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Electrochemical Treatment of Pharmaceutical and Industrial Wastewater by Anodic Oxidation

3IMEBE - Palma de Mallorca, 21-25 September 2008

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Content

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- Results
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Aim

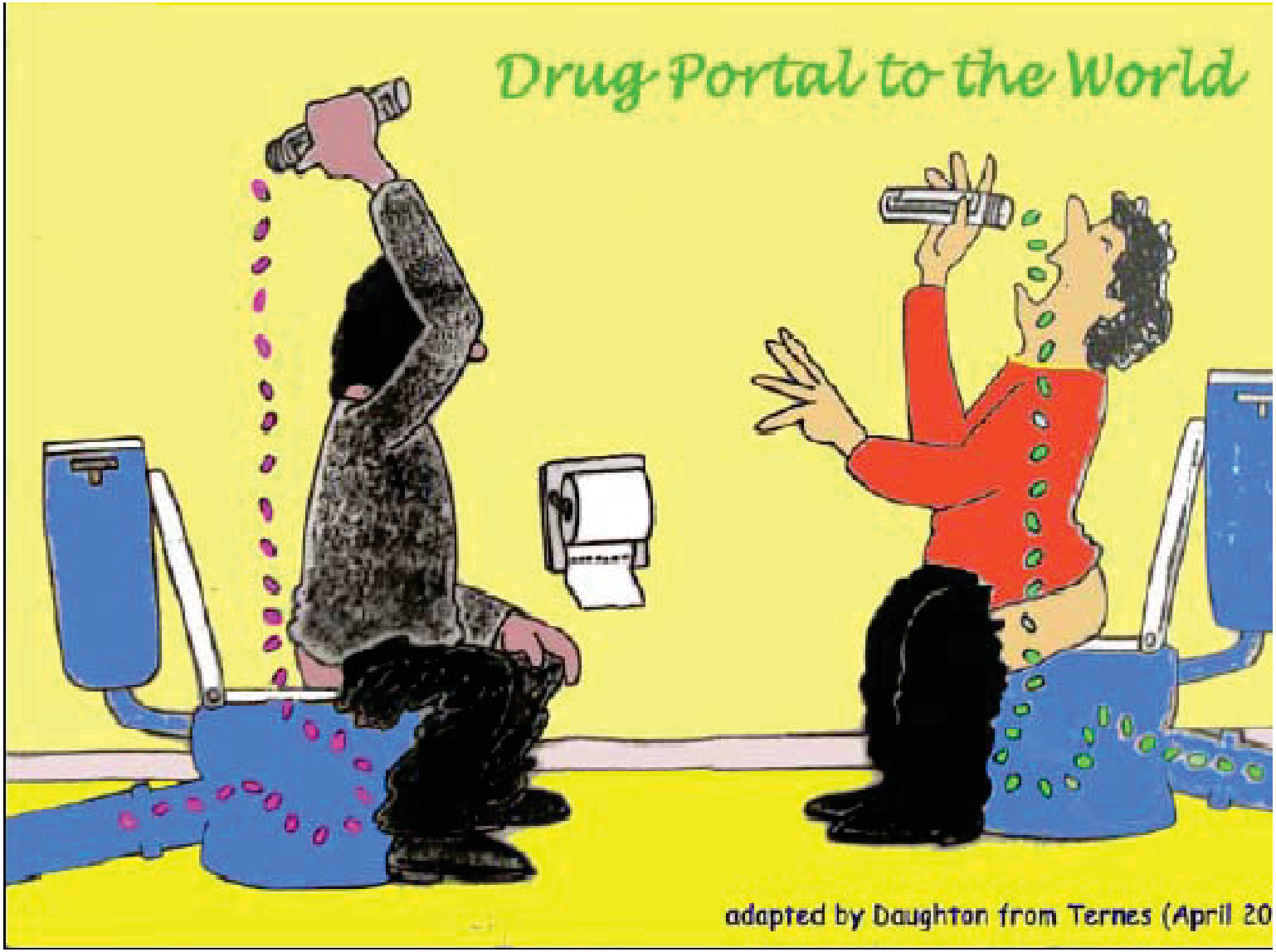
- Development of a treatment process for the degradation of pharmaceuticals and industrial used chemicals in wastewater
  - Release of pharmaceuticals into surface waters may lead to an increased dissemination of antibiotic resistance
  - Endocrine substances like hormones are suspected to promote feminizing effects

