UNIVERSITEIT GENT

CAMPUS KORTRIJK

Economical and ecological removal and/or recuperation of organic matter and ammonium from landfill leachate:

IMOG as a full-scale example

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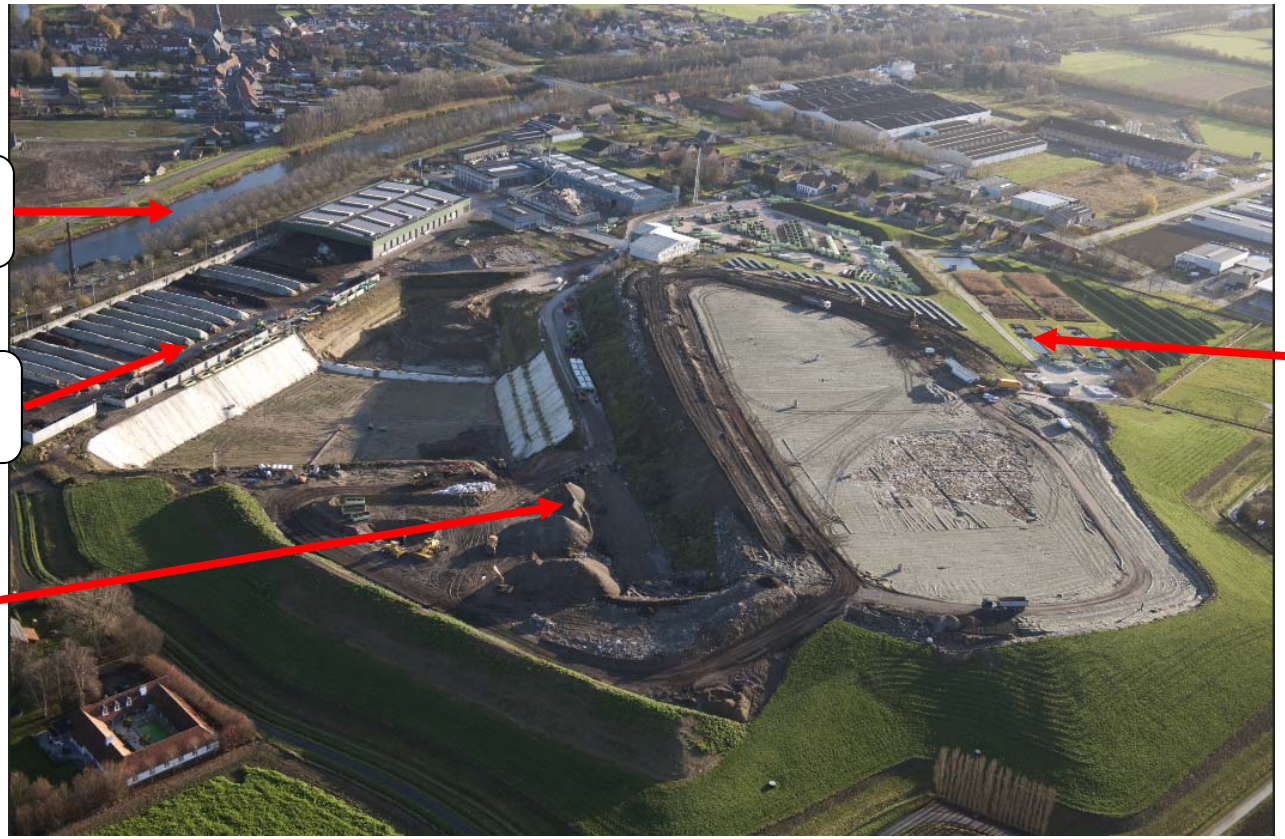
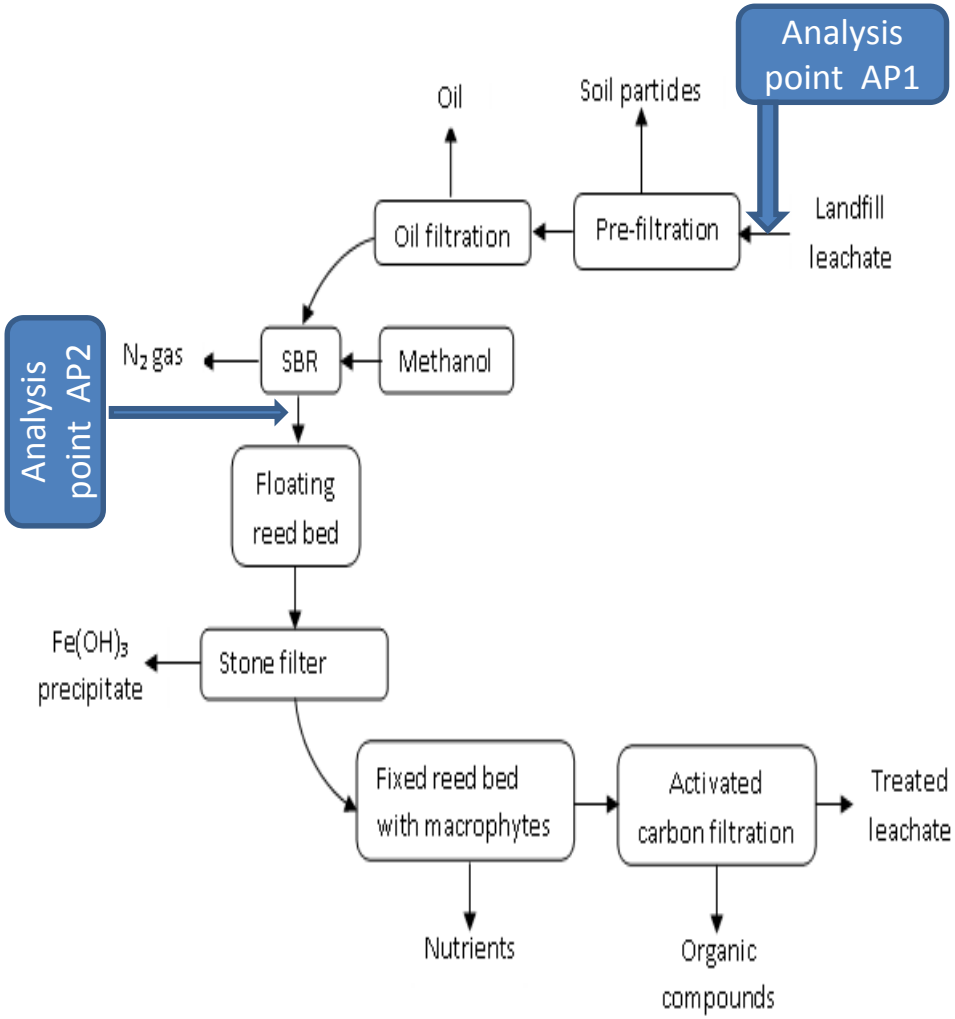
Landfill/leachate/treatment

- Intergemeentelijke Maatschappij voor Openbare Gezondheid in Zuid-West-Vlaanderen (IMOG): works for 11 municipalities in South-West Flanders
- Moen site: green composting, landfilling and leachate treatment



- Intergemeentelijke Maatschappij voor Openbare Gezondheid in Zuid-West-Vlaanderen (IMOG)
- Consists of 11 municipalities
- It runs two sites whose core activities include:
  1. Harelbeke site: sorting of PMD and paper cardboards, plastics recycling, incineration
  2. Moen site: green composting, landfilling and leachate treatment

