Wastewater treatment in Flanders: future challenges

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Surface water quality in Flandres

- 1991: 30% treatment
- 2012: 80% treatment
Drivers for innovation

- Changing legislation
- Climate change
- Population growth
→ Focus shift

Pharmaceuticals in wastewater
Greenhouse gas emissions
Resource recovery
Pharmaceuticals in wastewater

- Daughter directive on priority pollutants
  - Watch list of emerging pollutants
    - Ethenylestradiol
    - Estradiol
    - Diclofenac

Analytical techniques

![Graph showing concentrations of diclofenac in influent and effluent.](image)
Pharmaceuticals in wastewater

• Daughter directive on priority pollutants
  – Watch list of emerging pollutants
    • Ethenylestradiol
    • Estradiol
    • Diclofenac

Develop strategic approach to the risks posed by pharmaceuticals in the aquatic environment
Pharmaceuticals in wastewater

- Source control
- End of pipe treatment

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<th>Dose mg/L</th>
<th>Electricity consumption kWh/m³</th>
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Source: EU FP 7 project Neptune, project (Contract No 036845, SUSTDEV-2005-3.II.3.2),
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Conventional wastewater treatment: 0,7 €/m³

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Cheap and reliable removal technologies
Greenhouse gas emissions

• Electricity consumption wastewater treatment
  – 0,09 kWh/pp.d
  – Energy reduction measures

• Greenhouse gas emissions
  – Sludge incineration
  – Direct emissions CH₄ and N₂O
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Greenhouse gas emissions

Autotrophic nitrification

\[ \text{NH}_4^+ \rightarrow \text{NH}_2\text{OH} \rightarrow \text{NO}_2^- \rightarrow \text{NO}_3^- \]

Nitrifier denitrification by AOB:
Sec. 3.1.

\[ \text{NO}_2^- \rightarrow \text{O}_2 \rightarrow \text{NO} \rightarrow \text{N}_2 \]

Trophic denitrification

\[ \text{NO}_3^- \rightarrow \text{NO}_2^- \rightarrow \text{NO} \rightarrow \text{N}_2 \]

\[ \text{NO}_2^- \rightarrow \text{NO} \rightarrow \text{N}_2 \]

Sec. 3.4.

Chemical by e.g. NOH or N$_2$O$_2$H$_2$

Biological by e.g. Hydroxylamine-oxidation: Sec. 3.2.

Wunderlin et al., 2012, Water Wesearch 46 (2012) 1027-1037
Greenhouse gas emissions

- Challenges:
  - Insight in formation mechanisms
  - Modelling processes involved in emission
  - Measures to prevent emission
Greenhouse gas emissions
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Nutrient recovery

- Phosphorus recovery
- Yearly mining: 14.9 mio ton P
- 90% for feed
- 3 mio ton in human excretions
- +/- 9 ton P/day in Aqf WWTP’s
- Recovery potential?
  - Liquid phase: struvite
  - Ashes
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Struvite recovery pilot plant

- NuReSys technology
- 8 m³/h inflow (digestate)
- 220 mg P/l as PO₄³⁻ inflow
- pH reactor 7.5 ~ kWh + NaOH
- 1.2 Mg/P setpoint
Nutrient recovery

Costs
- Investment
- Man hours: 1.5...5 h/week
- Chemicals: MgCl₂ & NaOH
- kW: 7 (blower + circulation pump + dosing pumps)
- Maintenance

Benefits
- Struvite price ~ € 50-75/ton?
- ± 1% DS ~ €!!
- Lower PE use
- N and P load in rejection waters ...10-15%↓
- Natural scaling ↓
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Nitrogen removal

- Conventional air stripping: 100-150 MJ/kg/N
- Air stripping: 1.9-3.2 €/kg N
- Anammox: 0.8 €/kg N
- Haber Bosch + anammox: 60 MJ/kg N

(source: Stowa)

→ Reduction or use of waste chemicals/heat
Other recovery potentials

Wastewater as a carbon source
- Bioplastics
- Cellulose
- Energy nexus

Water reuse
- Water
- Landscape revaluation
- Irrigation
- Drinking water

→ safety monitoring
Hygienization and sanitation

Reduced impact (CO$_2$, micropollutants)

Recovery of valuable resources (nutrients, water)

Transformation to production facilities

Current practice

Future

Research

Under implementation