

Results

1. TITLE

New sustainable concepts and processes for optimization and upgrading municipal wastewater and sludge treatment

Contract no.: 119/2006

2. INTRODUCTION

Up to date municipal wastewater treatment plants (WWTP) were seen as an end-of-pipe treatment just before discharge, having the aim to avoid eutrophication and hygienic health hazard in surface water. Due to the global demographic trends as well as new legislations (e.g. the Water Framework Directive, WFD) increased focus is put on quantity and quality of effluents: more and more seen as interface between sanitation and environment, WWTP are delivering resources to the environment and for human activities (recharge of drinking water reservoirs, recycling of nutrient, efficient energy use). This focus shift has implications on the quality goals set for WWTP products. Existing focus: nutrient removal, pathogens removal, energy optimisation, sludge disposal. New focus: nutrient recycling, micropollutants and ecotoxicity, energy production, reuse of sludge and of its resources.

3. OBJECTIVES

- To obtain main contributes to sustainable growth, by providing technical solutions for upgrading a quantitatively significant water resource: municipal wastewater. New approaches for a sustainable WWTP design.
- To compare options for sludge processing and disposal, allowing evaluating feasible and safe solutions for nutrient recycle. Strategies for a sustainable and safe sludge management.
- To contribute to improve energy efficiency of municipal wastewater treatment and in developing new solutions promising energy autarchy.
- To contribute to reducing pollutant load discharged into the aquatic environment, by improving nutrient and micropollutant removal and by evaluating wastewater treatment options with new (eco-) toxicological methods: Strategies to minimize micropollutant release in plant effluent,

Control of chemical and microbial water quality is a crucial aspect to assess the appropriateness of mitigation technologies for municipal wastewater. The number of organic pollutants detected in surface waters increased dramatically during the last two decades. Most of these emerging pollutants originate from municipal wastewater.

4. MAIN DIRECTION OF ACTIVITIES

- The project was focused mainly on chemical groups which have not been thoroughly investigated so far from group of Priority substances (WFD) and persistent organic pollutants (POPs).
- For quality assurance of the analytical methods an interlaboratory comparison study (ILCS) was performed to guarantee and confirm the quality of the collected data.
- The development of suitable analytical methods was established for selected groups of chemicals.
- The determination of K_d values (sludge/water partition coefficient) for selected contaminants was performed for primary and secondary sludge at low suspended solid concentrations.

-The chemical structures of the oxidation products from selected organic micropollutants was elucidated, in order to understand the oxidation mechanisms in chemical transformation in advanced oxidation processes.

5. OBTAINED RESULTS

The main results obtained by running of project can be clasified in few groups:

- Informations valuable on the type of contaminants in all stages of waste water treatment.
- Information on transport process of the organic pollutants in environmental waters.
- The gain of data necessary in ecotoxicological testing in treatment relevant processes.
- Characterization of pollution sources and fate of pollutants in wastewater treatment plant.
- A main concept for development of mobile analytical unit for on site assessment of effluents was established.

In the period of project the following results were performed:

- Analytical methods was established, improved and in a few cases developed for sensitive determination of organic pollutants priority substances, biocides and ingredients of personal care products in relevant aqueous matrices such as wastewater and sludge.
- Analysis of aqueous and solid samples, to elucidate the removal of organic micropollutants in certain treatment processes.
- Participation in an interlaboratory comparison study (ILCS) in an europa group of laboratories for guarantee and confirm the quality of the collected data.
- K_d values (sludge/water partition coefficient) for selected contaminants were determined in laboratory for primary and secondary sludge according to sorption tests for secondary sludge.
- The chemical structures of the oxidation products from selected organic micropollutants were elucidated, in order to understand the oxidation mechanisms
- The main groups of selected contaminants were characterized by molecular markers using advanced analytical systems.