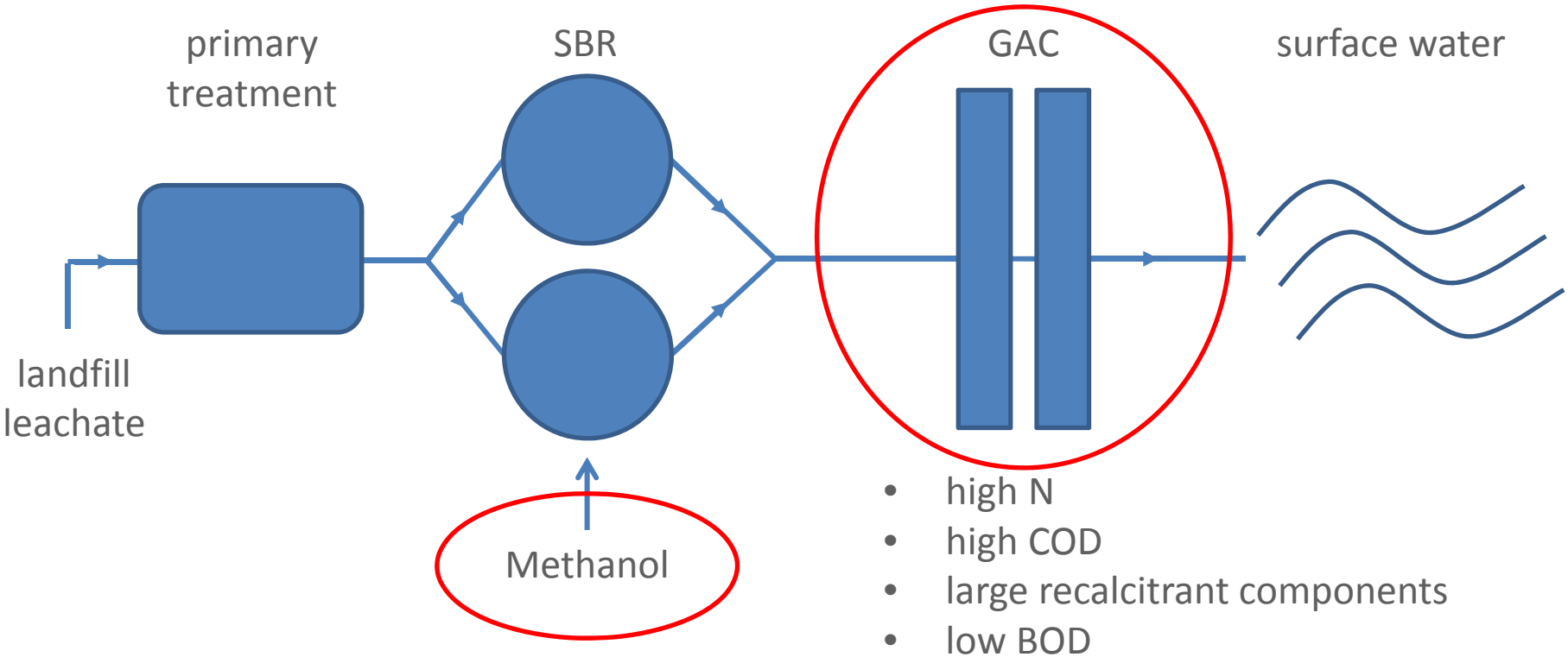
- Flow diagram of IMOG treatment plant



- Pysical chemical measurements of leachate at various points

Parameter	Raw leachate AP1 (average values)	biologically treated AP 2 Leachate	Flemish STD
pH	8.13	8.2 – 8.5	6.5-9.5
COD (mg/L)	1185	706 -1390	250
BOD_5 (mg/L)	189	50	25
BOD_5/COD	0.15	0.03	n.a.
UV254 absorbance (cm^{-1})	n.a.	5.98-8.53	n.a.
NO_3^--N (mg/L)	n.a.	3.9-19.5	n.a.
NO_2^--N (mg/L)	n.a.	0.33-0.66	n.a.
NH_4^+-N(mg/L)	535	2.42-9.22	5
Conductivity (µS/cm)	10002	6870	6000

IMOG as example

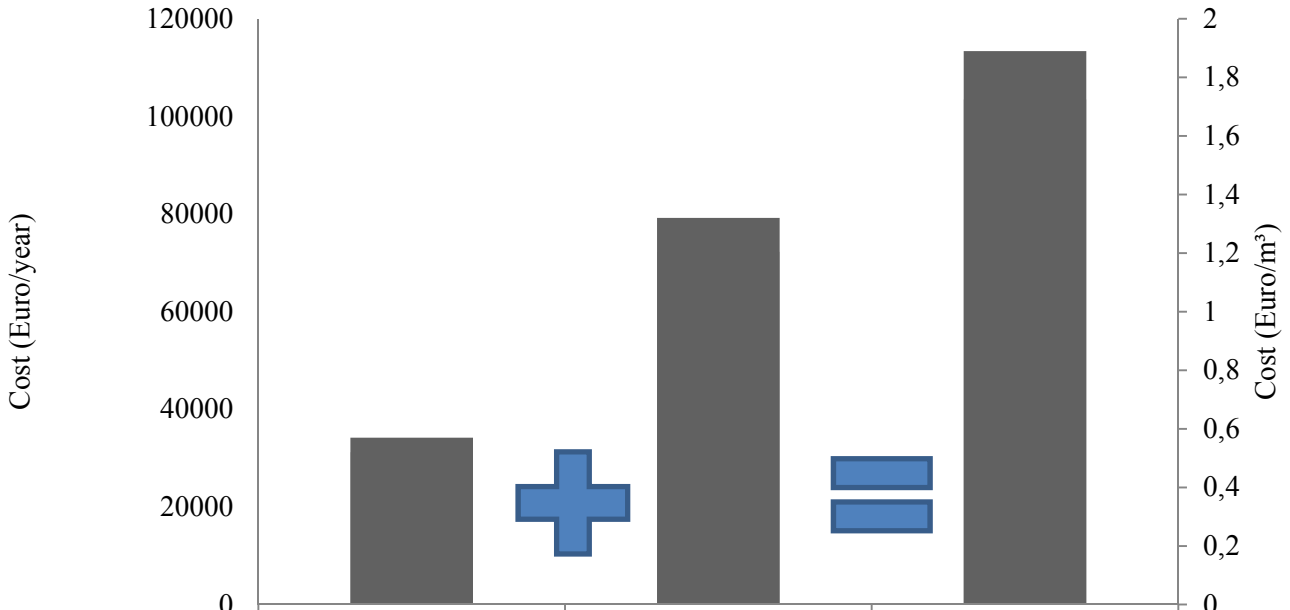


- high N
- high COD
- large recalcitrant components
- low BOD

Current operational costs

- Daily flow rate: 150 m³/d (365 d)
  - Nitrification/denitrification: 0,57 euro/m³
    -> 31 000 euro/y
  - Activated carbon: 1,32 euro/m³
    -> 72 000 euro/y
  - Combined costs: +/- 100 000 euro/y

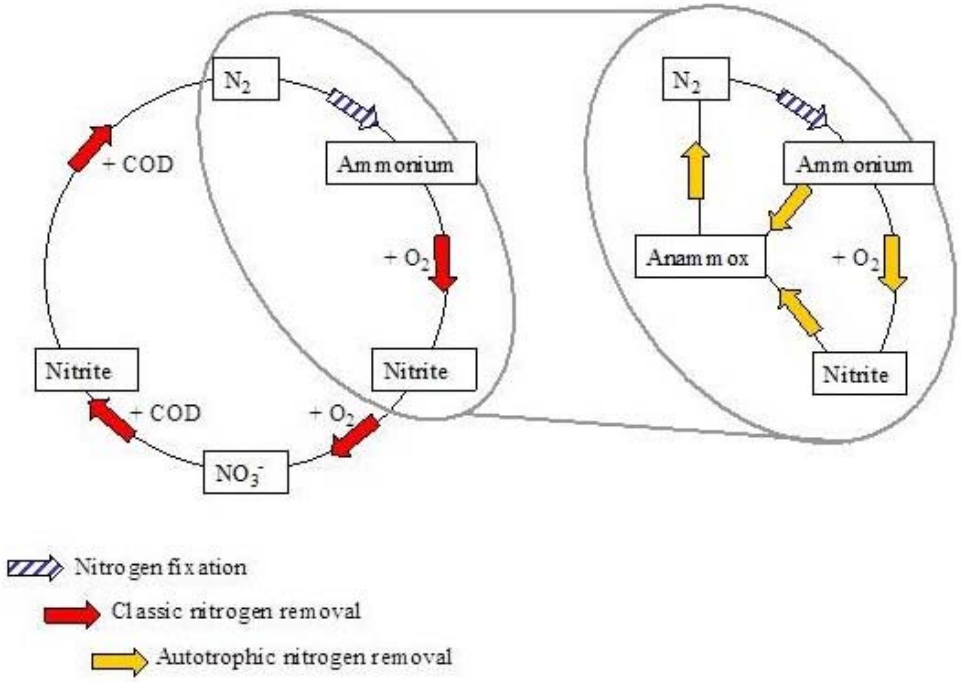
Current operational costs



	Nitrification /denitrification:	Activated carbon:	Combined costs:
Euro/year	31208	72270	103478
Euro/m³	0,57	1,32	1,89

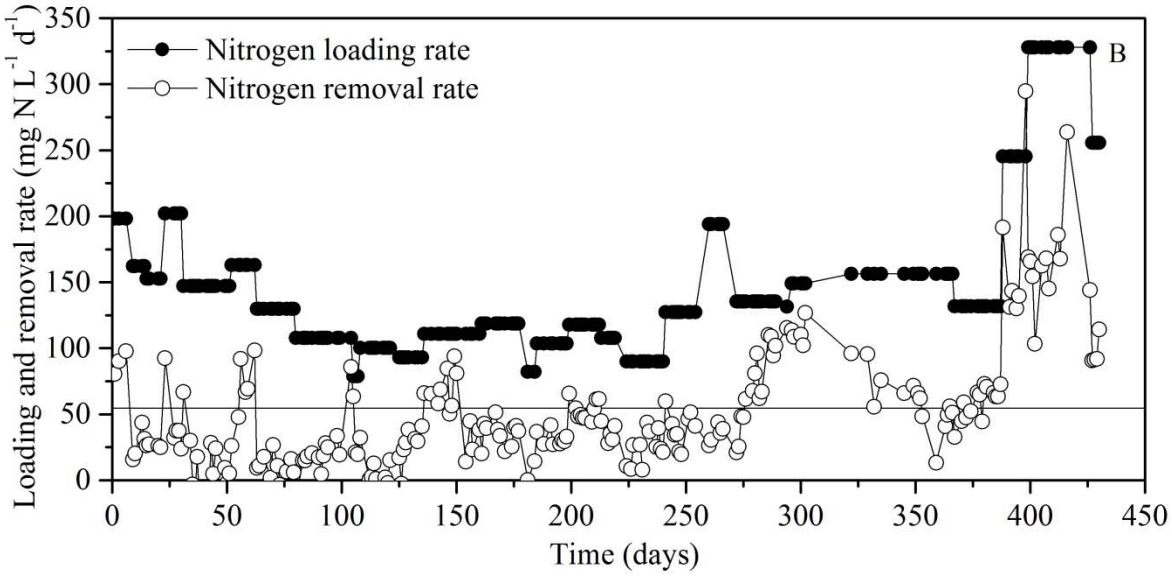
How can we reduce these costs?

