Activated carbon and UV treatment in TOC removal field tests

JP analysis

Main participants in the project

Contents

* Active carbon tests
  * TOC reductions
  * Effects on conductivity of water
  * Silica
* UV treatment tests
  * TOC reductions
  * Effects of number of UV lamps, wavelenght, H_2O_2 and TiO_2 catalyst
* LC-OCD measurement results

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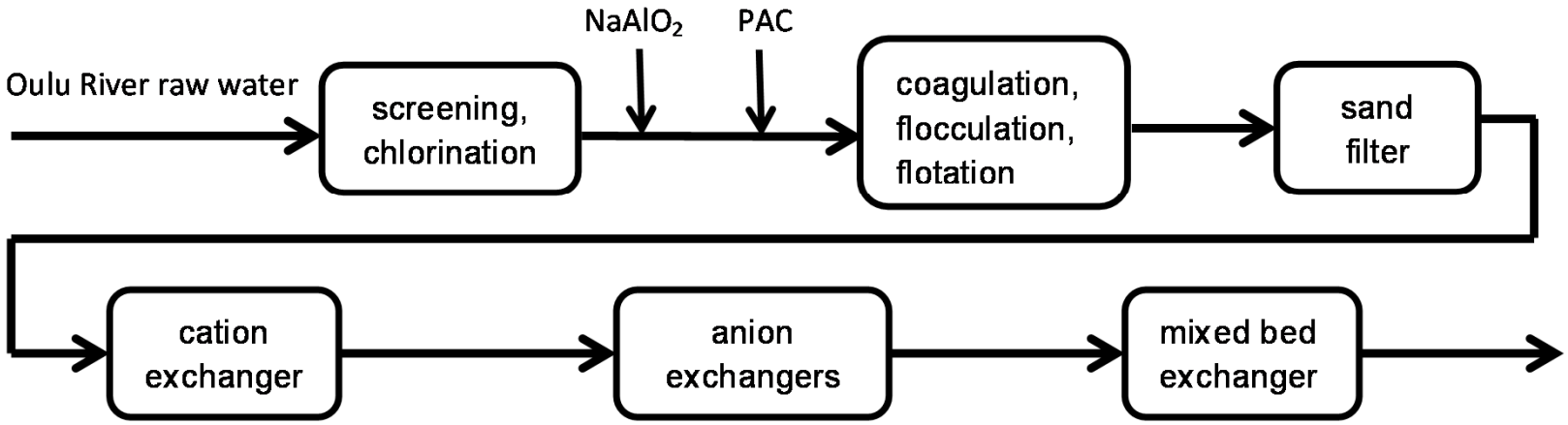
Active carbon tests: experimental set-up



Water treatment process of Stora Enso Oulu mill

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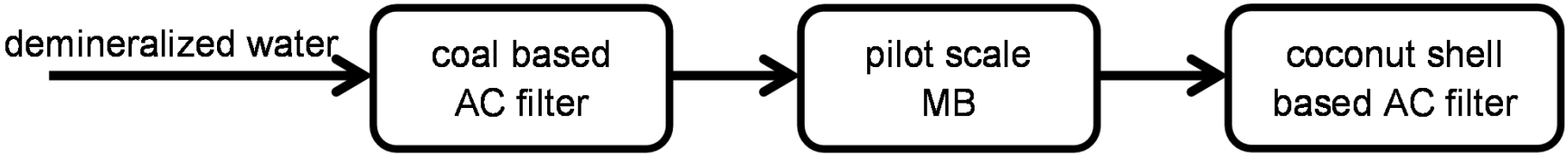
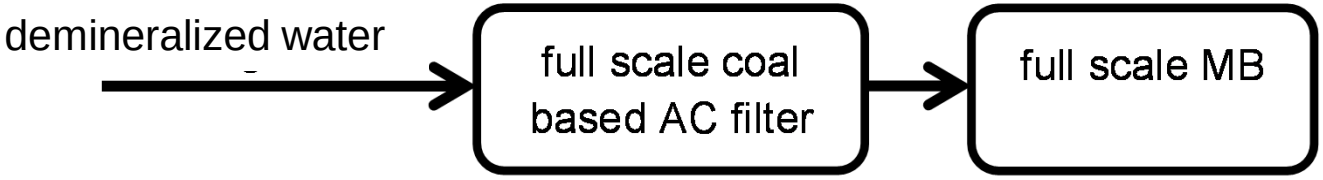
Active carbon tests: experimental set-up



Test scheme of pilot scale AC filters.



Test scheme of full scale AC filters.