Further Aims

- Elimination of pharmaceutical substances and complexing agents found in wastewater as micro pollutants
  - Verification through indicators (e.g. Carbamazepine, EDTA)
- Usability evidence and combination of two innovate technologies
  - Anodic Oxidation
  - Ozonation
- Pilot Plants in Lab-scale and Tech-scale
- Investigation of the applicability in central or decentral treatement systems
  - Sewage treatment plants (STP)
  - Hospitals
  - Pharmaceutical producers / Industry

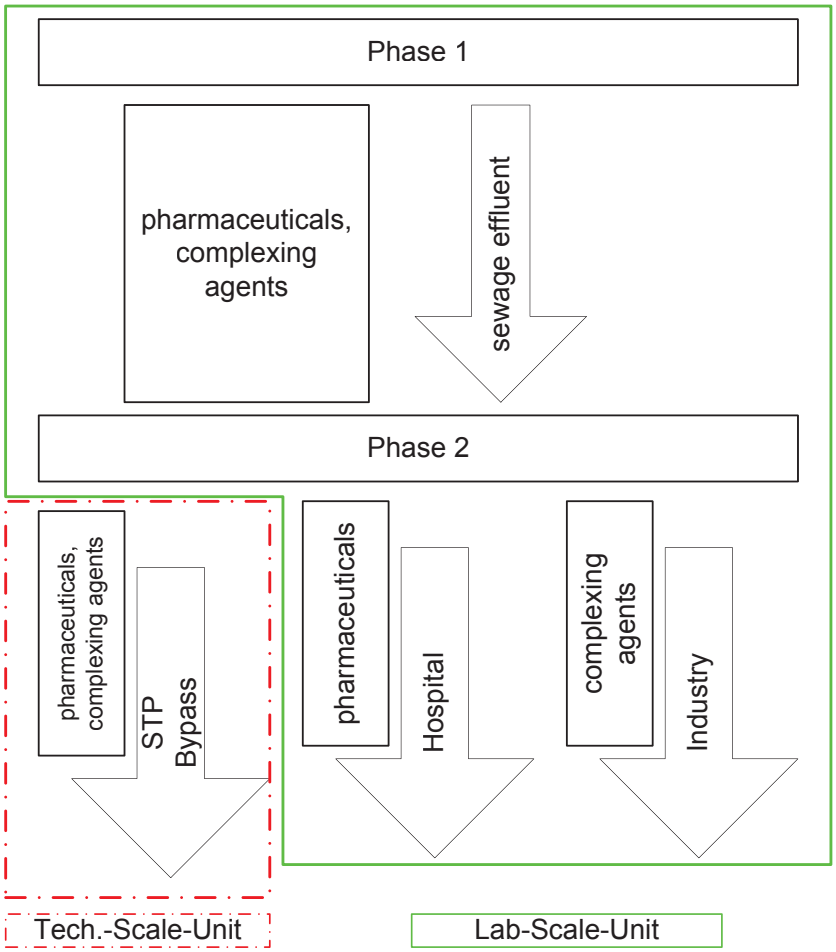
Background

- Complexing agents
  - Till 2015 complete implementation of Directive 2000/60/EC (framework for Community action in the field of water policy)
  - Austria: „QZV Oberflaechengewaesser" (Surface water)
  - Complexing agents listed as priority substances → threshold values
- Pharmaceuticals
  - Partial not treatable in conventional STP (e.g. Carbamazepin)
  - Impacts on humans and animals can't be ruled out
  - Risk of antibiotic resistances
  - Annual increase of pharmaceutical consumption (human aging, intensive care medicine)