- Nitrogen removal
  - ANR instead of nitrification-denitrification



How can we reduce these costs?

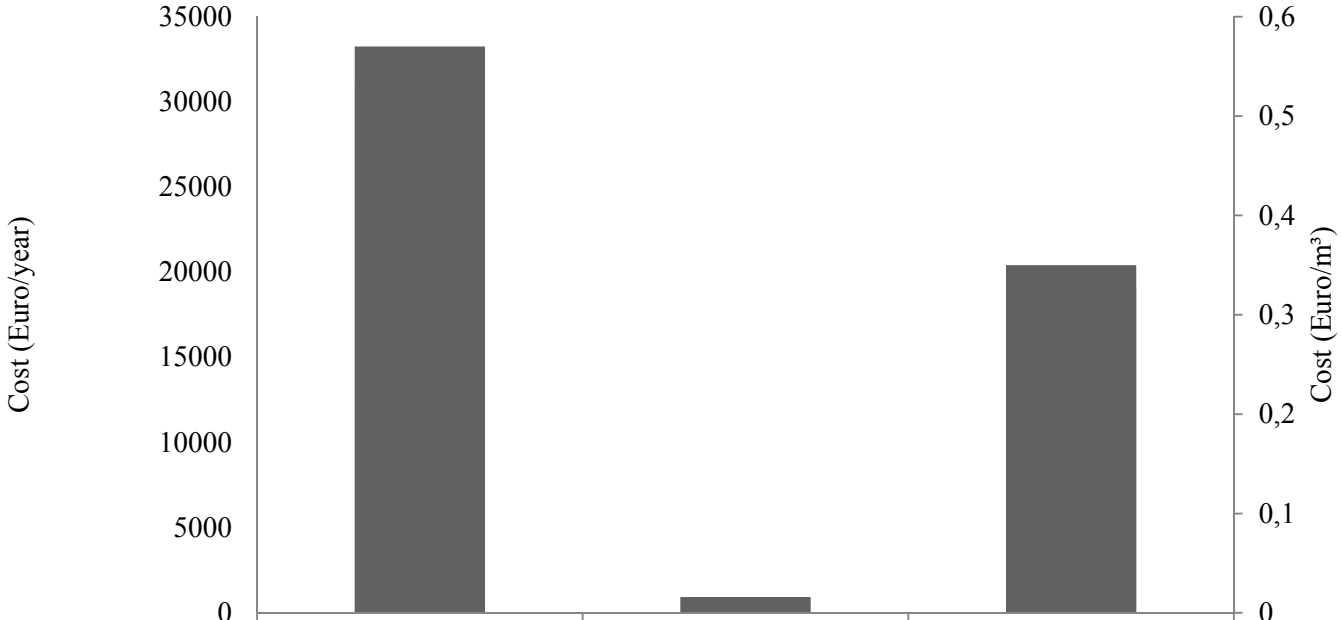
- Nitrogen removal
  - ANR instead of nitrification-denitrification
    - Lab-scale (6l) and pilot-scale (2m³): 40% N removal (on average), up to 90% in some periods



How can we reduce these costs?

- Nitrogen removal
  - ANR instead of nitrification-denitrification
    - Nitrification/denitrification: 0,57 euro/m³
      -> 31 000 euro/y
    - Full ANR: 0,016 euro/m³
      -> 900 euro/y
    - 40% ANR and 60 % N-DN: 0,35 euro/m³
      -> 19 000 euro/y

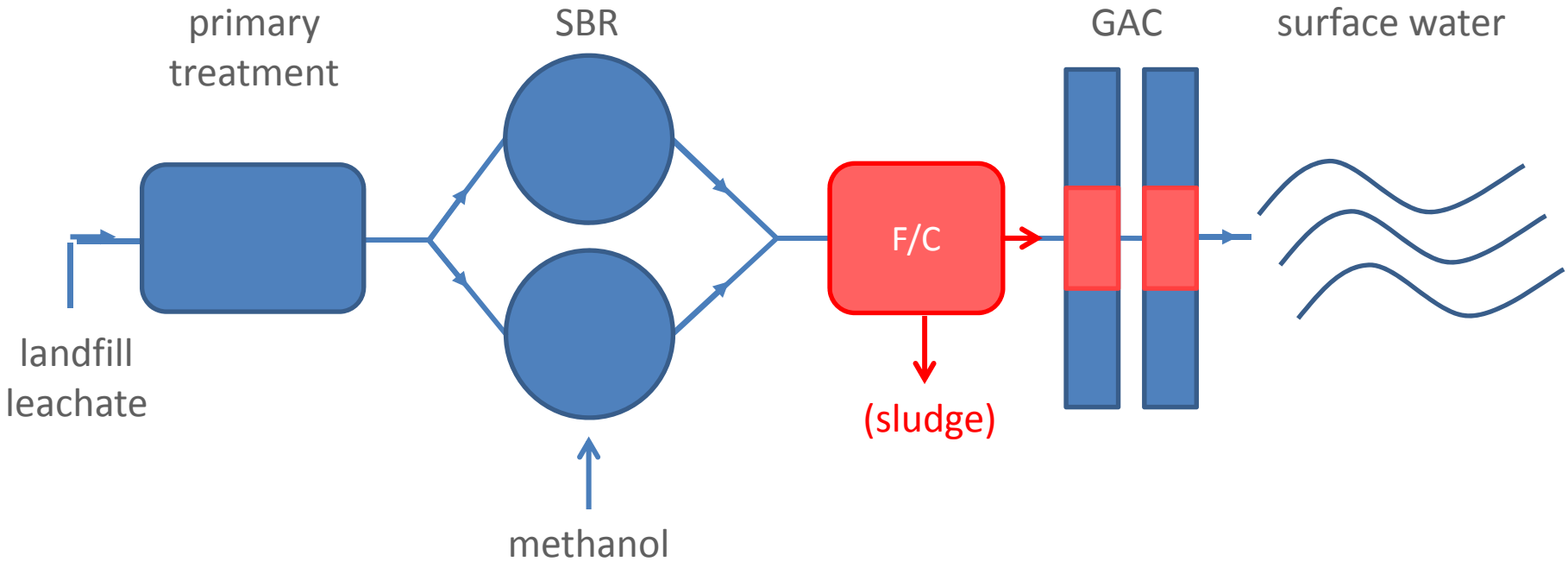
How can we reduce these costs?



	Nitrification /denitrification:	Full ANR	40% ANR/60% N/DN
Euro/year	31208	876	19163
Euro/m³	0,57	0,016	0,35

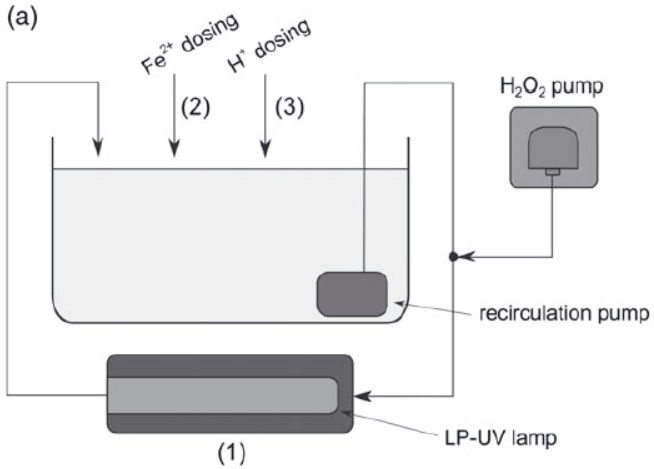
How can we reduce these costs?

