DEMEAU

Demonstration of promising technologies to address emerging pollutants in water and waste water

Demonstration of advanced oxidation technology

UV/H_2O_2 processes

Dunea and WML

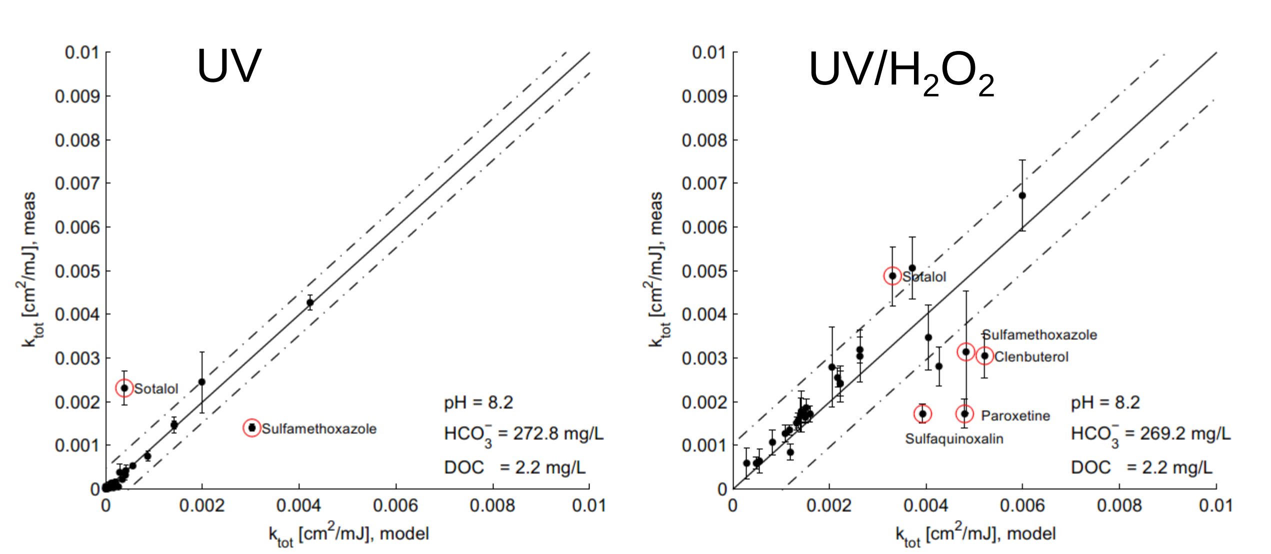
This project has received funding from the European Union's Seventh Programme for Research, Technological Development and Demonstration under Grant Agreement no. 308339.

Previous project (KWR, Wetsus, van Remmen, BTO):

- Kinetic model
  conversion of compounds as a function of UV dose
- CFD model
  UV dose distribution in reactor
- Combined model: conversion prediction in UV reactor

Accurate predictions by model for LP UV reactor, taking into account:

CO_3^{2-} and HCO_3^-, NO_3^-, NOM, temperature

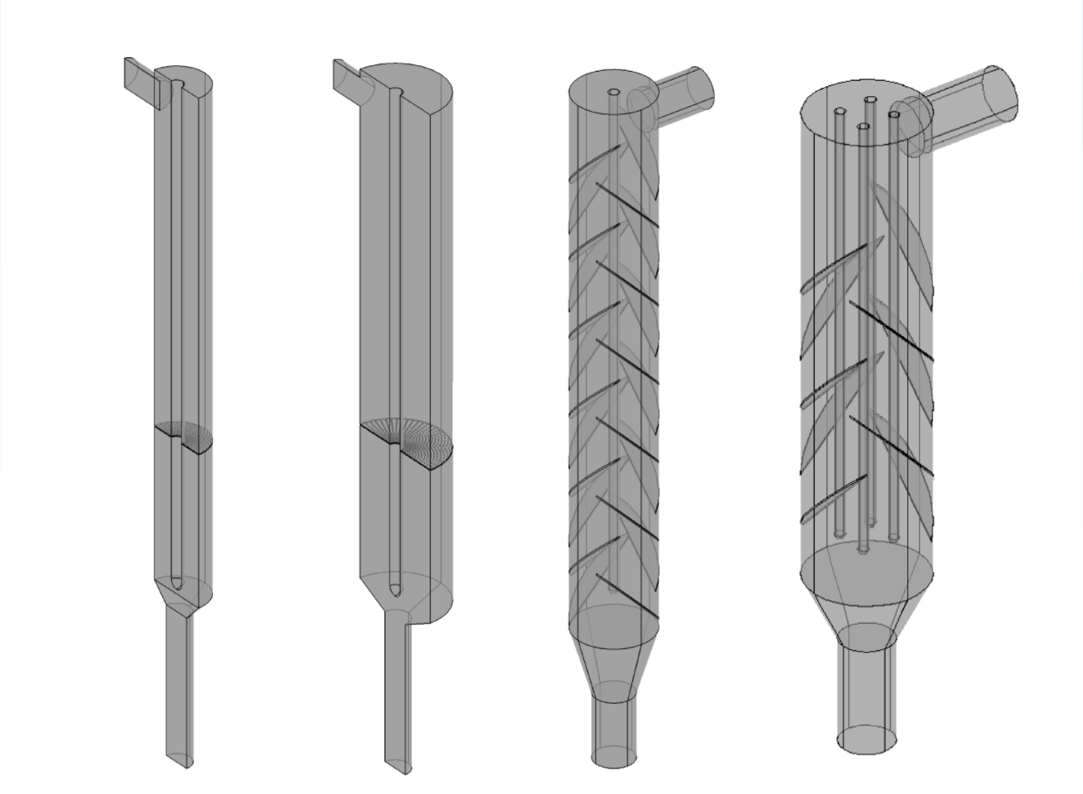


Model can be used to:

- Predict conversion of micropollutants in UV/H_2O_2 reactor
- Optimize geometry of UV/H_2O_2 reactor

Number of lamps, position of lamps, water layer thickness, etc.

Optimization of reactor geometry



Various types of reactors, differing in geometry

Dunea: 3 reactors

D200: optimized disinfection reactor (1 flow plate)
- one 120 W LP UV lamp
- 1 m^3/h
- Prediction: energy demand 20-30% lower

NEW: optimized by means of CFD for
- UV-T 85-90%: additional 5-15% energy savings predicted
- four 300 W LP UV lamps
- 10 m^3/h

Dunea: 3 reactors

CHAOS: design by van Remmen
ten 120 W LP UV lamps
10 m^3/h

35-40 pharmaceuticals, pCBA and atrazine

Effect water matrix determined in CB

Dunea: 3 reactors

Effect of water matrix:

Pretreatment by means of ACF or O_3/H_2O_2

Improvement in log degradation: 30-70%

ACF more efficient:

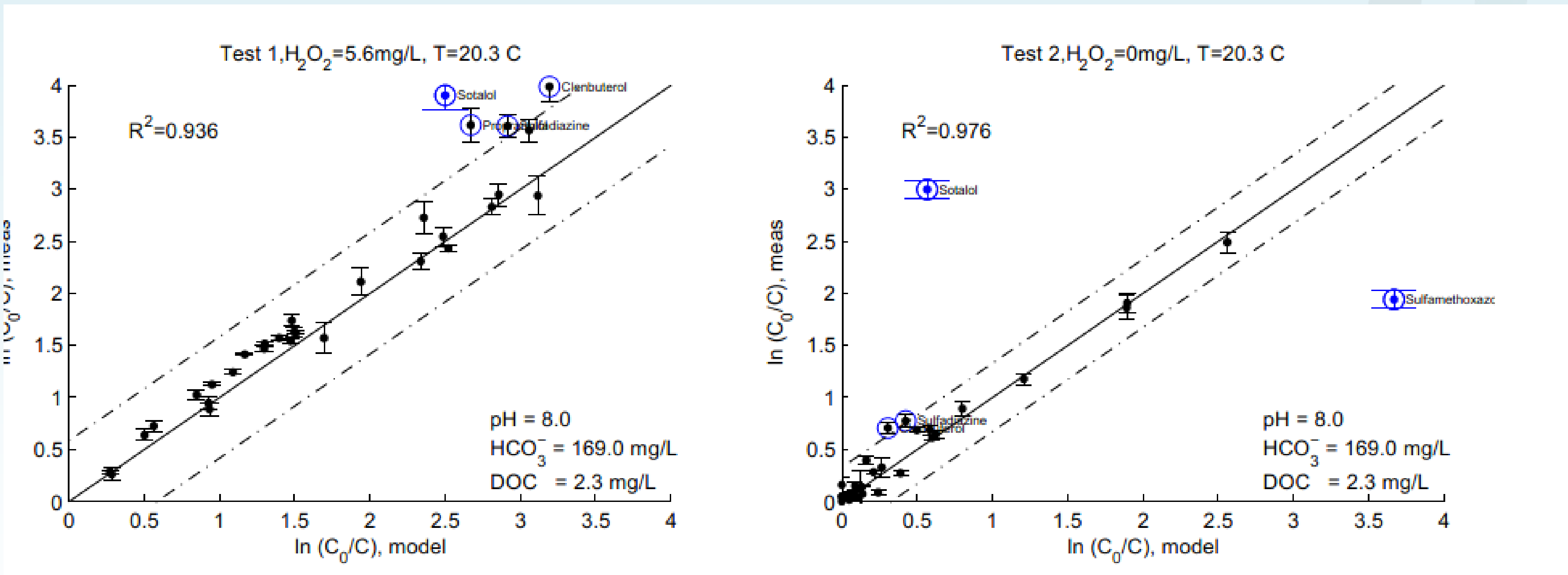
- higher UV-T increase
- DOC decreased

Dunea: 3 reactors

Efficiency increase:

- D200: 20-40% compared with disinfection reactor
- NEW: 5-10% compared with D200 for high UV-T (lower efficiency at lower UV-T) for all compounds
- CHAOS: 5-10% lower compared with D200. Higher mean UV-dose beneficial for some compounds. Compounds with high removal rate less efficient, due to high sensitivity towards UV dose distribution

Modelling of NEW reactor: good accordance



WML

D200 with 2 flow plates

First series: much higher conversion than predicted (average 92%)

Explanations:

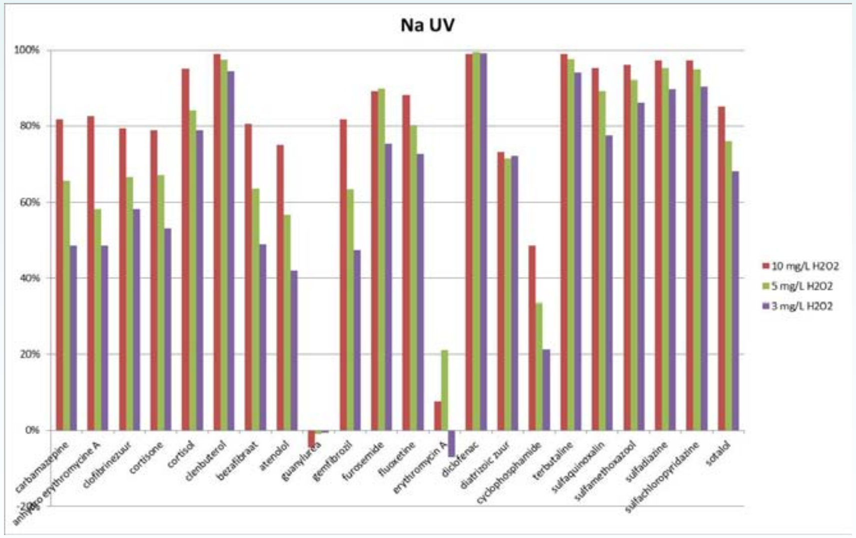
- high UV-T (93%), increased UV dose by reflection at reactor wall
- Increase of UV-T during experiment
- two flow plates in stead of one.

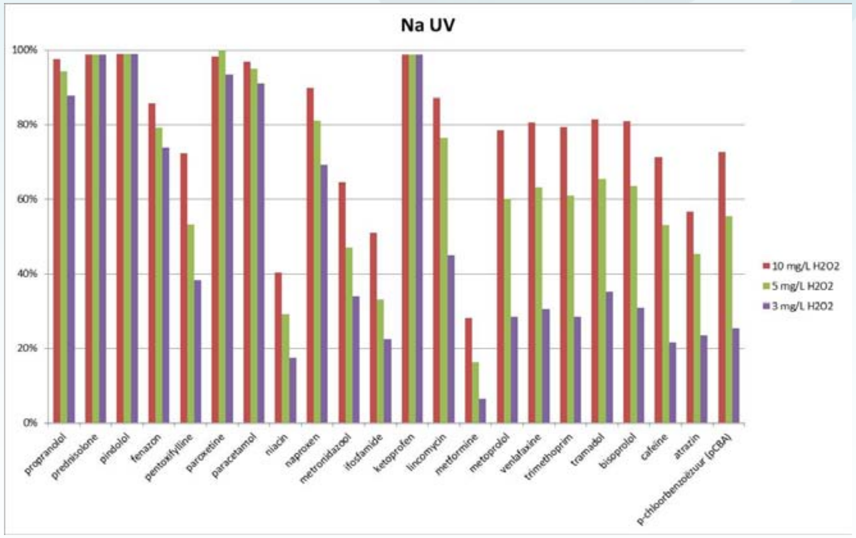
Demonstration at WML

Lamp power 80%, increased flow

Flow (m^3/hour)	UV dose (mJ/cm^2)	Predicted conversion (%)	Measured conversion (%)
1	601	84	90
1,5	401	75	85
2	301	68	81