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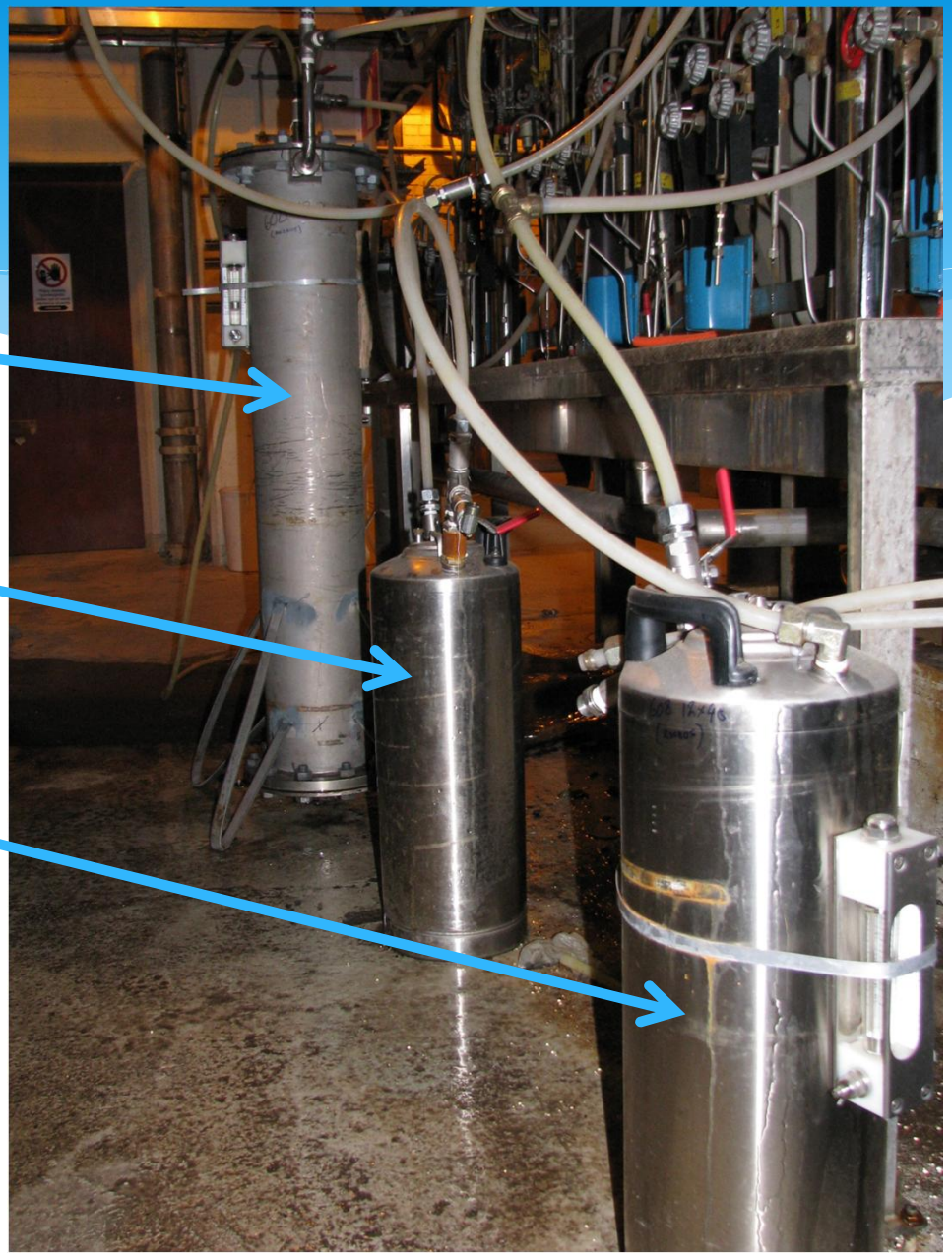
AC 1

MB

AC 2



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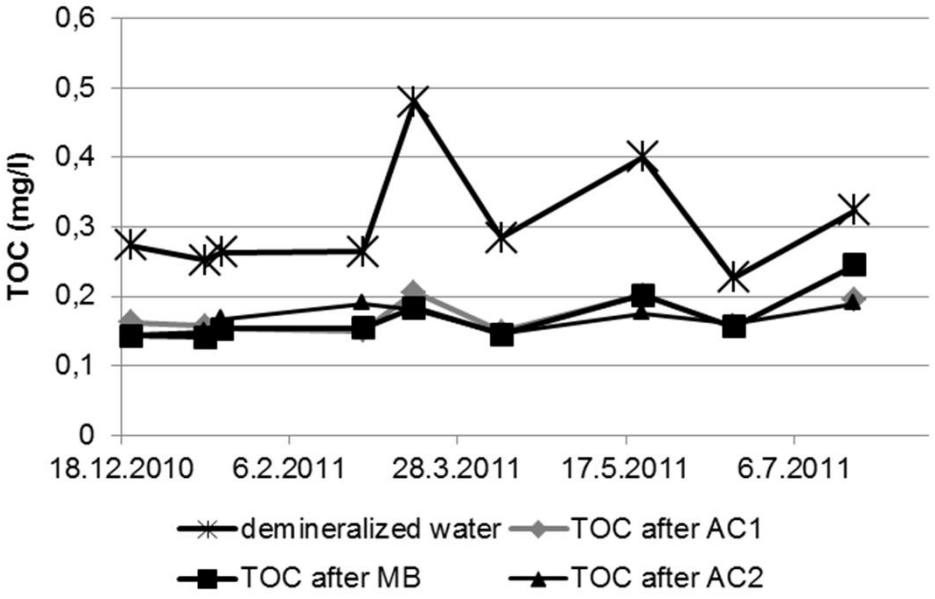
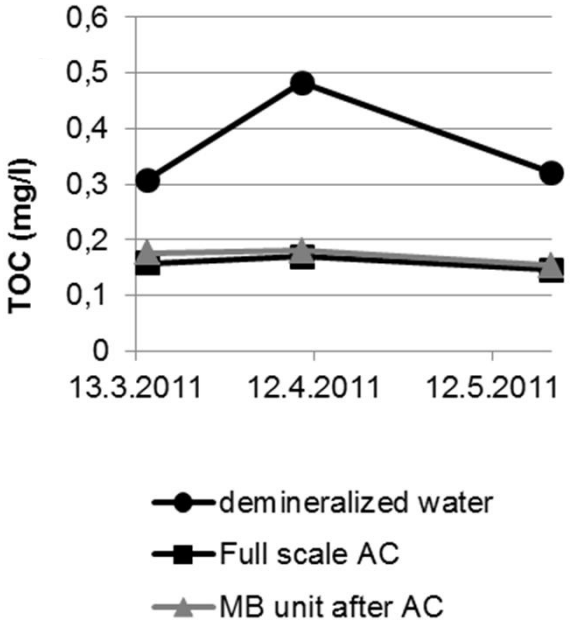
Active carbon: TOC reductions