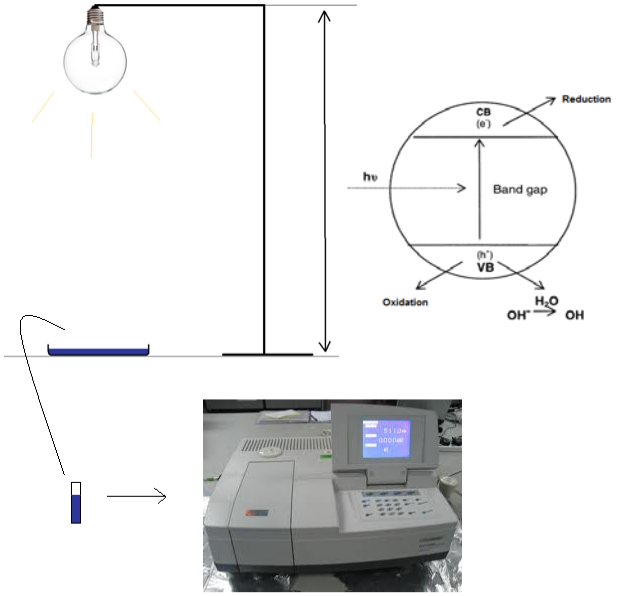
- COD removal
  - Pretreating the leachate



How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - UV based techniques



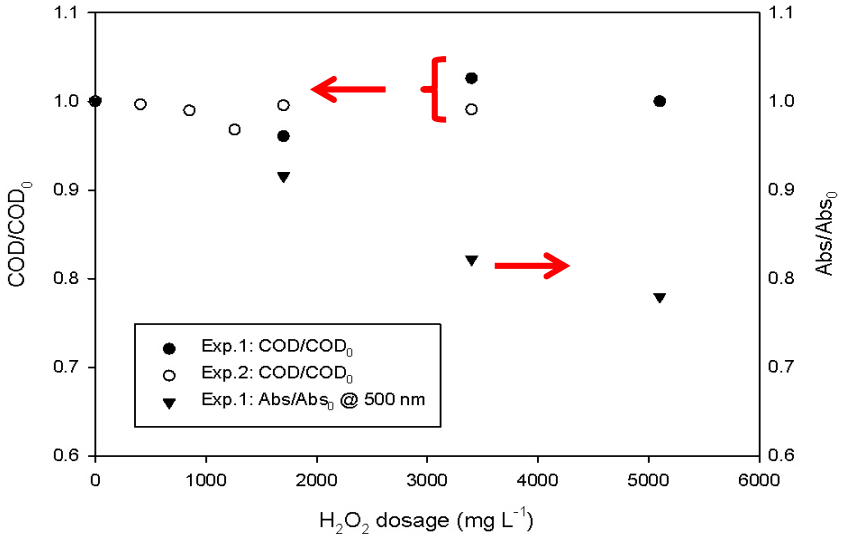


How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - UV based techniques
      - Colour removal >20% (at 500 nm)
      - Only 3% COD removal
      - Lower than expected, mainly due to low transparency and cost efficient use of UV-light (0,6 kWh/m³)

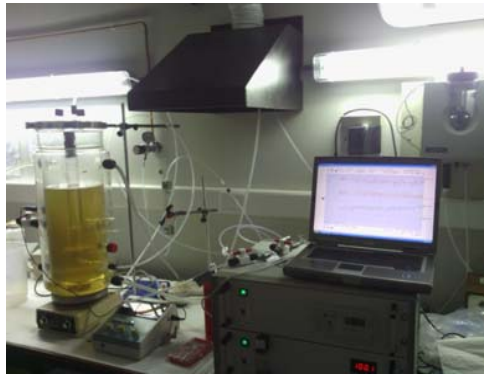
COD_0 = 859 ± 26 mg L^{-1}
Abs_0 = 0.10 cm^{-1}

- .



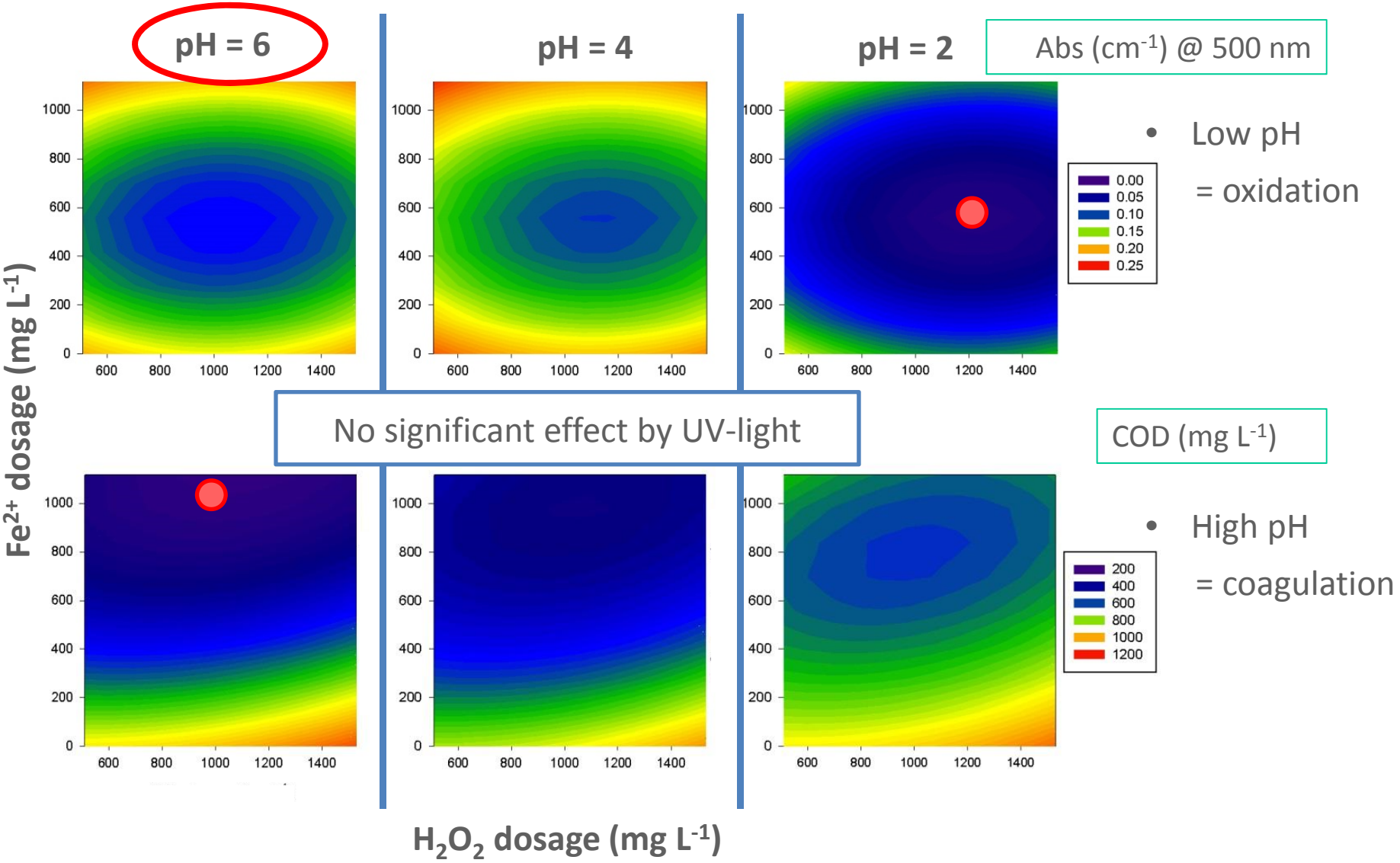
How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - AOP techniques
      - UV/H_2O_2 (see above)
      - Fe^{++}/H_2O_2 (Fenton)
      - Foto Fenton (see above)
      - O_3



