Chemical precision treatment of acid sulfate soils to prevent acid formation

2010 – 2018

Sten Engblom, Novia University of Applied Sciences
Pekka Stén, Vaasa University of Applied Sciences
Peter Österholm, Åbo Akademi University
Krister Dahlhem, Åbo Akademi University
Rainer Rosendahl, Pro Agria, Rural Advisory Centre of Ostrobothnia
Anders Grannäs, YA! Vocational Education and Training

Facts

There exist sulfides, e.g. pyrite FeS₂, in the coastal soils.

The coastal areas in Finland are subject to land uplift.

Soils have to be drained for several reasons.

When the groundwater table is lowered, sulfides are exposed to air and oxidized.

When sulfides are oxidized, sulfuric acid is produced, e.g.

\[ 4 \text{FeS}_2 + 15 \text{O}_2 + 14 \text{H}_2\text{O} = 4 \text{Fe(OH)}_3 + 8 \text{H}_2\text{SO}_4 \]

The result is acid drainage waters, which leach metals, e.g. Al.
Method

In our experiments, we mix treatment chemicals with irrigation water and inject the suspension into the environmentally critical subsoil using the subsurface drainage system.

Soil sample used in the laboratory experiments showing that it is possible to introduce CaCO₃ suspension into the soil via cracks and channels.
Facts about the Risöfladan Experimental Field:

- Twelve 1-hectare subfields
- Each subfield has its own drainage system consisting of subsurface drain pipes, a collector pipe and a control well
- Every subfield is surrounded by a plastic sheet that extends from about 0.4 m below the surface down to about 1.9 m
- The plastic sheet prevents water flow between the subfields, and between the subfields and the ditches
Subsurface drainage and irrigation

In the PRECIKEM project subsurface irrigation is done with suspensions of treatment chemicals.

Animation by Rainer Rosendahl

Modified from Paasonen-Kivekäs, Säätösalaojitus in Paasonen-Kivekäs, Peltomaa, Vakkilainen, Äijö (Ed.) Maan vesi- ja ravinnetalous, Salaojayhdistys 2009

Plastic film hinders by-pass flow

Animation by Rainer Rosendahl
Chemical treatments since July 2012

170 – 1 600 kg of chemical suspended in 100 – 400 m² of river water has been applied for a 1-hectare subfield

CaCO$_3$ (2,5 µm) and CaCO$_3$ (0,3 µm)
Ca(OH)$_2$
CaCO$_3$ (2,5 µm) + peat

Four reference subfields with only subsurface irrigation.

Chemical treatments applied to the Precikem subfields during 2012 - 2017

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</table>
**Following up the field experiments**

During seasons with a high groundwater table, waters from the control wells and groundwater pipes are sampled. Analyses include pH, EC, redox potential, major anions, and important metals.

Autumn 2014 visual inspection of the treated soil in the subfields took place by digging trenches perpendicular to the drain pipes down to, or below, drainage depth.
**Highlights of the results**

Evaluation was done by comparing the quality of the discharge waters from the treated fields to the discharge waters from the reference fields.

Best results were obtained with a CaCO$_3$ dose of 700 kg/hectare.

pH increased up to 2 units

In the best case acidity was halved

Al concentration decreased up to 95 %

Some effects can be obtained still, 5 years after the first treatments, but they fade as time passes and some were obvious only during ca. 2 years.

**Conclusions**

- Visual inspection showed that the treatment suspension has reached a few meters from the subsurface drainage pipes. This is sufficient to improve the quality of the discharge water from the treated subfield.

- We have been able to target the hydrologically active macropores and form buffering coating for the acidic groundwater.

- However, total S concentrations are similar in the discharge waters from the treated fields and the reference fields. Hence, sulfur oxidation is not affected.
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Two papers on laboratory experiments published


The paper on full scale experiments to be submitted this summer