Pilot scale AC filters



Residual TOC removal 38 – 57 %

Full scale AC filters



Residual TOC removal 40 – 65 %

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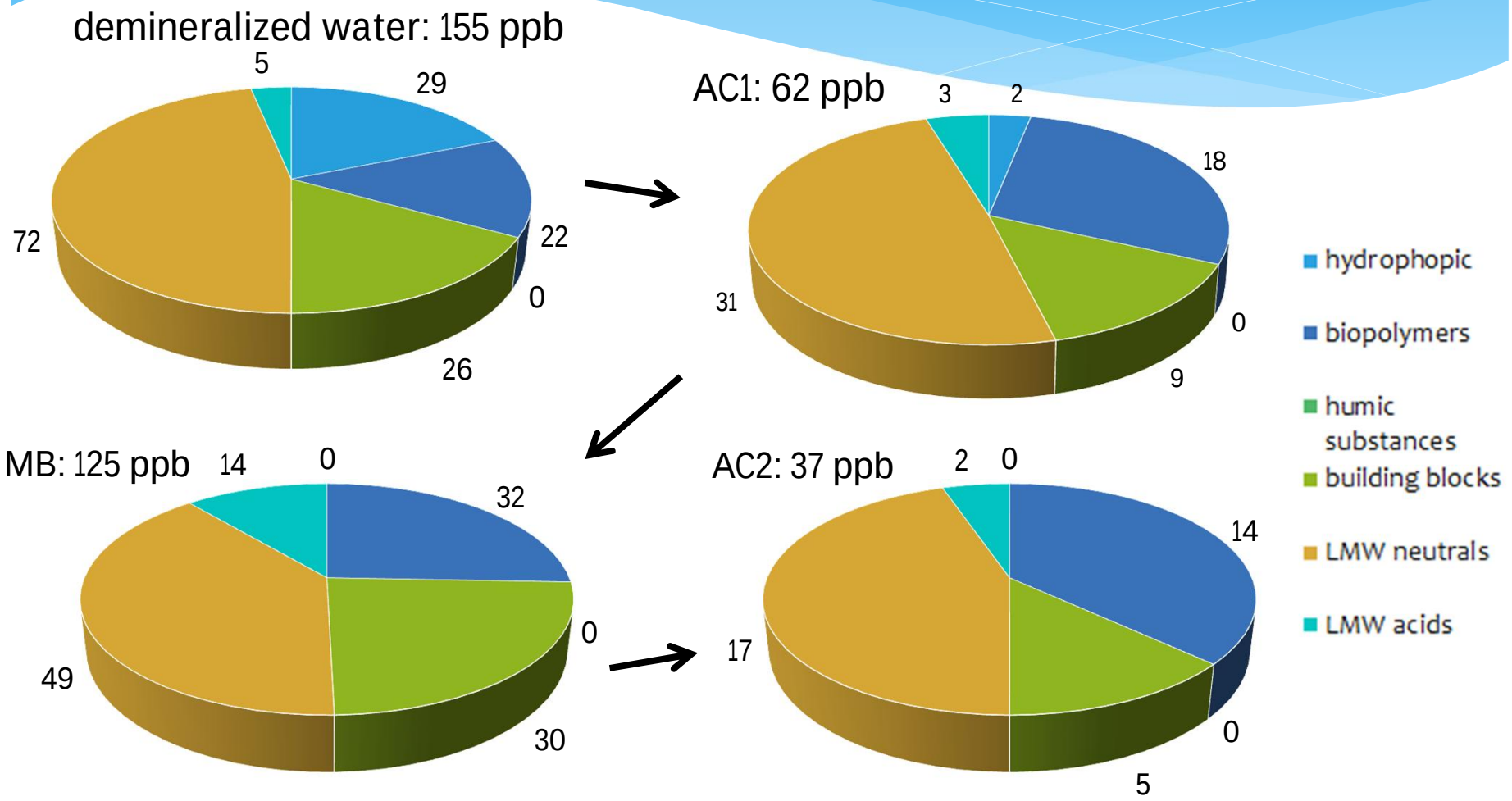
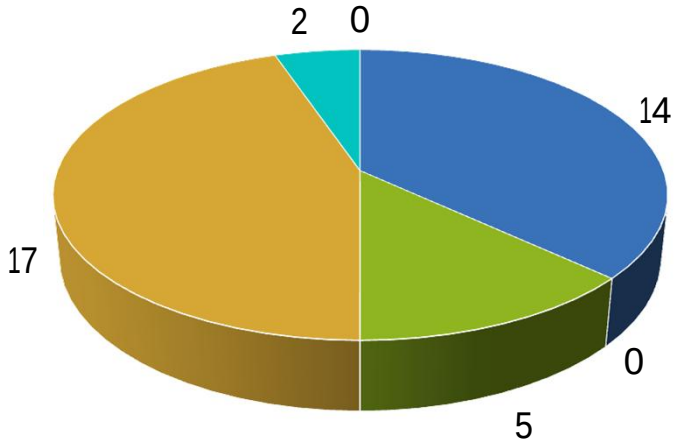
Active carbon: LC-OCD results