Fenton

	H_2O_2	Fe^{2+}
mg L^{-1}	1020	1117
g oxidant g^{-1} COD_0	1.3	1.4



- Low pH = oxidation
- High pH = coagulation

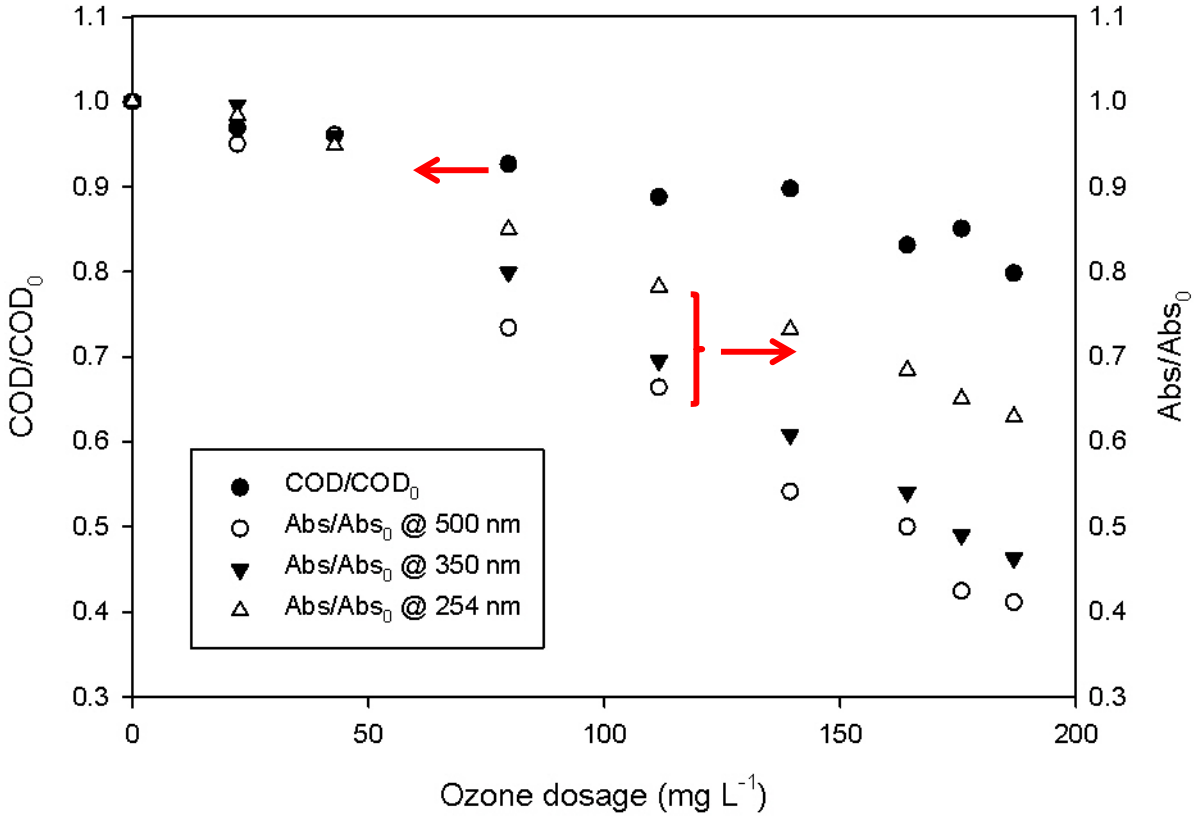
O_3

mg L^{-1}	112
g oxidant g^{-1} COD_0	0.14

- COD: linear decrease
- Abs: linear decrease

254 nm < 350 nm < 500 nm

COD_0 = 724 mg L^{-1}
$Abs_{0,\ 254\ nm}$ = 6.4 cm^{-1}
$Abs_{0,\ 350\ nm}$ = 2.0 cm^{-1}
$Abs_{0,\ 500\ nm}$ = 0.47 cm^{-1}



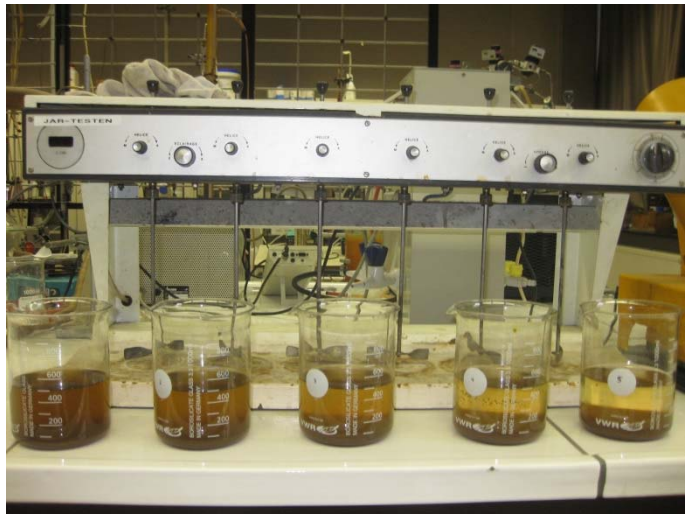
Comparison

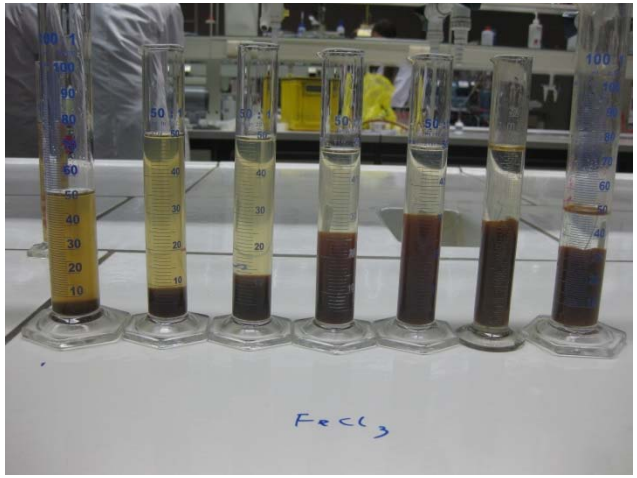
	unit	untreated	UV/H_2O_2	O_3	Fenton
COD	mg O_2 . L^{-1}	812	756	729	303
COD removal	%	-	7	10	63
BOD	mg O_2 . L^{-1}	58	58	96	47
$\Delta BOD/BOD_0$	%	-	0.0	65	-19
$\Delta BOD/COD_0$	%	-	0.0	4.7	-1.4
BOD/COD	-	0.07	0.08	0.13	0.16
UV_{254}	cm^{-1}	6.0	5.9	4.9	14.1

- COD: decrease
- BOD: increase with O_3

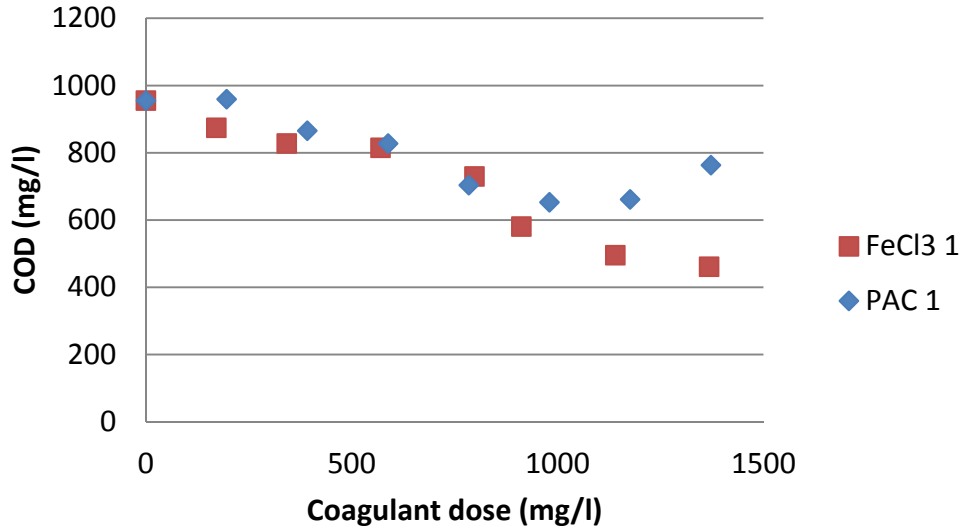
How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - Coagulation/flocculation
      - Fe^{+++} (Fenton)
      - PAC
      - …

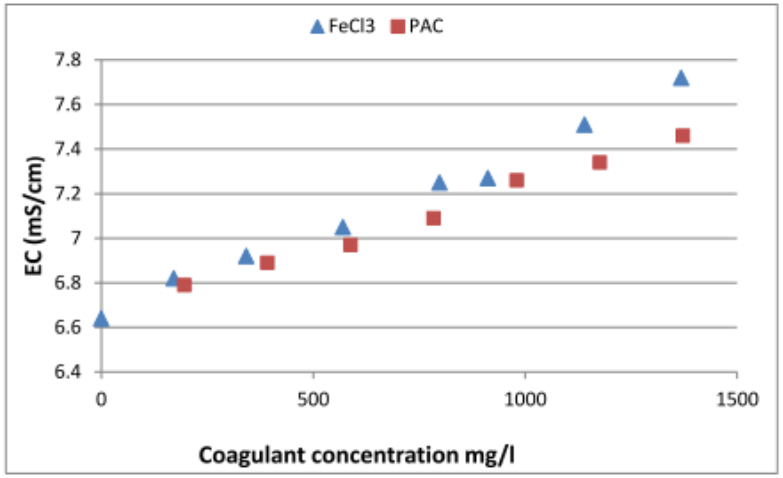


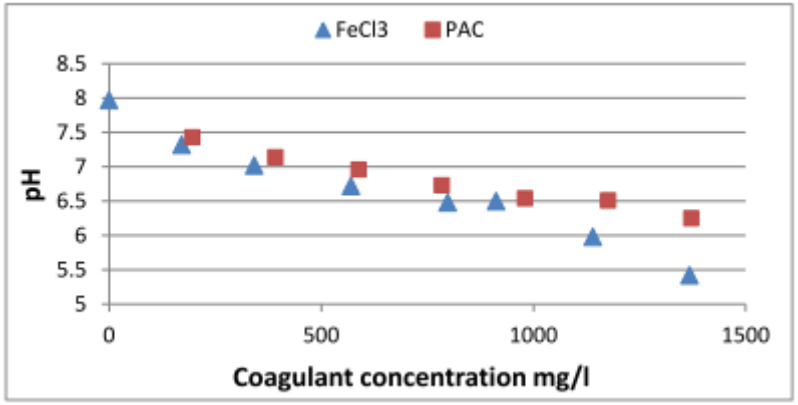


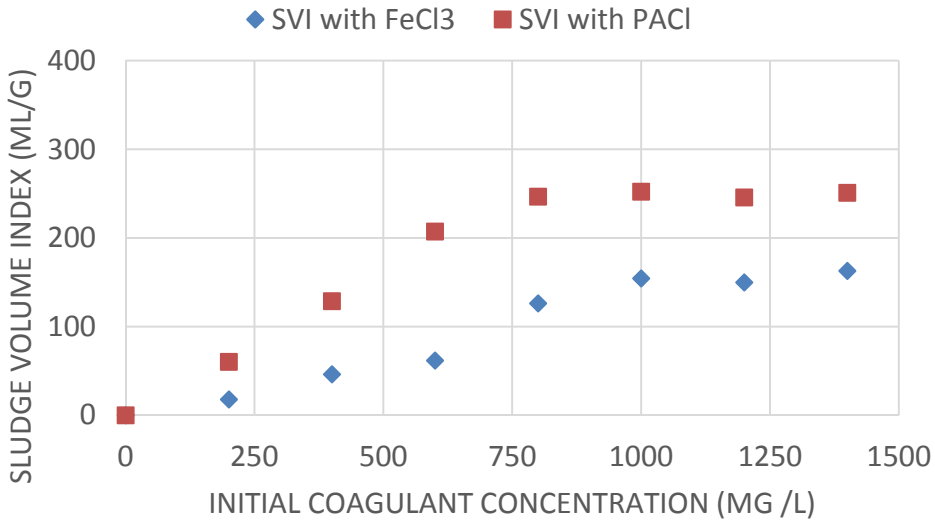
- FeCl3 <-> PAC
  - COD: (initially 955 mg O_2 /l)