Source: Koelner Wasser- und Abwassertage, Ternes 2005

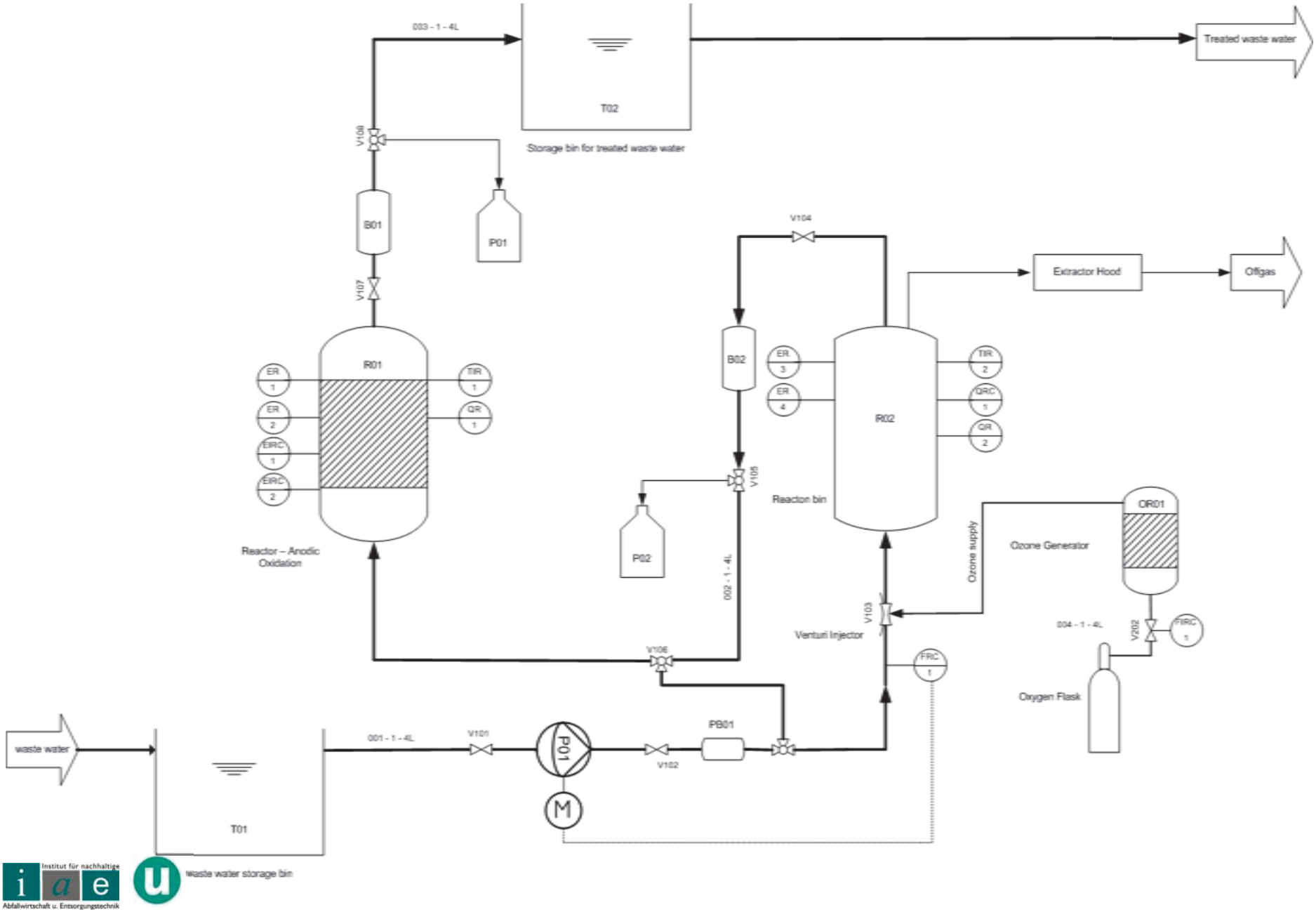
Project Phases



Investigated Substances

Substance	CAS-number	Category
1.3-PDTA	---	Complexing agent
DTPA	---	Complexing agent
EDTA	60-00-4	Complexing agent
NTA	139-13-9	Complexing agent
Carbamazepine	298-46-4	Antieptileptic drug
Caffein	48-08-2	Psychostimulant
Diazepam	439-14-5	Psychiatric drug
Erythromycin-H_2O	114-07-8	Antibiotic
Josamycine	16846-24-5	Antibiotic
Roxithromycin	80214-83-1	Antibiotic
Sulfomethoxazole	743-26-6	Antibiotic
Trimethoprim	738-70-05	Antibiotic

