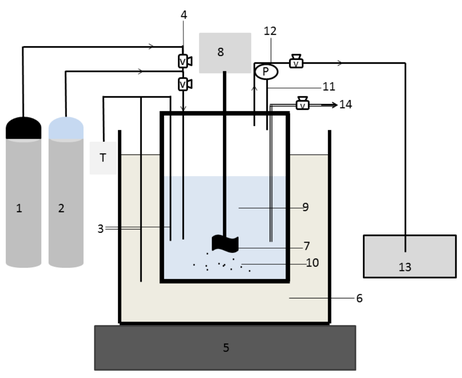
Industrial wastewater treatment – current research at the University of Oulu (Applied chemistry group)

Anne Heponiemi[1], Ville Kuokkanen[1], Hanna Prokkola[1], Emma-Tuulia Tolonen[1], Jaakko Rämö[3], Toivo Kuokkanen[1] and Ulla Lassi[1,2]

1. University of Oulu, Department of Chemistry, FIN-90014 University of Oulu, P.O.Box 3000
2. Kokkola University Consortium Chydenius, Talonpojankatu 2B, FIN-67100 Kokkola
3. University of Oulu, Thule Institute, FIN-90014 University of Oulu, P.O. Box 7300

Catalytic wet air oxidation (CWAO)

In the **AOPI-project**, the goal is to develop an eco-efficient hybrid process based on different **AOP** (advanced oxidation processes) techniques, **photocatalysis** and **CWAO** (catalytic wet air oxidation). The focus is on **wastewaters** with a **high and recalcitrant organic load.** In the CWAO, oxidizable aqueous **organic compounds** are decomposed at **elevated temperatures** (125-200 °C) and **pressures** (5-50 bar) in the presence of **catalysts** to intermediates, **CO_2 and water**. The schematic diagram of the CWAO reactor system are described in ***Fig. 1***.



1 Air
2 N_2
3 Temperature control
4 Valve
5 Heating plate
6 Oil bath
7 Impeller
8 Motor
9 Liquid sample
10 Catalyst
11 Pressure gauge
12 Gas sampling
13 Cold trap
14 Liquid sampling

Fig. 1. Schematic diagram of the CWAO experimental set-up.

Chemical precipitation

- As part of **SULKA-project** the enhancement of lime precipitation for **mine water** is investigated.
- Different **coagulants** and **flocculants** are studied for the improvement of the settling characteristics of the sludge.
- **Lime precipitation** as a pretreatment before other treatment methods such as adsorption is studied for **sulphate** removal from mine water as well.
- Also **by-products** from quicklime manufacturing which are largely considered waste have been tested succesfully for mine water treatment as substitutes for commercial lime products.
- Precipitation experiments are performed with the **jar test** presented in ***Fig. 1***.

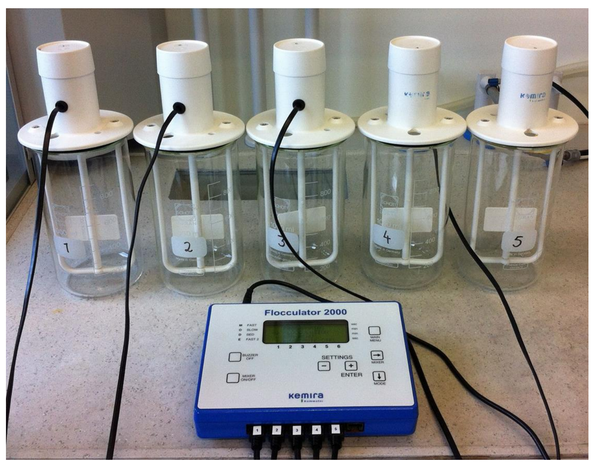


Fig. 1. The jar test device Kemira Kemwater Flocculator 2000.

This research is carried out with the financial support of the Council of Oulu region from the European Regional Development Fund (A32164, 524/2012).

Electrocoagulation (EC)

- In our research (also in **the RAE-project**), we have achieved very promising results in the treatment of various types of wastewater by EC such as acidic metal mining wastewater, phosphate mine wastewater, dairy wastewater and especially peat bog drainage water (***Fig. 1***)
- EC is an eco- and cost efficient method which has recently become subject to a vastly growing interest in the treatment of different types of water and wastewater.
- EC is **based on the dissolution of the anodic material** (Al or Fe) which is submerged in the aqueous solution being treated; the **cathodic reaction is H_2-gas and OH^- -generation**.
- **Advantages of EC** (over chemical coagulation): economic aspects (see caption in *Fig. 1*), significantly lower volume of sludge produced, avoidance of chemical additions, ease of automation, simple equipment and compact size of EC systems (allowing decentralized treatment), significantly greater functional pH and temperature range, pH neutralization effect as well as the presence of simultaneous electroflotation (EF).

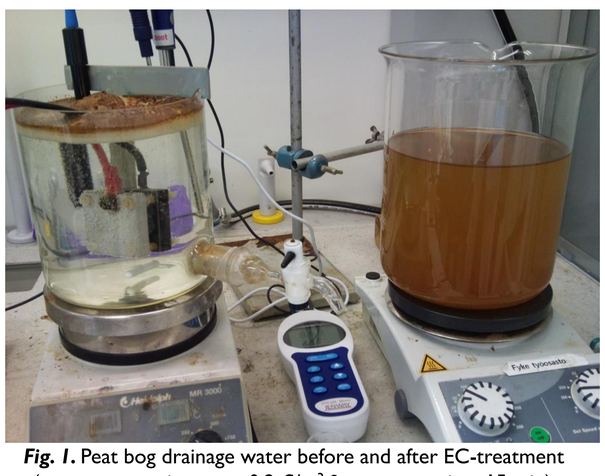


Fig. 1. Peat bog drainage water before and after EC-treatment (approx. operating costs 0,2 €/m^3 & treatment time 15 min).

Biodegradation

Biodegradation is "the own purification method of nature". **BOD value** is a quality parameter which is measured from wastewaters for controlling purposes and it describes the amount of oxygen consumed in biological reactions. Activated sludge process is a widely used purification method in wastewater treatment plants (WWTP) and is based on bacterial functions. Process conditions strongly affect the rate of biodegradation, and therefore we have modeled biodegradation of different samples in standard conditions (OECD 301F), natural waters, as well as in groundwater. We have used the manometric respirometric **BOD OxiTop -method** in the biodegradation measurements and supporting measurements as TOC and COD analyses. Different types of wastewater have also been examined: municipal WWTP´s and industrial sources (pulp and paper, potato refinery and various oily wastewaters). In addition, biodegradation of condensing waters from wood drying and gasification processes were studied in the **HighBio2 -project.** In conclusion, it can be said that conditions have a strong effect on spontaneous biodegradation and therefore it can be affected by optimizing them.

Fig. 1. OxiTop measuring system for liquid and solid measurements.

Leverage from the EU 2007–2013 · European Union European Regional Development Fund · ACADEMY OF FINLAND · JYVÄSKYLÄN YLIOPISTO KOKKOLAN YLIOPISTOKESKUS CHYDENIUS · UNIVERSITY of OULU OULUN YLIOPISTO