– Conductivity, Turbidity, SVI



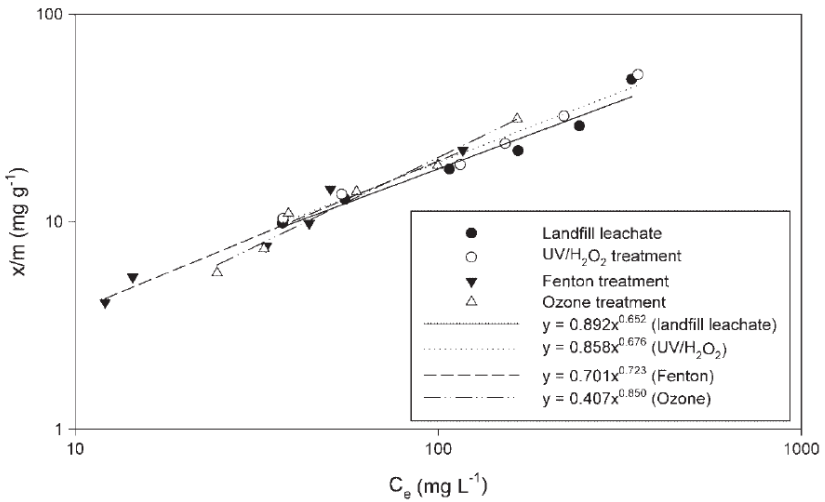




EC↑and pH↓ -> problems with discharge limits?
SVI lower for $FeCl_3$ -> less sludge production

How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - Coagulation/flocculation
      - Effect on activated carbon polishing: low (relative)



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    - Coagulation/flocculation
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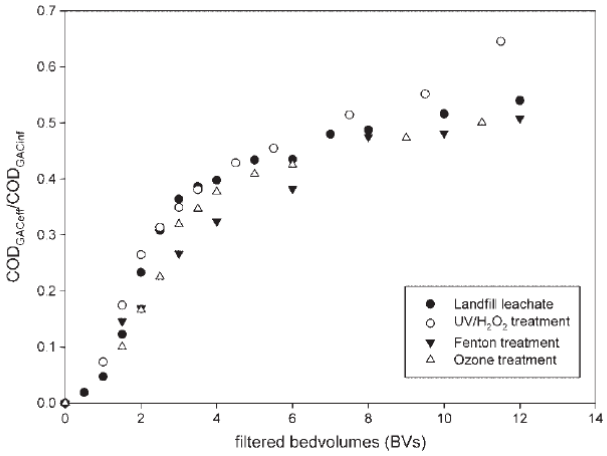
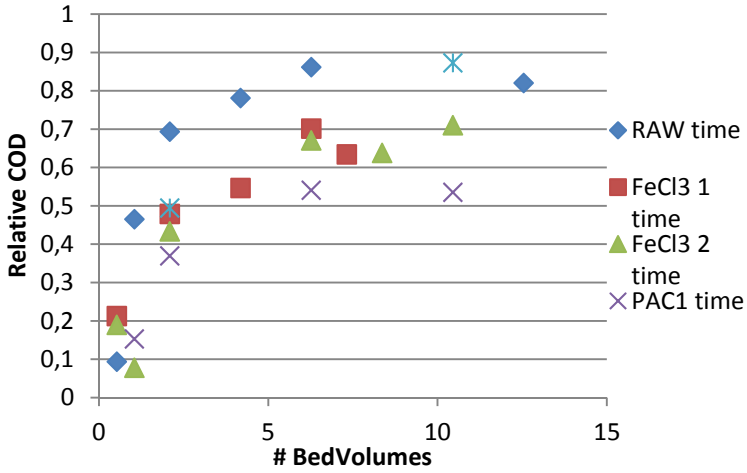
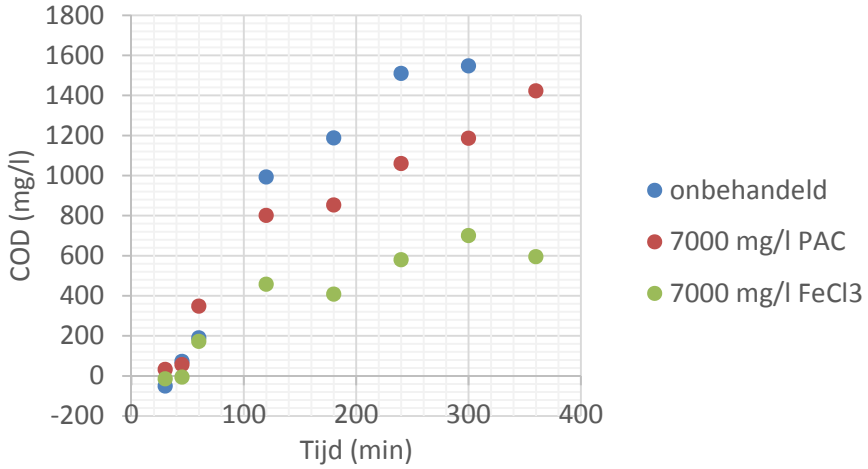




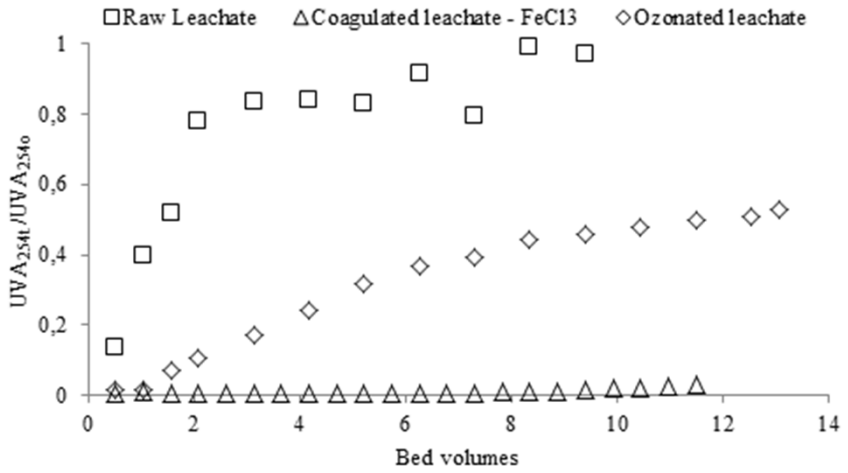
How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - Coagulation/flocculation
      - Effect on activated carbon polishing: low -> except for more concentrated leachate/higher dosages

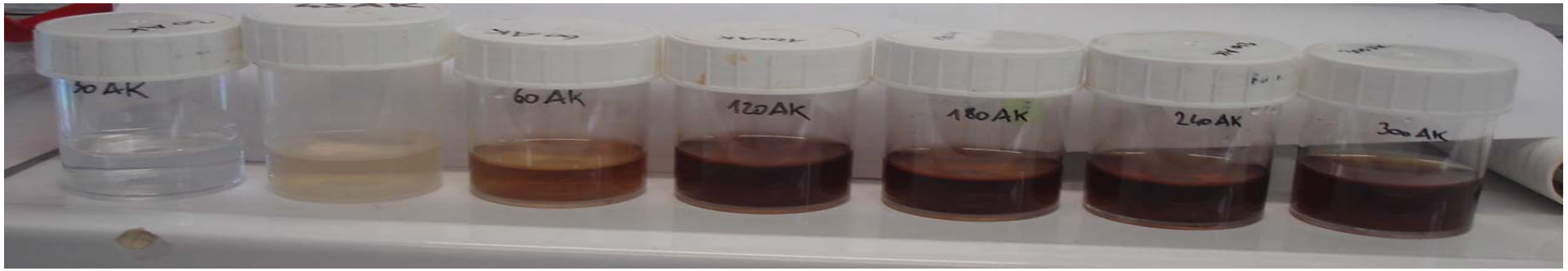


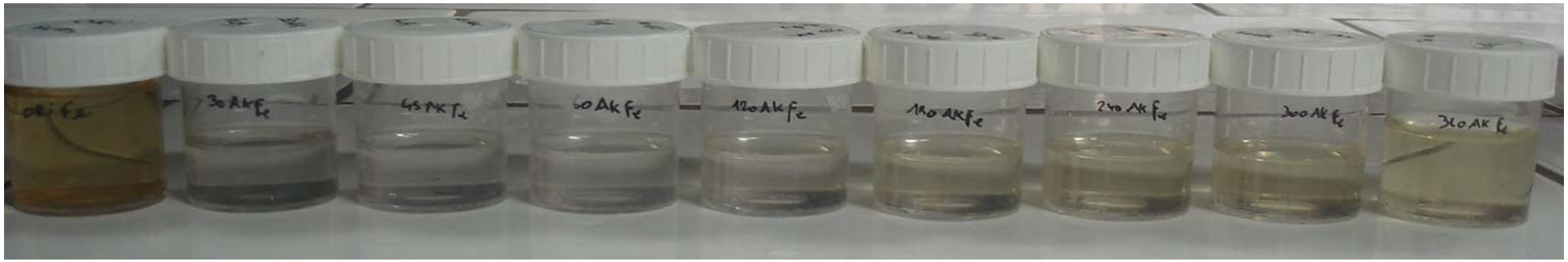
How can we reduce these costs?

