ELECTROCHEMICAL TREATMENT OF PHARMACEUTICAL WASTEWATER BY COMBINING ELECTROCHEMICAL OXIDATION WITH OZONATION

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Introduction

The topic of this research project, started in December 2006, is to eliminate pharmaceutical substances and complexing agents found in waste water as micropollutants. Although pharmaceuticals are absorbed by human and animal organisms after their intake, significant amounts of the active substances are excreted without alteration. Several scientific reports have been published about the pollution of surface- and groundwater with pharmaceutical substances. The objectives of the current project focus on an electrochemical treatment of pharmaceutical wastewater by combining two different techniques: electrochemical oxidation and ozonation. Although these impurities are at very low concentrations (in the scale of ng/L up to µg/L), scientists have not been able yet to estimate all involved possible risks, its investigation will be forced in the future. As an example, the release of pharmaceuticals to nature via wastewater could lead to an increased dissemination of antibiotic resistance. Endocrine substances like hormones are suspected to promote feminising and masculinising effects on organisms in ecosystems.

The aim of the current project is to achieve the most complete elimination of the examined substances with the combination of electrochemical oxidation and ozonation. For the development of the treatment process (Figure 1) a total running time of 2.5 years is scheduled.

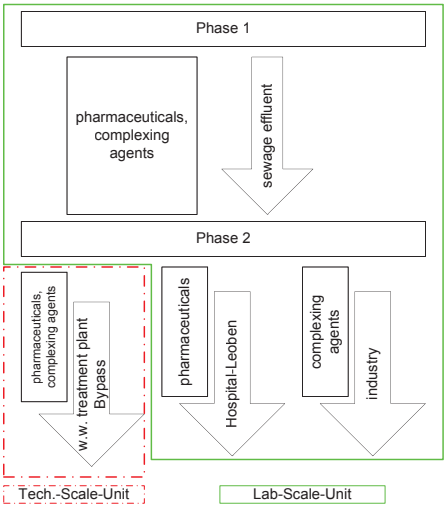

Figure 1: Scheme of the planned workflow

Process combination

The complete treatment would be done in two steps. In the first one, the wastewater will be treated by electrochemical oxidation with diamond electrodes. Then ozonation

completes the process. The ozone will not be produced as the conventional ozone producing systems; i.e., with coaxial dielectric-barrier-discharge in air. In this case ozone will be formed by electrolysis with diamond electrodes.

The whole process can be described as follows. Firstly, the wastewater under analysis will be taken from the effluent of a wastewater treatment plant (RHV-Leoben) and will be treated in a lab scale unit. In the second phase – after approximately one year – water from the local hospital in Leoben and a circuit board producer will be sampled. This wastewater will be treated on the pilot plant. Additionally, experiments will be carried on directly at the wastewater treatment plant. To accomplish this, a tech scale unit will be installed in a bypass-system of the facility.

The needed amount of ozone will be produced in a non-conventional, separate generator. In this process the ozone will be directly produced from clean water by electrolysis with diamond electrodes. The injection of the concentrated ozonic water to the wastewater will be progressive. After ozone addition, a post mixing chamber for the mixture will be used to install a sensor at this step. With this ozone detector, it will be possible to calculate an ozone balance of the reactor system. This balance in addition to the other parameters (e.g. COD, Chemical Oxygen Demand and DOC, Dissolved Organic Carbon) will allow getting conclusions about the ozone consumption of the substances existing in the sample, which depends on the existing organic matrix of the water samples (scavengers).

In the second treatment step, the waste water will be delivered to an electrochemical reactor. Inside, electrodes for an anodic oxidation with doped diamond electrodes are located. In the process OH-radicals will be directly produced and used for the oxidation of the substances (pharmaceuticals and complexing agents).

Analysis

As shown in Table 1, the samples taken after the treatment modules will be analysed for several different parameters (e.g. DOC, COD, AOX, conductivity, redox potential, pharmaceutical substances and complexing agents content). The pharmaceutical substances and also the complexing agents will be analyzed by the Federal Environment Agency of Austria (this agency has been a project partner in different studies about pharmaceuticals in the ecosystem, as in the ARCEM project). COD and DOC will be analysed by the laboratory of the Institute for Sustainable Waste Management and Technology in Leoben, and the other parameters will be measured using inline instruments during the test runs.

Table 1: Overview of the analytic plan

Substances	Analysis	made by	
		AE	UBA
sum parameter / online measurement	DOC	X	
	AOX	X	
	Conductivity	X	
	Redoxpotential	X	
	pH-Value	X	
	COD	X	
pharmaceuticals	Carbamazepin		X
	Coffein		X
	Roxithromycin		X
	Erythromycin-H2O		X
	Josamycin		X
	Diazepam		X
	Trimethoprim		X
	Sulfamethoxazol		X
complexing agents	EDTA		X
	DTPA		X
	1,3-PDTA		X
	NTA		X