PILLS Final Conference
19th / 20th September 2012

The PILLS project - Background, objectives & main topics

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(on behalf of the PILLS partners)
The consumption of pharmaceuticals is increasing across OECD countries, particularly for antidiabetics and antidepressants.

Consequences of drug residues in waters?

http://www.drugsnews.org/?p=1235


10,600,000 results for the search term: "pharmaceutical residues in water"
Sources and pathways

- Human drugs
  - Hospitals
  - Households
  - Municipal sewage treatment plant

- Factory
  - Veterinary drugs
  - River
  - Drinking water production
  - Groundwater
Objectives of the PILLs project

- What is the contribution of healthcare institutions to the loads of drug residues?
- Which impact may point source treatment have on the load of specific drugs mainly consumed in hospitals?
- Which techniques are appropriate to reduce the emission at point sources?
- What is the role of point sources in terms of the spread of multi-resistant bacteria?
- What steps are needed for a sustainable reduction of the overall emissions?
PILLS Partnership

- 2 Water associations
- 2 Universities
- 2 research institutes
- Budget: 8,0 Million Euro
- Project Duration: 2008 – 2012
**Main topics**

- **WP 1 Analysis**
  - Characterisation of waste water from point sources

- **WP 2 Technology**
  - Design, construction and operation of advanced waste water treatment technologies at point sources
  - Assessment of different advanced treatment technologies (Removal of pharmaceuticals, of ecotoxicological effects and antibiotic resistant bacteria; costs and environmental balance)

- **WP 3 Assessment**

- **WP 4 Communication**
  - Communication of the issues and of the results of the project.
Characterization - by chemical analysis

• Selection of 16 PILL S common pharmaceutical active substances
• Determination of loads based on consumption data
• Measurement of substance concentrations
• Contribution to loads in catchment areas

Ciprofloxacin

Carbamazepine

Diclofenac

Sulfamethoxazole

Diatrizoate
Characterization
- by evaluation of ecotoxicological effects

• Short-term and long-term toxicity tests with organisms from different aquatic trophic levels and representing functions

• *In-vitro* screening tests for the assessment of specific effects (e.g. cytotoxicity or endocrine disrupting effects) and general toxicity to bacteria and algae

• *In-vivo* tests on organisms like snails, worms, water fleas or fish.

• Comparison of ecotoxicity potential of hospital and municipal waste water

Pictures: C. Kienle, Oekotoxzentrum/Eawag; M. Hammers-Wirtz, gaiac RWTH Aachen
Characterization
- by evaluation of antibiotic resistant bacteria

• Determination of the quantity of antibiotic resistant genetic elements of bacteria (the resistant Integrons) → importance of antibiotic resistance in a sample independently of the quantity of bacteria

• Determination of the proportion of bacteria harbouring a resistant Integron in a same sample (the relative abundance)

• Comparison of hospital and municipal waste water

Scheme: T. Stadler, 2011
### Technology
- Investigated advanced treatment processes

<table>
<thead>
<tr>
<th>Membrane filtration</th>
<th>Oxidation processes</th>
<th>Adsorption on activated carbon</th>
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<tbody>
<tr>
<td>Microfiltration</td>
<td>Ozonation</td>
<td>Powdered activated carbon</td>
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<tr>
<td>Ultrafiltration</td>
<td>Advanced oxidation processes (UV/Ozone, UV/H₂O₂, Ozone/H₂O₂, Fenton reactions, UV/TiO₂)</td>
<td>Granulated activated carbon</td>
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<tr>
<td>Reverse osmosis</td>
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Technology
- Schematic illustration of the investigated pilot plants

**Small-scale plants**
- Switzerland: 1.2 m³/day
  - Influent → Primary clarifier → Membrane Bioreactor (MBR) → Powdered activated carbon
  - Effluent: public sewer system

**Luxembourg**
- 1-3 m³/day
  - Influent → Screen → Membrane Bioreactor (MBR) → Reversed Osmosis → Effluent: public sewer system

**Full-scale plants**
- Germany: 200 m³/day
  - Influent → Fine screen → Membrane Bioreactor (MBR) → Ozonation → Sand filtration → Effluent: Water body

- The Netherlands: 240 m³/day
  - Influent → Coarse screen → Membrane Bioreactor (MBR) → Ozonation → GAC → Effluent: public sewer system

- Pre-treatment → Main Biological treatment → Advanced treatment → Post-treatment
Building of the Pilot plant at Marienhospital Gelsenkirchen, Germany

Site visit tomorrow 14:00
Communication
- Information and discussion with stakeholders

Symposium – Arzneimittel im Wasser
Ziele und Rahmenbedingungen

Freitag, 25. November 2011
Thursday 20th

09:00  PILLS partners plenum presentations
1. Pharmaceutical consumption and emission in hospitals
2. Advanced waste water treatment for the elimination of pharmaceutical residues in hospital wastewater
3. Occurrence of antibiotic resistant bacteria in hospital wastewater
4. Ecotoxicological assessment of hospital wastewater

Questions, discussion & votings

11:00  Coffee

11:30  PILLS partners plenum presentations
5. Life Cycle Assessment of the elimination of pharmaceutical residues in hospital wastewater
6. Conclusions – Criteria for the selection of measures for elimination of pharmaceutical residues in hospital wastewater

Questions, discussion & votings
Thank to all the supporters of the PILLS project

… and you for your attention!