Removal of priority and emerging pollutants by biological and tertiary treatments

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Plan

1. Scientific context
   - A WWTP today
   - Conventional and tertiary treatment

2. Issues and goals

3. Focus on tertiary treatment
   - Methodology
     - CarboPlus®
     - Sampling strategy
   - Primary results

4. Significance and limitations for developing countries?

5. Planning
A WWTP today

Wastewater

Pre-treatment
- Removal of voluminous solids, grease and sand

Primary treatment
- Removal of total suspended solids (TSS)

Biological treatment
- Removal of nutrients – C/N/P

Sludge treatment

Discharge to environment

Presence of micropollutants

Incineration, agricultural use, disposal

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Context

- General
  - Presence of micropollutants in WWTPs discharges \( (\text{Heberer 2002}) \)
  - European regulation: WFD \( (2000/60/EC) \)

- Conventional treatments
  - Fate of some compounds not well documented in WWTPs
  - Conventional primary and biological (conventional activated sludge) treatments quite well studied \( (\text{Clara et al. 2005; Ruel et al. 2010}) \)
  - Lack of knowledge on enhanced primary treatment (coagulation/flocculation), biofiltration and MBR at industrial scale

- Tertiary treatments
  - Hardening of regulations, anticipation of water operators and insufficient efficiency of conventional WWTPs \( \Rightarrow \text{development of tertiary treatments} \)
  - Efficiency of activated carbon for micropollutants removal was highlighted in literature \( (\text{Delgado et al. 2012; Margot et al. 2011; Nowotny et al. 2007}) \)
Issues and goals

- Primary and biological treatments
  - Efficiency of biofiltration for micropollutants? Comparison with conventional activated sludge (CAS) treatment
  - MBR a relevant solution to improve biological treatment of micropollutants?
  - Removal mechanisms at industrial scale
  - Comparison of the three main biological treatments (process and facility)

- Need to develop tertiary treatments and to study them
  - What about emerging pollutants?
  - Efficiency of activated carbon for persistent pollutants?
  - Impact of operational parameters?
  - Type and dose of activated carbon?
  - How to regulate micropollutants adsorption processes? UV signal a relevant indicator?

- Presentation: *focus on tertiary treatment*
CarboPlus®

- Concept
  - Contact of PAC with water in a reactor
  - Fluidized bed of PAC
  - Coagulant and polymer addition prevents PAC discharge with water
    - *No filtration system needed*

- Operational parameters
  - Capacity of 50 m³/h
  - SRT of a couple of days (3-7)
  - HRT of about 15 minutes

- Fed with treated water from biofiltration unit (SIAAP - Seine Centre)
Organization of campaigns

**Phase 1**
PAC Optimization
- June – October 2013 (16 weeks)
- 12 campaigns
  - 4 configurations
  - Influence of operational conditions, dose and type of PAC

**Phase 2**
PAC Optimized regime
- October – December 2013 (13 weeks)
- 6 campaigns
  - Best configuration
  - Variability of results, efficiency and cost of CarboPlus, removal mechanisms

**Phase 3**
Micro-grain configuration
- January – November 2014 (48 weeks)
- 12 campaigns
  - Comparison between powder and micro-grain
  - Efficiency, cost, biological activity, etc.?
Sampling strategy

- Screening: 135 persistent and/or problematic compounds
  - Pharmaceuticals and hormones
  - Pesticides
  - Priority substances (WFD)
  - Metals
- Accredited laboratory for all compounds except metals (independent protocol - LEESU)
- Sampling of inlet and outlet water with automatic samplers (4°C)
- 24 h average samples (organics) or punctual (metals)
- Measure of total fraction and UV signal
- 30 campaigns in 18 months (70 samples)

→ Large scale and high frequency approach
Primary results

- Characterization of 4 activated carbons
  - Laser granulometry
  - Electron microscopy
  - Removal of UV$_{254}$ signal after 45min contact

<table>
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<th>PAC</th>
<th>UV before (mg/L)</th>
<th>UV after (mg/L)</th>
<th>Removal (%)</th>
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Effect of activated carbon type

Effect of activated carbon dose

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Developing countries...

- A vague notion: what a developing country?
  - Diversity in terms of infrastructures (i.e. Brazil vs. Mozambique)
  - Inequality between economically dynamic countries and the poorest countries

- Significance:
  - Wastewater treatment and quality of discharges are crucial issues
  - Improving knowledge on contamination and treatment of wastewater is useful for all operators and scientists in the world
  - Tertiary treatments could be directly applied in developing countries where biological treatment often doesn’t exist

- Limitations: a developed countries issue?
  - In the 59 poorest countries in the world, half of the people have no access to water and sewer system (United Nations source)
  - Sewer systems often in poor condition (when they exist!)
  - When sewer systems: other conventional water quality parameters are more problematic (nitrogenous/phosphorous pollution, total suspended solids, etc.)
  - A lot of countries couldn’t afford tertiary treatment now
Planning

- Conventional treatments
  - Final correction and submission of an article (July 2013)
  - Campaigns on MBR unit from SIAAP’s La Morée WWTP (second semester of 2014)
- Tertiary treatments
  - Large scale pilot campaigns: from June 2013 to November 2014
  - Complementary lab scale experiments (2013-2014)
  - Paper (2015)
- PhD oral presentation (end of 2015)
Thank you for your attention
Any questions?