(after ~ 10 months in use)

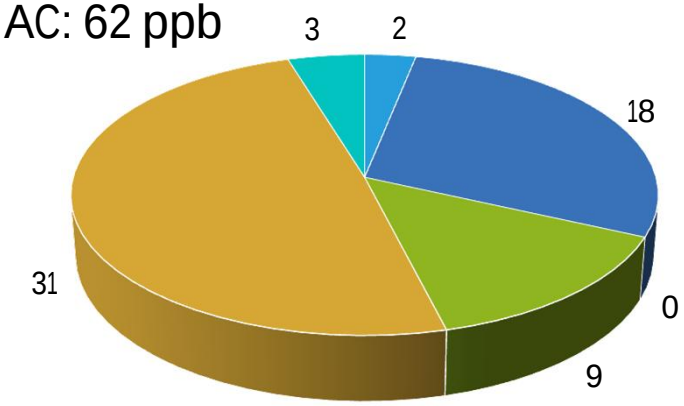


AC vs. RO (LC-OCD)

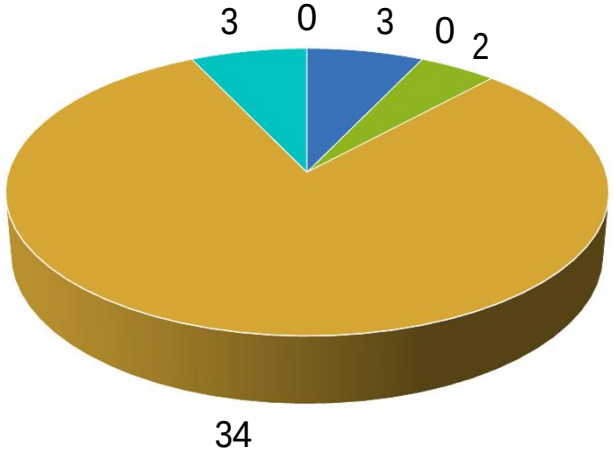
AC + MB + AC: 37 ppb

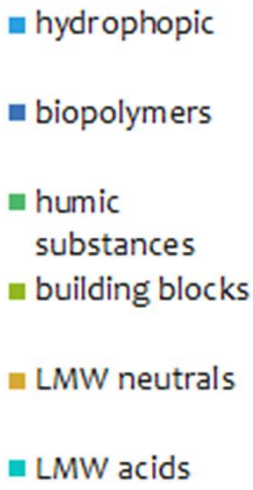


AC: 62 ppb

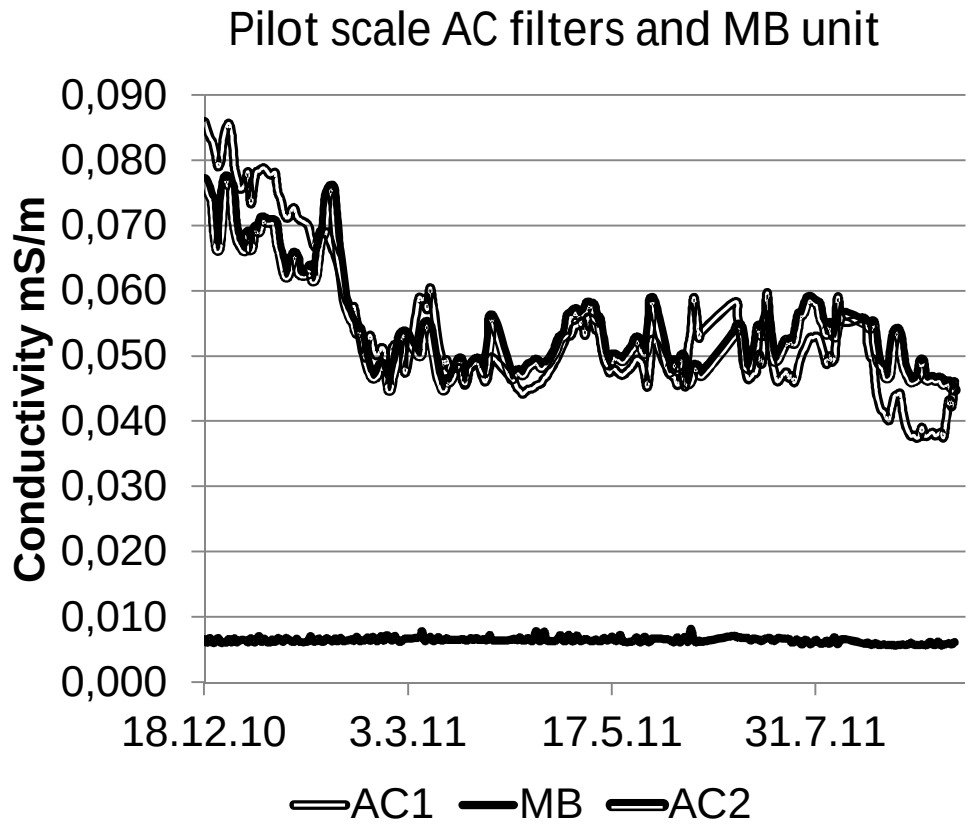


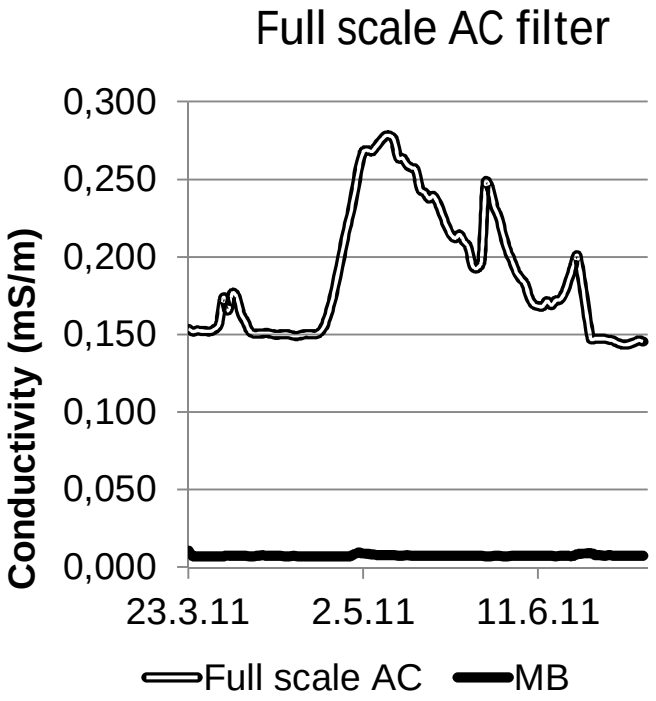
RO (Ahlholmens Kraft): 42 ppb





Active carbon: conductivity





Active carbon: conductivity, some remarks

* MB unit needed after AC to decrease conductivity