- COD removal
  - Pretreating the leachate
    - Coagulation/flocculation vs. Ozone: colour removal during activated carbon polishing



C/F + AC


30 AK
60 AK
120 AK
180 AK
240 AK
300 AK


30 AK Fe
45 AK Fe
60 AK Fe
120 AK Fe
180 AK Fe
240 AK Fe
300 AK Fe
360 AK Fe

How can we reduce these costs?

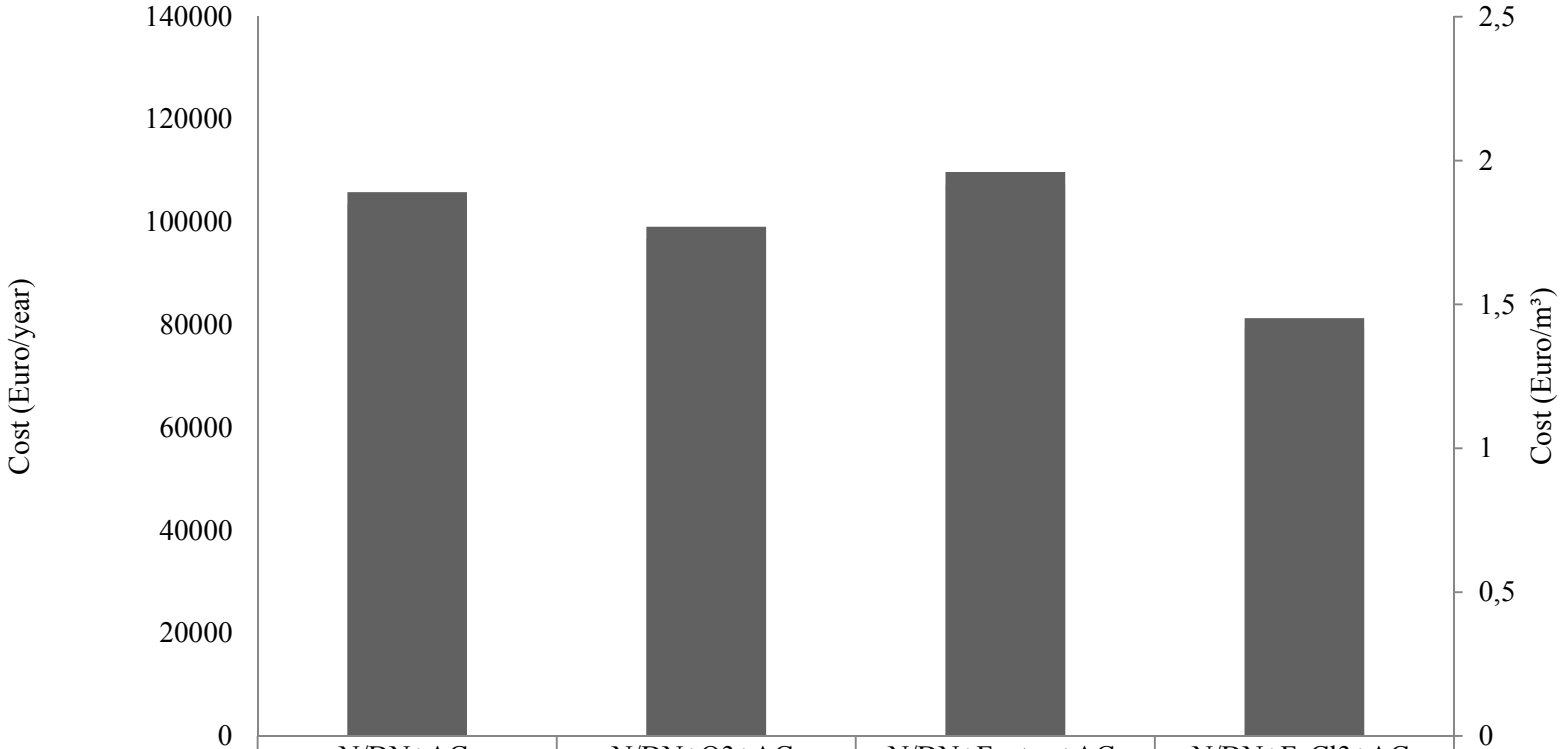
- Daily flow rate: 150 m^3/d (365 d)
  - Activated carbon: 1,32 euro/m^3 ->
    72 000 euro/y (+ 31 000 euro/y for N/DN)
  - Pretreatment
    - Ozone: @0,1gO_3/gCOD: 1,2 euro/m^3

    -> 65 700 euro/y (+ 31 000 euro/y for N/DN)
    - Fenton: @1gFe^{++}/gH_2O_2/gCOD: 1,39 euro/m^3

    -> 76 000 euro/y (+ 31 000 euro/y for N/DN)
    - $FeCl_3$: @1g$FeCl_3$/gCOD: 0,88 euro/m^3

    -> 48 000 euro/y (+ 31 000 euro/y for N/DN)

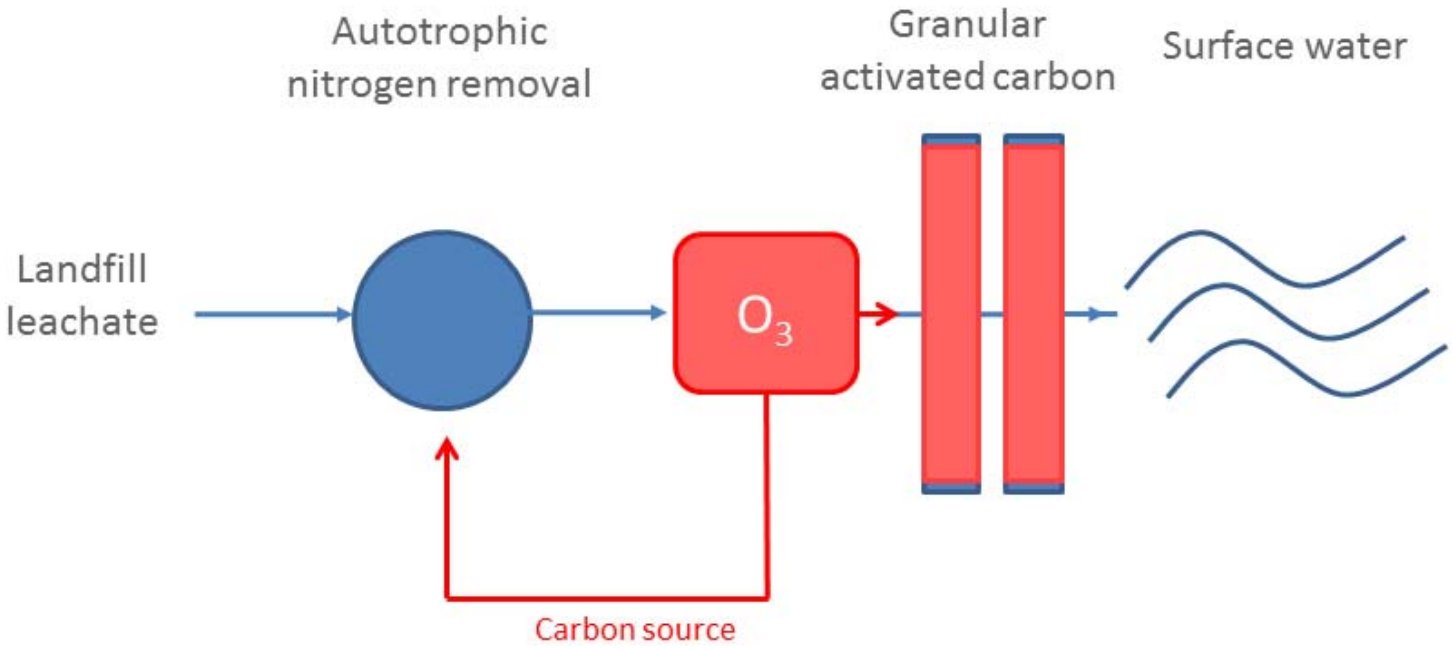
How can we reduce these costs?