Setup: lab scale



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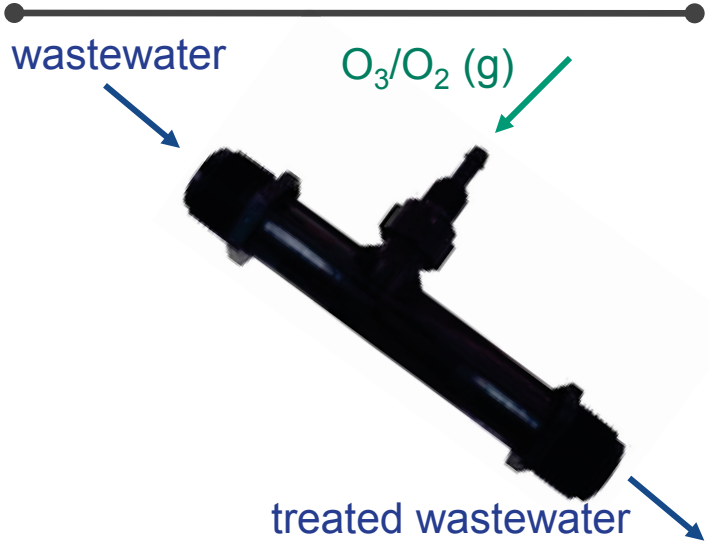
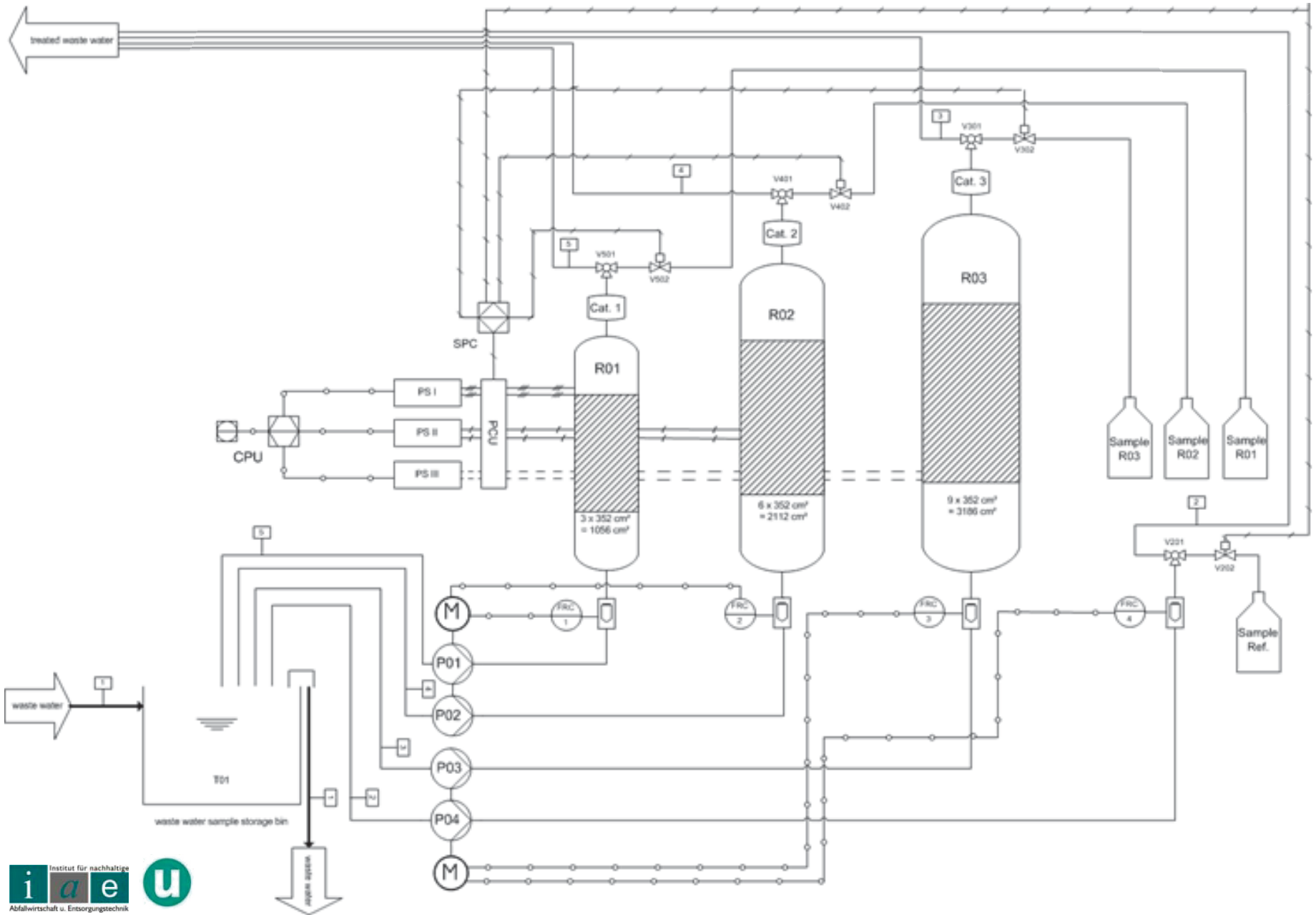
Setup: lab scale



