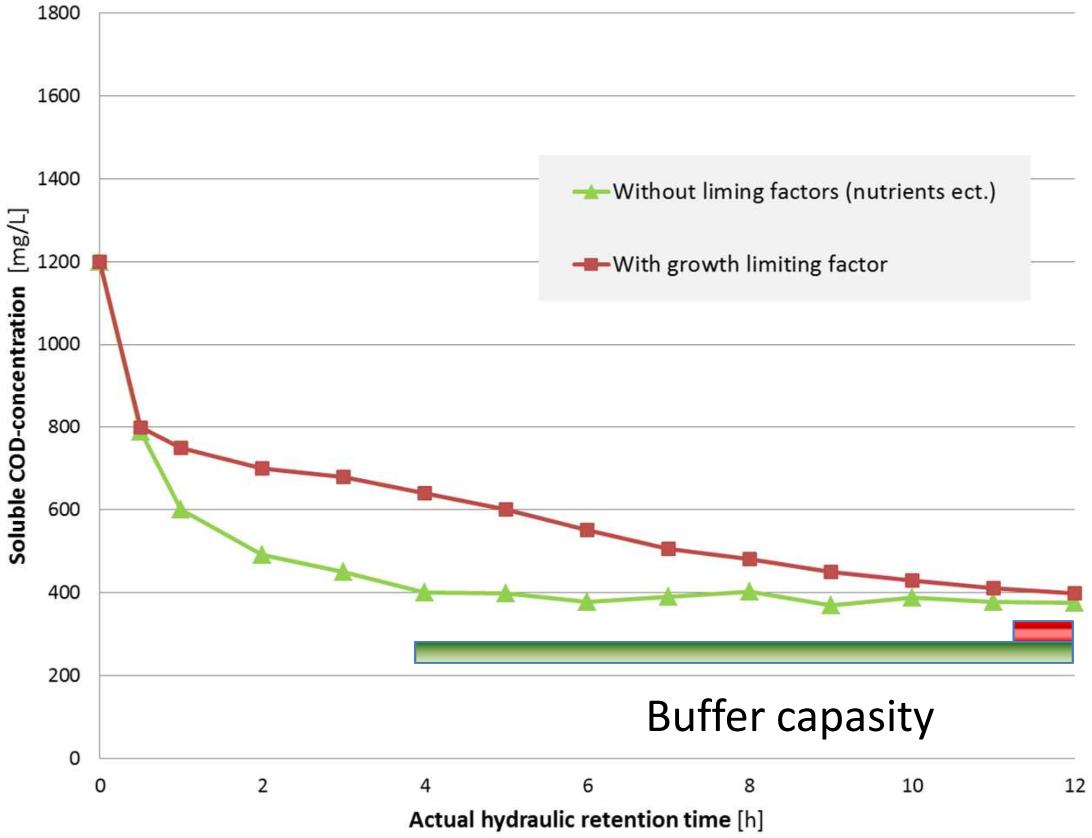
Results

DYNAMICS IN THE AERATION BASIN



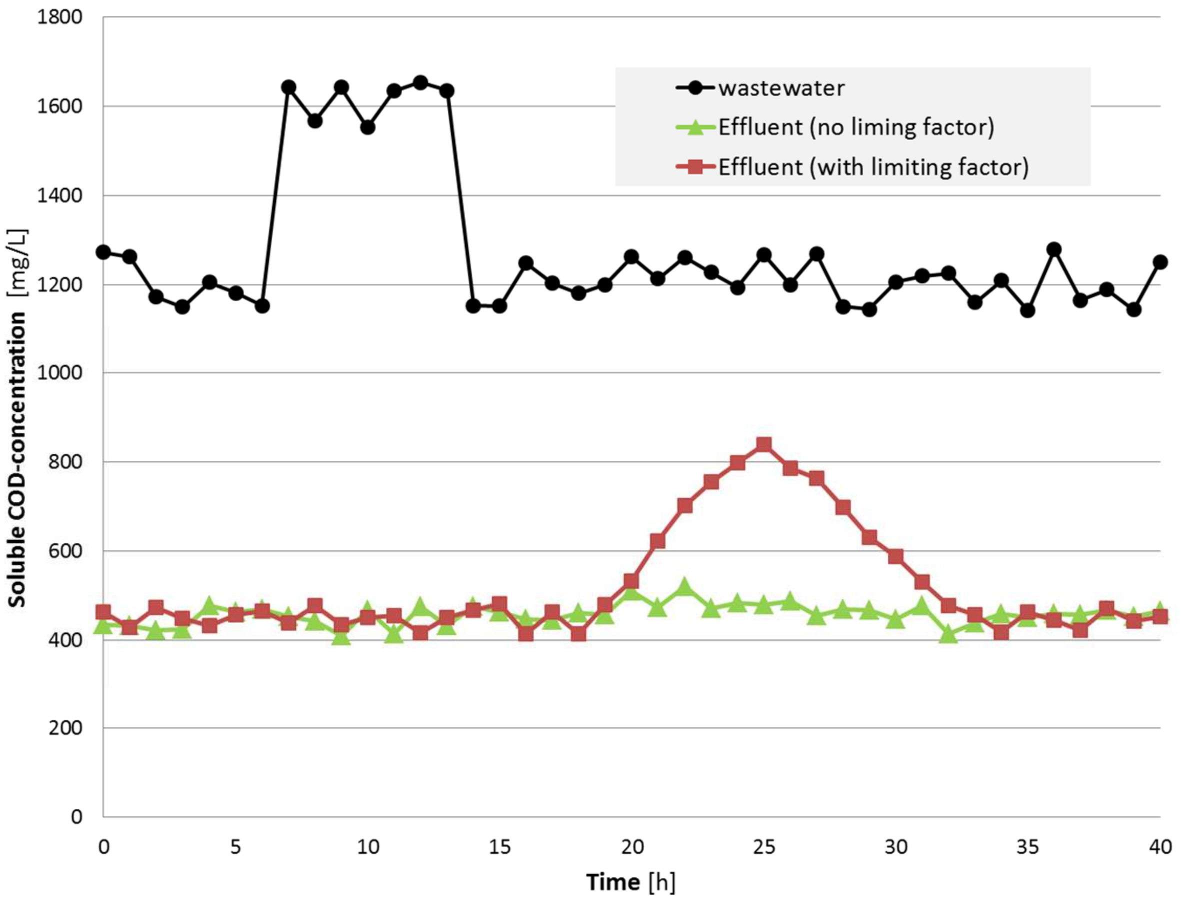
Implications

DYNAMICS IN THE AERATION BASIN (simulation)



Implications

INFLUENT AND EFFLUENT COD-concentrations (simulation)



Conclusions

The major part of the biochemical activity occurs during the very beginning of the plug flow aeration process.

Aeration profiles can reveal useful information about the state of a biological WWTP.

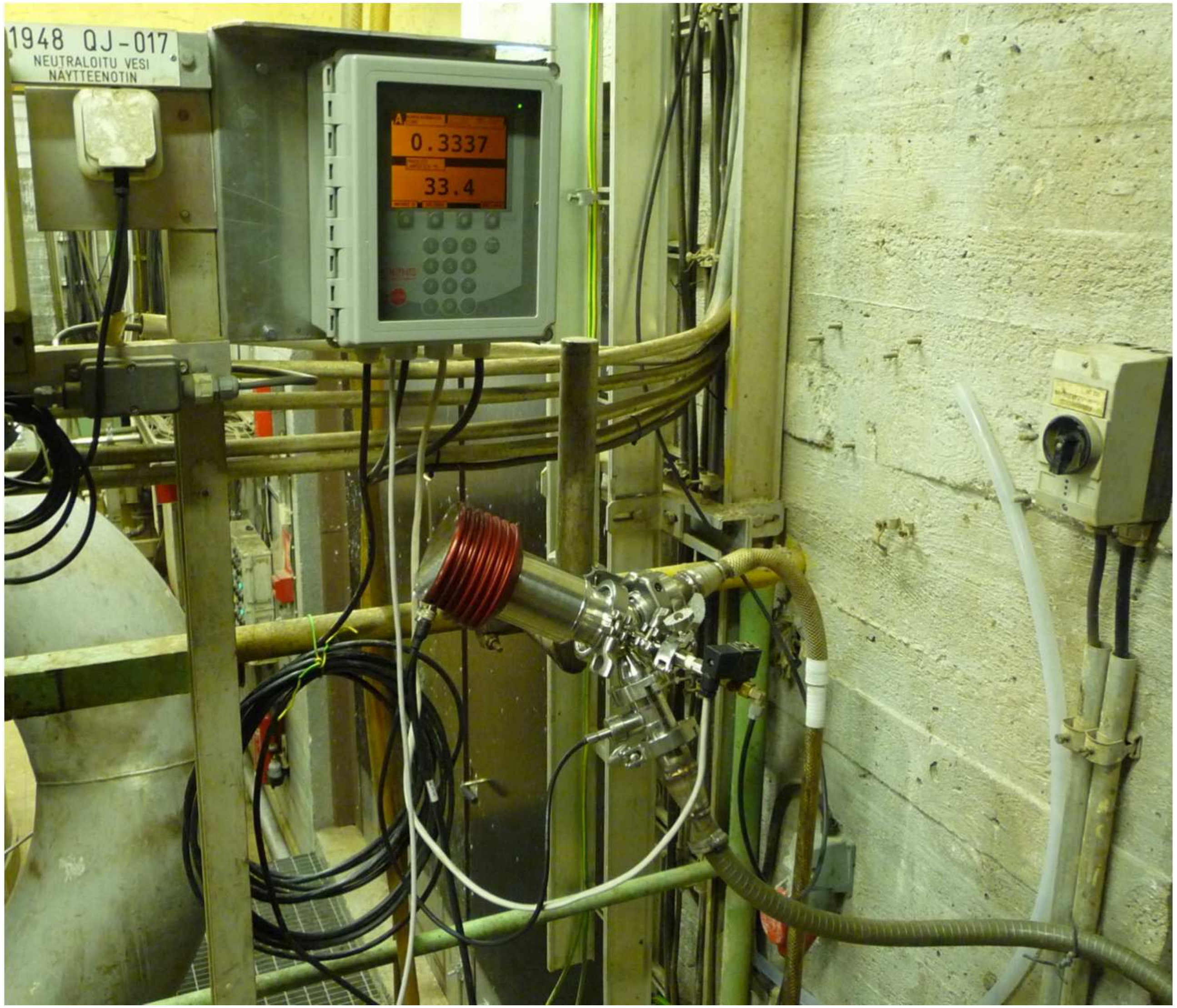
Aeration profiles can be used for example when observing possibly nutrient limitations as well as optimizing and controlling WWTP.

Refractometers are suitable for the detection of very small changes in the dissolved dry solids at low concentrations, about 50 mg/l. It follows the mill's COD and TOC analyses quite well → ***suitable for monitoring concentration changes in the WWTP.***

For on-line control of wastewater treatment efficiency we need simultaneous measurements, refractometer, conductivity and pH.

Well implemented optimization and ASP control can compensate tertiary treatment.

Refractometer



Thank You

Thank you for your attention!
Please ask questions?