Demonstration at WML, lower H_2O_2 concentration (10, 5 and 3 mg/L)

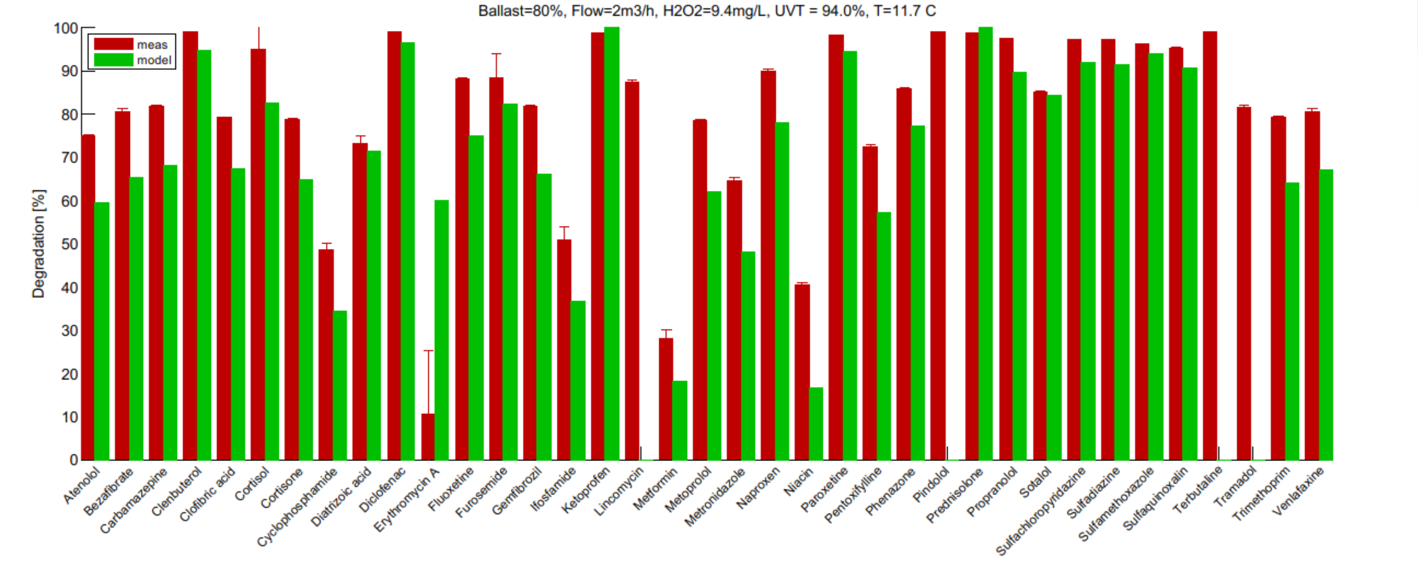




WML: predicted versus measured

Modeling: UV-T = 94%, but increases

Good reproducibility Nov. 2014 vs. March 2015



WML: metabolites

- Metabolites may be present in pretreated water
- Metabolites and transformation products can be formed or degraded by H_2O_2;
- conversion in UV/H_2O_2 process: more conversion at higher UV doses
- Lower H_2O2 concentrations: more metabolites/transformation products

Optimization:
Conversion of target compounds AND formation and conversion of metabolites and transformation products.

WML: formation of mutagenic byproducts?

Expectation: no problem, LP UV lamp, low NO_3^- content.

In general low responses

- Sometimes positive response, but never in duplo: sample ≠ mutagenic
- Positive response sometimes found in influent or in drinking water
- Responses are not increased by UV process

Operational Challenges

- How to implement AOP in an existing plant with UV for disinfection?
- Flexibility (modularity) required: optimal system setup and operation depending on (uncertain) future conditions (higher/extremer concentrations of OMP, as a result of climate change, demographic changes);
- What are decisive compounds, with (future) concentrations and standards, how does the complete system (reservoir, bank filtration) perform?
- Discussion precautionary principle versus curative solutions; AOP techniques may reduce intake stops;
- Focus wider than pharmaceuticals, pesticides bigger problem despite discharge WWTP upstream

Thank you for your attention!

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