Setup: tech scale



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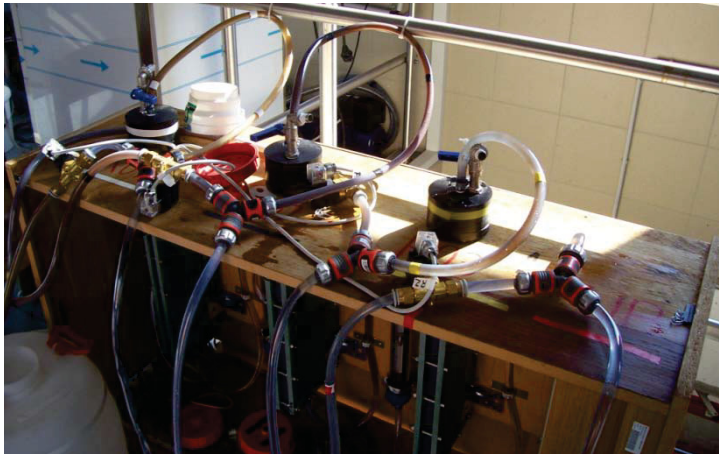
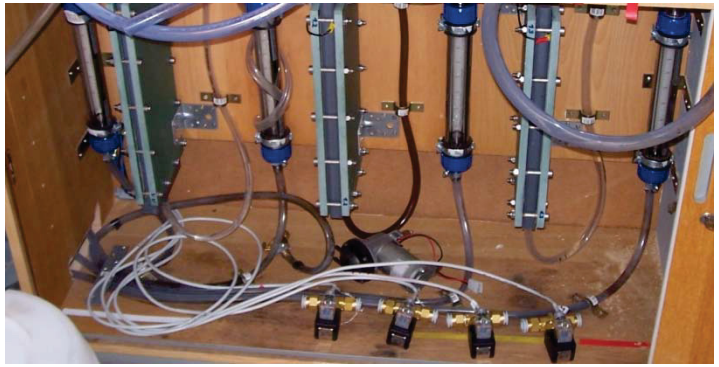
Setup: tech scale