* Correlation between TOC removal efficiency and conductivity was a bit unclear (linear R^2 only ~ 0,5)
* Conductivity rise at AC bed was due release of ionized compounds from AC itself – not ionization of TOC
* AC bed was not operating as biological filter because of low nutrient content of water

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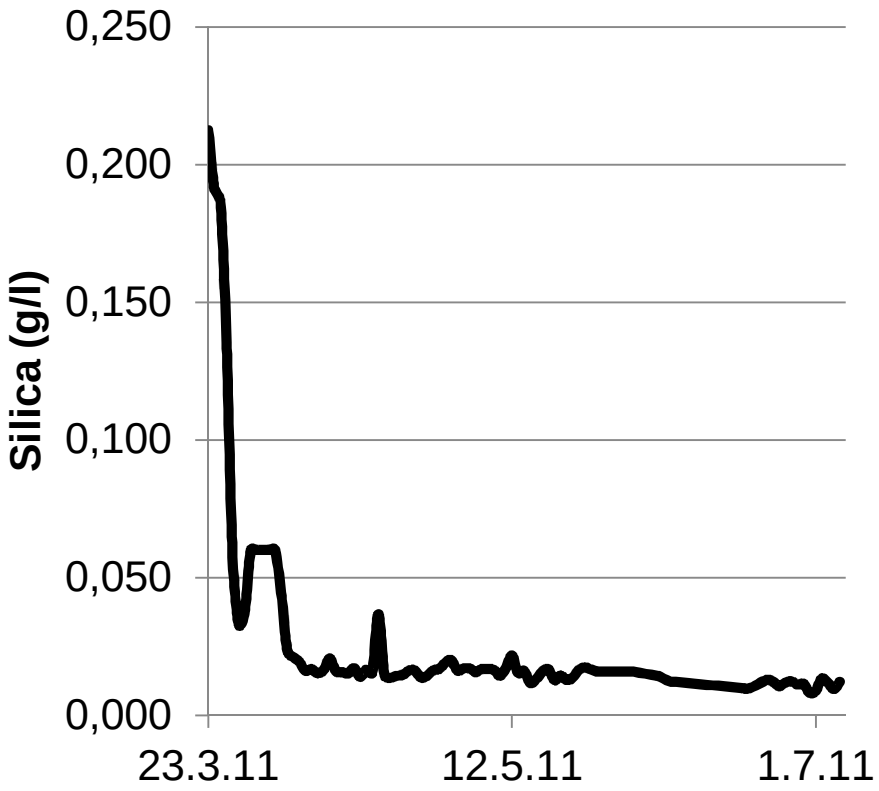
Active carbon: silica