	N/DN+AC	N/DN+O3+AC	N/DN+Fenton+AC	N/DN+FeCl3+AC
Euro/year	103478	96908	107310	79497
Euro/m³	1,89	1,77	1,96	1,45

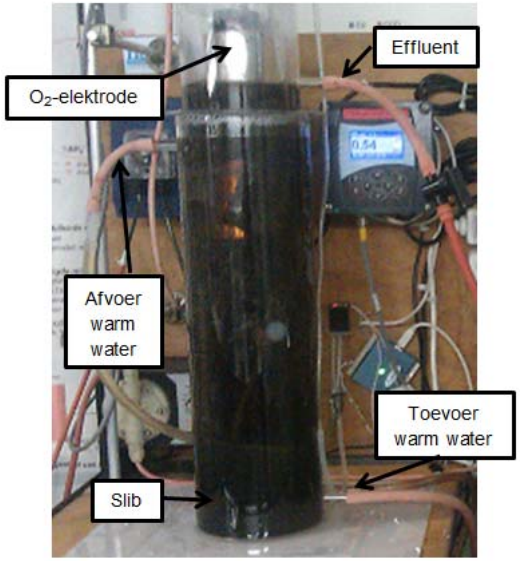
Integration of techniques

- Coupling biological treatment to physical-chemical treatment



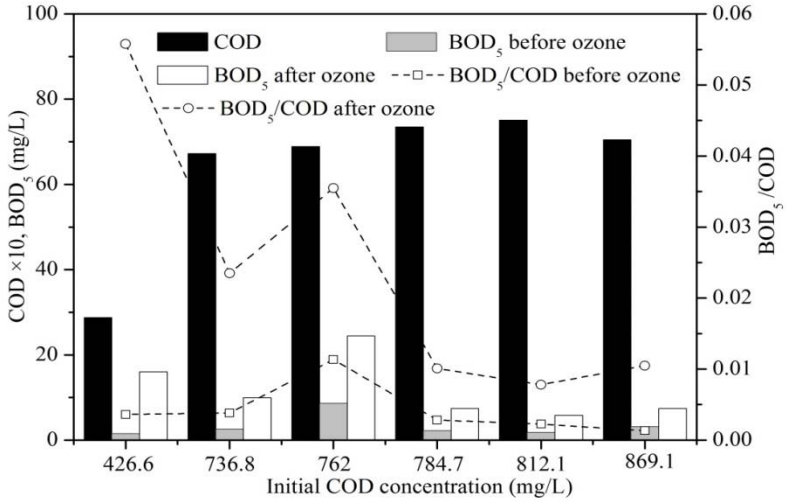
Integration of techniques

- Coupling biological treatment to physical-chemical treatment
  - e.g. ANR+O_3+AC



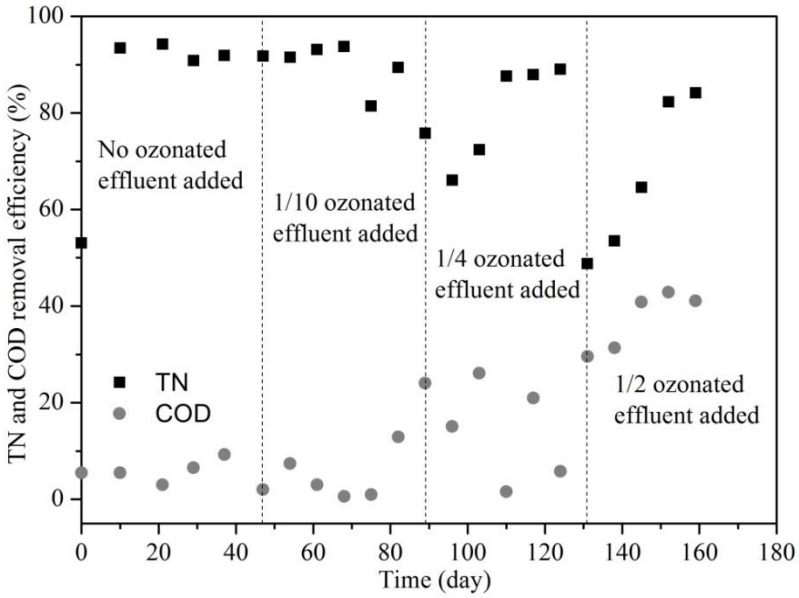
Integration of techniques

- Coupling biological treatment to physical-chemical treatment
  - e.g. ANR+O_3+AC
    - BOD increase (after O_3), mainly at lower COD concentration



Integration of techniques

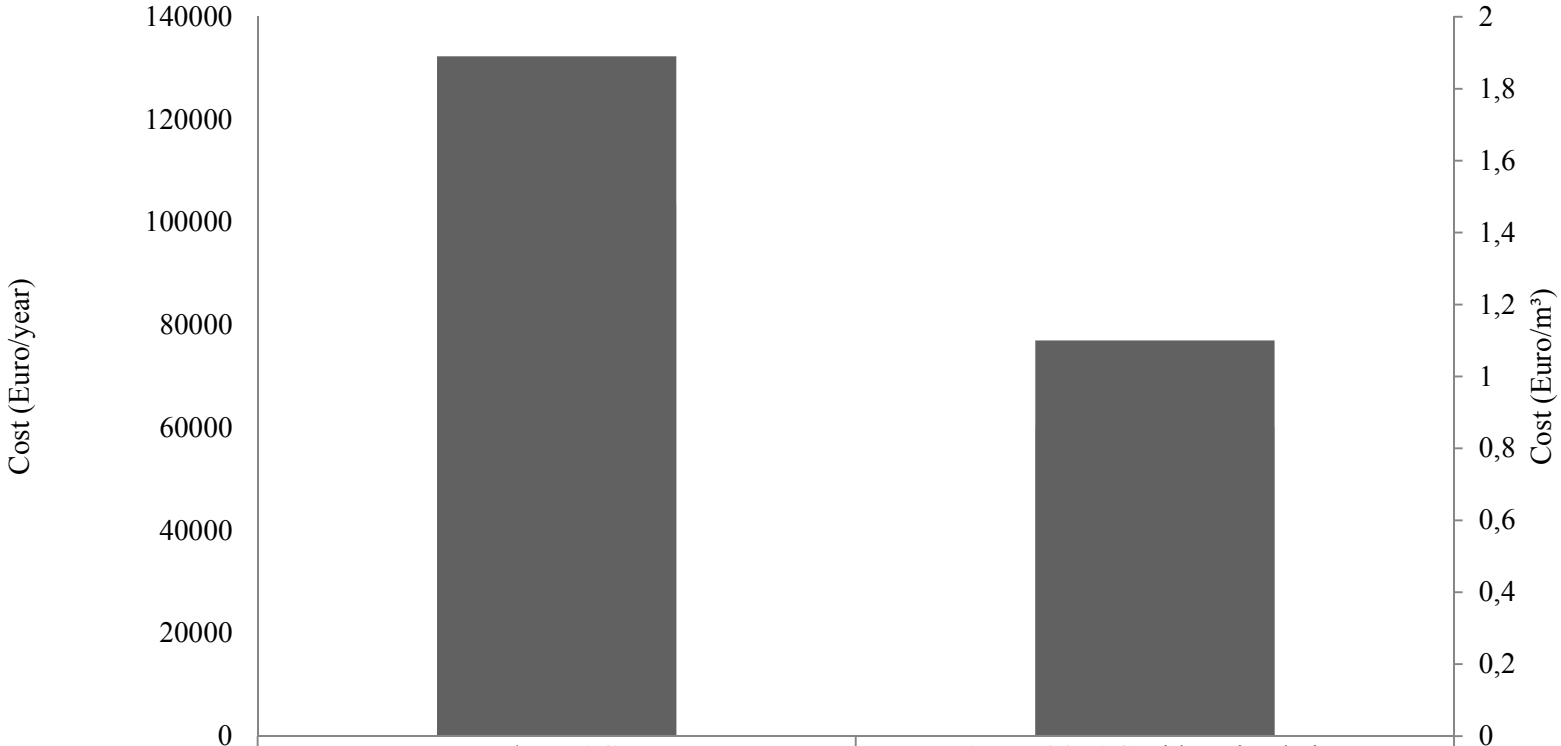
- Coupling biological treatment to physical-chemical treatment
  - e.g. ANR+O_3+AC
    - (Partial) recirculation
      - increased COD and nitrate removal
      - Competition between anammox and denitrifiers for nitrite



Integration of techniques

- Daily flow rate: 150 m³/d (365 d)
  - ANR+O_3+AC: 1,1 euro/m³
    -> 60 000 euro/y
  - 40% reduction compared to original +/- 100 000 euro/y

Integration of techniques



	N/DN+AC	ANR+O3+AC with recirculation
Euro/year	103478	60225
Euro/m³	1,89	1,1

Conclusion

- Operational costs can be reduced by combining techniques
- Future
  - More combinations will be tested
  - Full cost estimation (e.g. sludge disposal) should be implemented
  - Other parameters (e.g. metals) will be looked at)
  - Pilot-scale testing

Thanks to the sponsors

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Some references

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