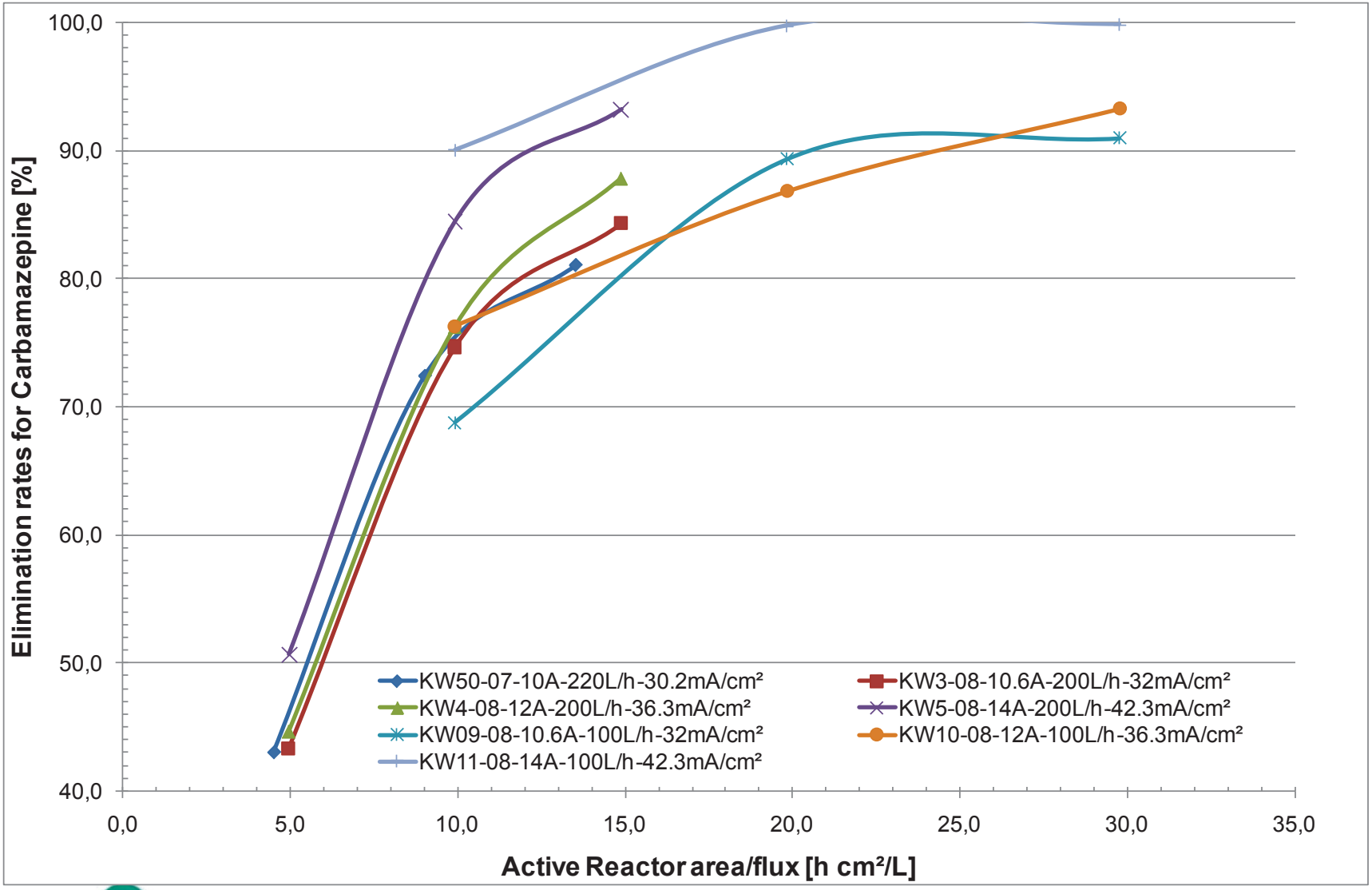
Test program

Project phase	Experiment parameter	Aggregate		
		Lab scale unit		Tech scale unit
		Anodic Oxidation	Ozonisation	
I	Synthetic waste water with EDTA	x	x	
	Degradability experiments with pharmaceutics endowment	x	x	
	Real waste water without additional endowment	x	x	
	Variation of current densities and flow rates	x	x	
	Different contact methods		x	
	Treatment combinations	x	x	
II	Experiments with industrial waste water	x	x	
	Variation of current densities and flow rates	x	x	x
	Serial connections of the reactors			x
	Venturi injector for the ozone contact		x	
	Ozonization as reference method			x

Results – a short overview

- Degradation of Carbamazepine with Anodic Oxidation (tech scale)
- Comparison of the usability of O_3 depending on the treated media
- Comparison of the achieved redox potential (lab scale)