- Silica causes severe scale problems in water-steam cycle
- Measured on-line during full scale test
- New AC bed released silica for ~ 2 weeks
- Silica was removed with subsequent MB



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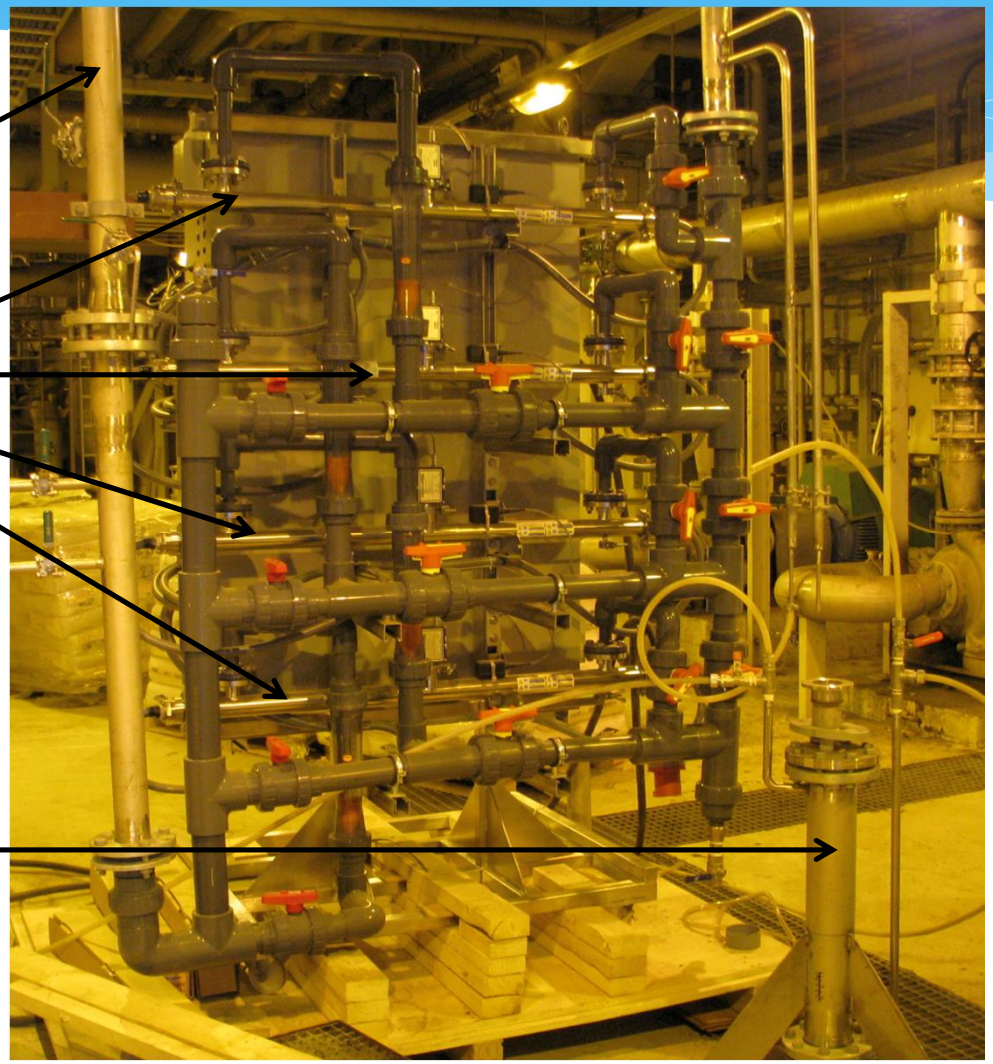
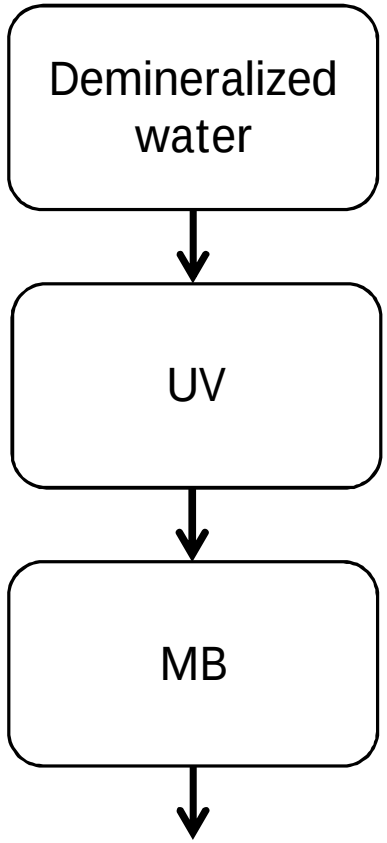
UV treatment: experimental set-up