5.1. Target studied compounds

Most compounds already listed as priority substances (WFD) and POPs were measured. Analytical methods were established for alkyl phenols, alkylphenolethoxylates, PAHs, organochlorines (e.g. PCBs, HCHs, HCB, DDT), pesticides (e.g. triazines, phenyl urea herbicides) and related metabolites (e.g. hydroxylated and desethyl/desisopropyl triazines).

In addition to POPs and WFD priority substances, the emission of so-called “emerging” chemicals is of major environmental and drinking water relevance. Emerging micropollutants such as estrogens, neutral and acidic pharmaceuticals or benzothiazoles, triclosan, or DEET have been thoroughly investigated.

5.2. Developed of Analytical methods

- a) For pesticides determination of type Triazines at level of 10 ng/l was developed a method based on SPE extraction followed of analysis by GC/MS system.
- b) The Herbicides from group of Phenyl Urea Herbicides (PUHs) are thermal instability and therefore need special procedures. Were developed a method based on measurement of decomposition products in established analytical conditions. In every situation the mode of presentation SIM based on abundant selected ions was used.
- c) Because that a lot of compounds of pronounced polarity can not be determined by classical methods the derivatization methods were developed after concentration stages. The derivatization with silica byproducts was applied (MSTFA).

5.3. Sensitive measurements on organic pollutants in WWTP units

Based on analytical data on organic pollutants determined in different points of the WWTP few important data on removal processes were obtained:

- 1) The WWTP is not able to totally remove the compounds of type Pharmaceutical and Personal Care products (PPCPs). The concentrations in treated effluents are in the same range in different European WWTPs.
- 2) The observed removal rates vary strongly from compound to compound. A first group of compounds were removed to more than 90% (caffeine) with variable rate in different units of the WWTP.
- 3) Partial removal (40-60 %) is seen for compounds with aromatic structure (Triclosan).
- 4) For groups of neutral compounds (tonalide) the removed rates in the WWTP are low (under 26 %).

5.4. Studies for elimination of the organic pollutants by sorption processes

In laboratory experiments the partition coefficients K_d values were determined on selected compounds based on Freundlich and Langmuir isotherms.

The method for 25 biocides and polar UV filter and vulcanization compounds has also been developed and validated. The sorption and behaviour of biocides, triazines and phenyl urea herbicides in waste water treatment plant was done. The sorption study of compounds produced K_d values and Freundlich isotherms. The addition of azide did affect the sorption of some compounds and did not always totally inhibit degradation. For the triazine compounds the simplified K_d approach is valid for describing sorption. In the experiments with activated carbon it is not possible to desorb the compound totally.

5.5. Characterization of the organic pollutants by molecular markers

Both anthropogenic and naturally occurring compounds are found mixed together in recent environmental samples and several of these compounds may be used as tracers to study natural processes affecting the fate and effects of chemical contaminants in water. We used as markers following class of compounds;

- 1) Steroidal compounds of type 5β -stanols (biomarkers of human activity), 2) Phthalate acid esters (PAEs) (industrial activities), 3) Polyethoxylate compounds (currently used as surfactants), 4) High-branched chains (antioxidants used in the food industry), 5) Long chain amides (TAMS), 6) n-Alkanes, 7) Acyclic isoprenoids (depositional environments), 8) Pentacyclic triterpanes (Hopanes) (petroleum geochemistry), 9) Linear Alkylbenzenes (LABs), (sulfonic surfactants), 10) The pharmaceuticals, (caffeine and triclosane. Triclosan), 11) Polycyclic Musk Fragrances (Galaxolide and Tonalide), 6) Polyaromatic Hydrocarbons (PAHs), 7) Sulphonated Polyaromatic Hydrocarbons (SPAHS).

5.6. Interlaboratory studies

The INCDTIM group participate in European Interlaboratory exercise. This consists of 14 European laboratories known as being of high performance in environmental field. The values obtained by INCDTIM laboratory are comparable with of the other laboratories.

6. RESULTS DISEMINATION

The results were disseminating by 10 publications in Scientific Research from which 3 in ISI base of data and 7 in other base of data. A number of 3 papers were published in national journals. A number of 29 of papers were presented at international conferences.