Reduction of carbamazepin



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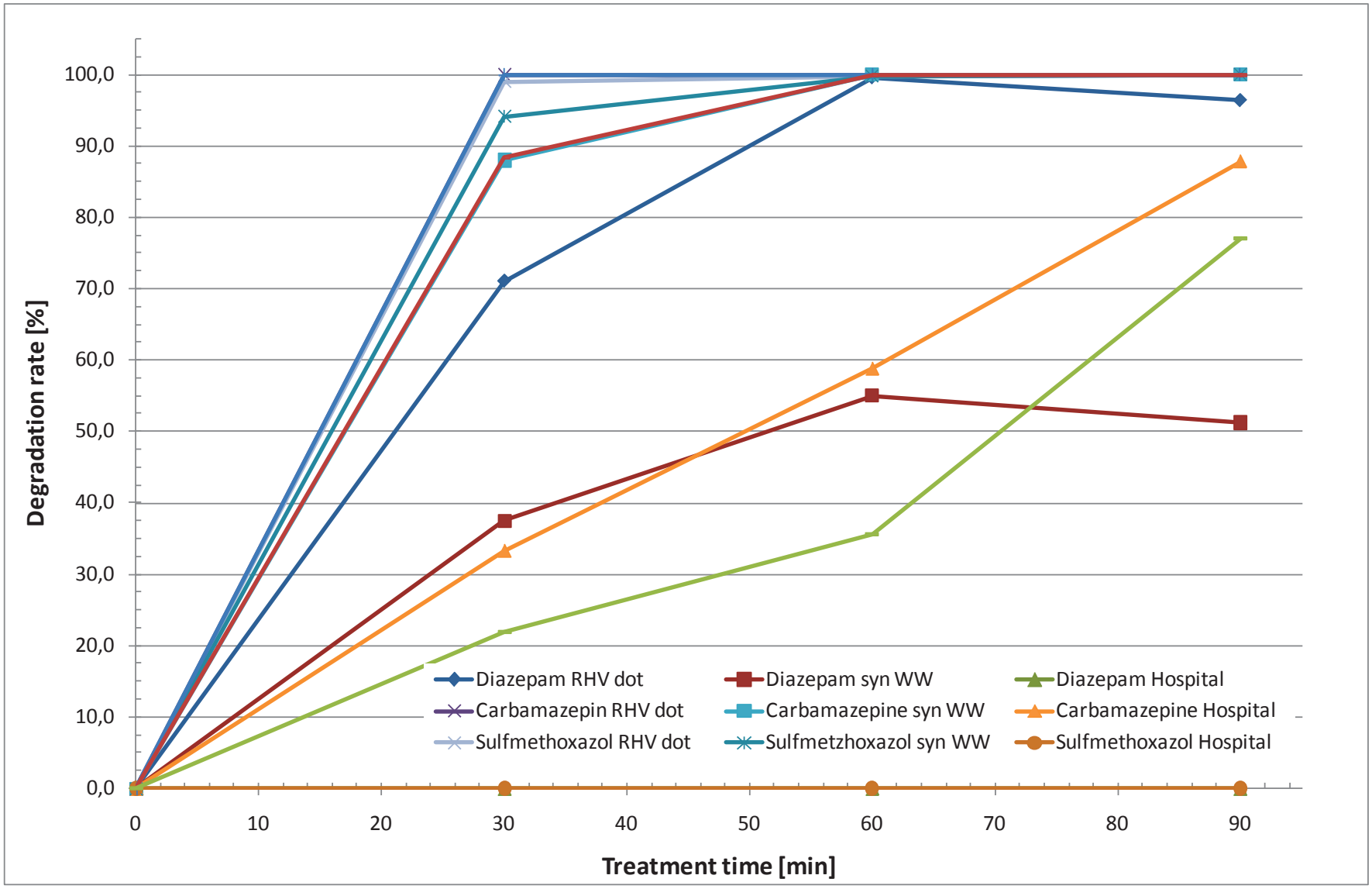
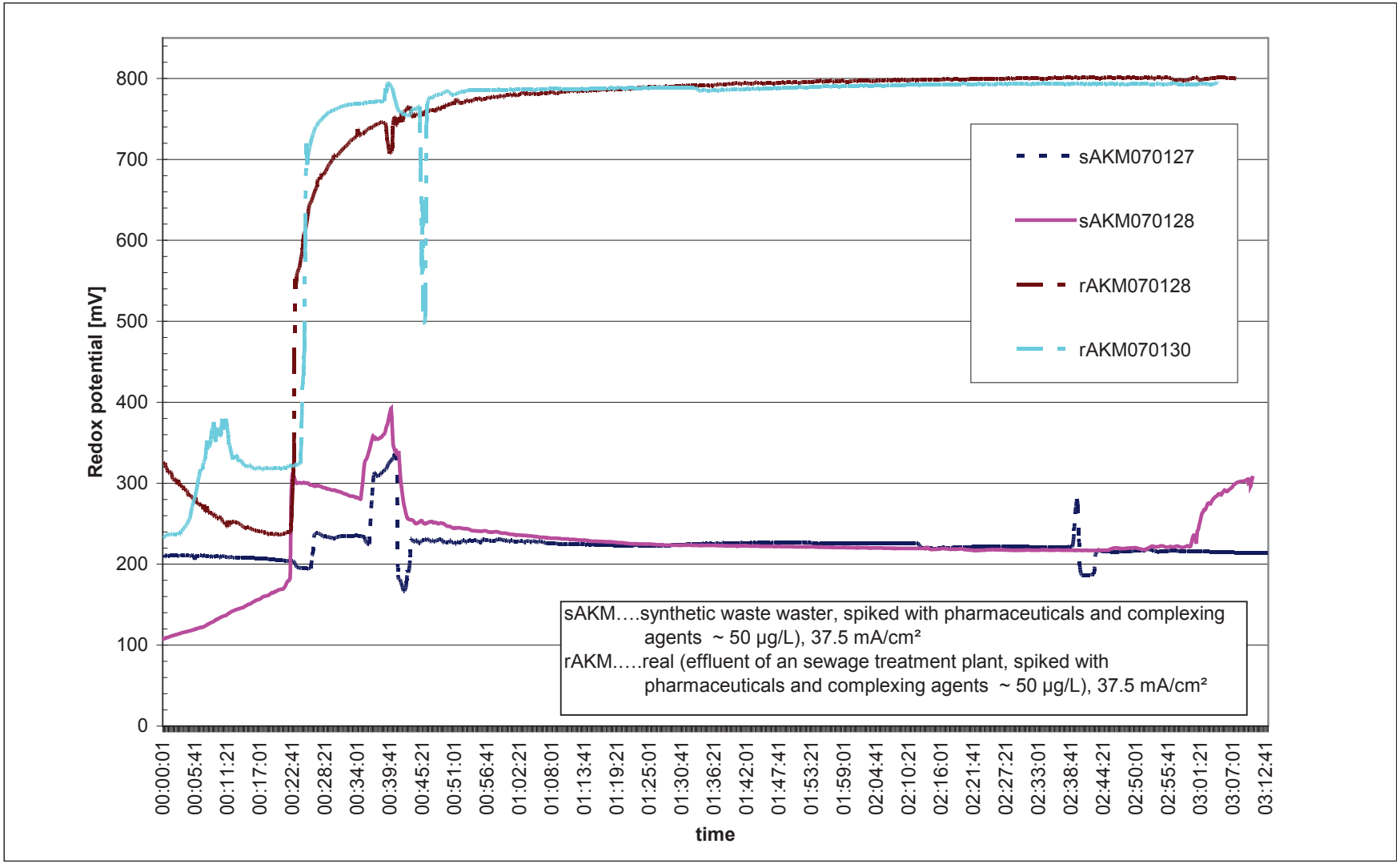
Ozonation