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UV treatment: results

* One chamber: max. 30 % TOC removal
* Four chambers: only 4 % increase in TOC removal

* Effect of TiO2 catalyst: negligible
* Effect of H2O2: ? (experimental set-up failed: plastic piping released organic compounds)

* Effect of wavelenght:
  * Medium pressure lamp (wavelenght peaks at 254 nm and 185 nm): better (30 % TOC removal)
  * Low pressures lamp (wavelengh peak sharply at 185 nm): not that effective

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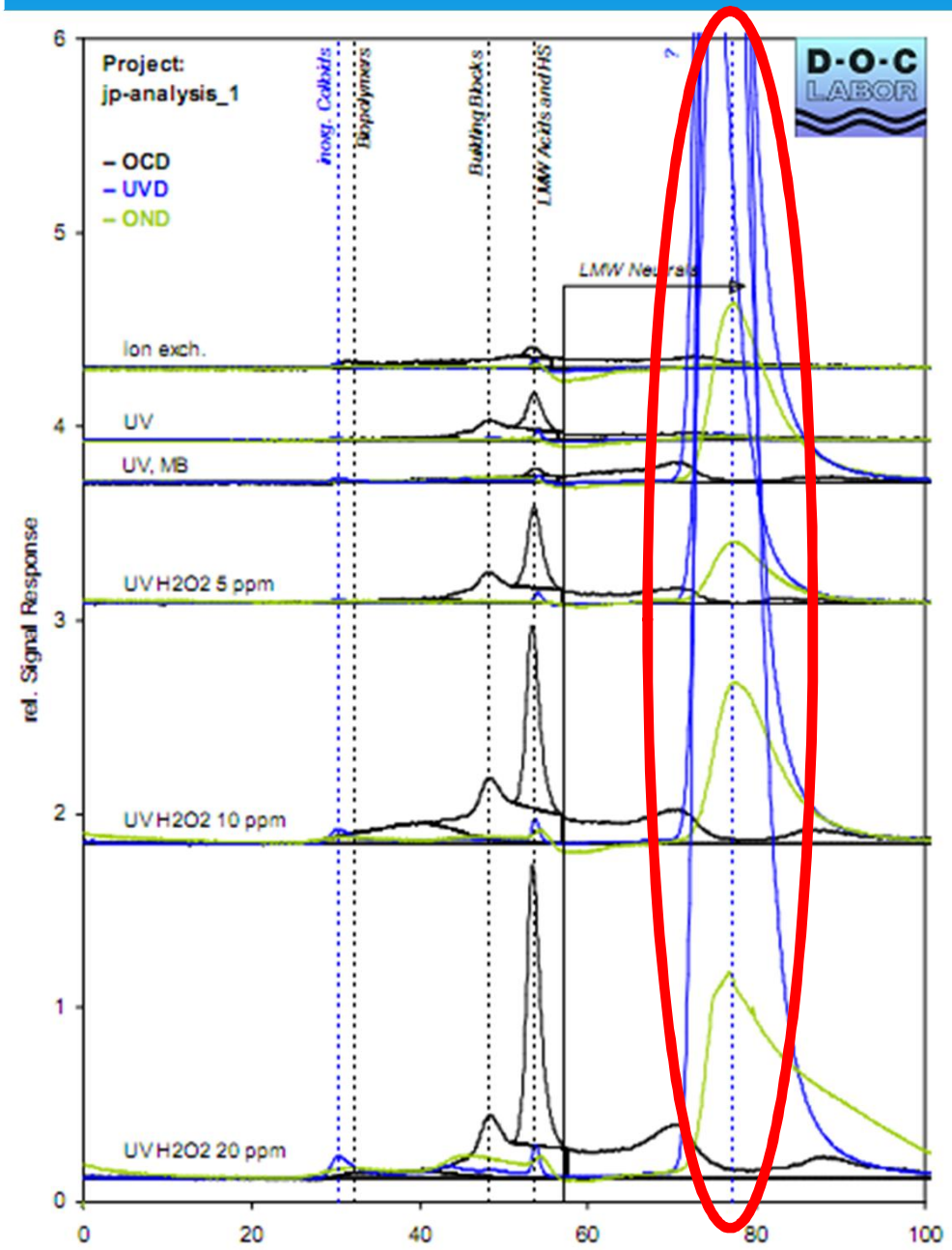
TiO2 catalyst

* TiO2 should enhance hydroxyl radical formation
* This type of catalyst (porous net) had no effect

UV treatment: H2O2 dosing

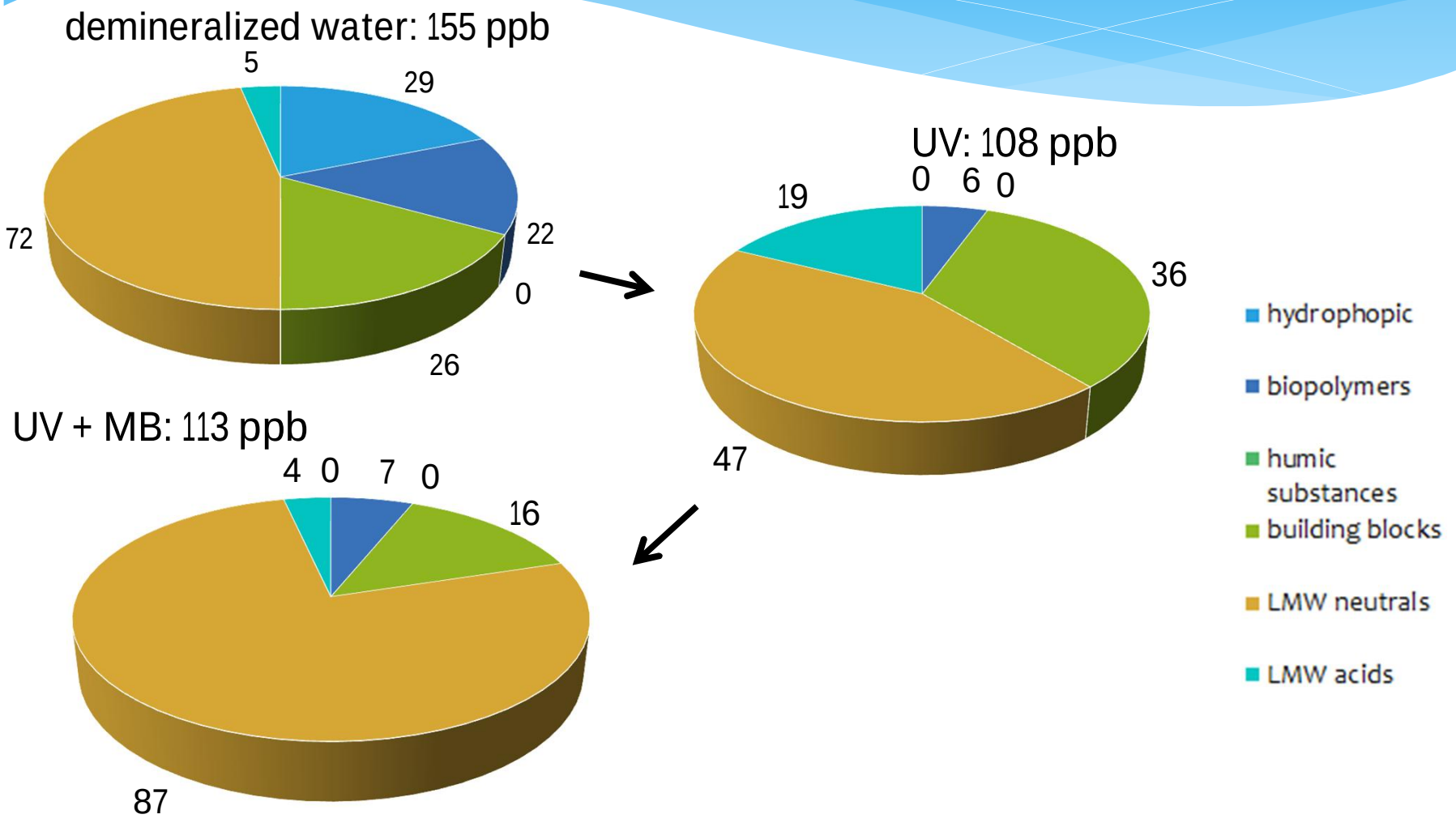
H2O2 (35 %), elevated to ~ 40 m from dosing point

Flowmeter



* Unknown peaks in LC-OCD chromatogram which are probably plastic additives

UV treatment: LC-OCD



Conclusions: AC

* Active carbon can remove up to 40 - 60 % of residual organic material (TOC)
* AC bed lifetime before regeneration is at least 10 months
* Subsequent MB is needed to remove elevated conductivity and silica
* AC works fine in full scale

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Conclusions: UV

- UV treatment was able to remove up to 30 % of residual TOC
- Removal efficiency did not improve with:
  - Lower wave lenght (more energy)
  - H2O2 (oxidant)
  - TiO2 (catalyst)
  - Number of UV chambers (contact time)
- Possible reason for this: water should be pretreated with e.g. RO (this is normal procedure in microelectronic or pharmaceutical industry water treatment)

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Thank you!

Questions, comments

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