Degradation rate [%]
100,0
90,0
80,0
70,0
60,0
50,0
40,0
30,0
20,0
10,0
0,0
0
10
20
30
40
50
60
70
80
90
Treatment time [min]
Diazepam RHV dot
Diazepam syn WW
Diazepam Hospital
Carbamazepin RHV dot
Carbamazepine syn WW
Carbamazepine Hospital
Sulfmethoxazol RHV dot
Sulfmetzhoxazol syn WW
Sulfmethoxazol Hospital

Process data redox potential



Comparison of the redox potential – synthetic wastewater vs. real wastewater

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Summary & next steps…

- Real wastewater shows better results after the treatment with anodic oxidation than synthetic wastewater
- Elimination rates up to 99 % (pharmaceuticals (e.g. Carbamazepine), complexing agents approx. 50 %
- Problems with sample quality (ng/L-range)
- Max. flow rate 250 L/h (x4)
- Costs depends on current density (0,16-0,60 €/m³)
- Usage of an automatically sample unit
- Installation of an ozonation treatment system on the tech. scale unit
- Further optimisation of the treatment systems (costs for power supply, increased flow rate)
- Combination of both treatment technologies
- Balance influent/effluent/treatment unit of the investigated STP

Many thanks for your attention!

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KOMMUNAL KREDIT

Das Land Steiermark

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