Can on-site sanitation systems be up-graded with reactive filters?

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Research on reactive filters at Luleå University of Technology

< Evaluation methods to determine reactive filter materials' long term efficiencies>

< Blast furnace slag as a phosphorus sorbent>

< Combining reactive filters with willow beds>

< Ammonium adsorption in reactive filters >

< Sustainable and cost efficient small wastewater treatment systems in Northern Sweden>

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Evaluation methods to determine filter materials' long term efficiencies

- On-going project
- Financed by Formas (ends Dec 2012)
- Combining experimental work with modeling tools
- Co-operation project between divisions Architecture & Infrastructure and Fluid mechanics
- 2 PhD students: Inga Herrmann and Amir Jourak
- Supervisors: Ass prof Annelie Hedström
  Prof Staffan Lundström

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Preliminary results

- High phosphate reduction of tested material
- Total P reduction low

- Total phosphorus reduction depends on a combination of:
  - Properties of filter material (e.g. chemically and pore size)
  - Design of reactor (e.g. size, hydraulic load, location of out-let)

- The model fit the phosphate reduction rather well but not the total P removal

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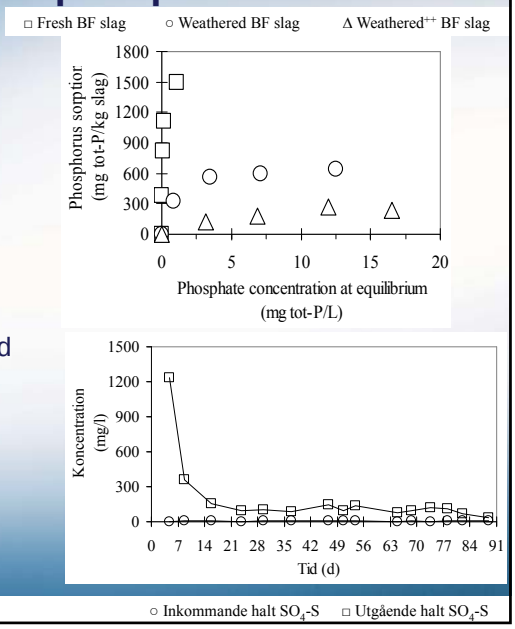
Blast furnace slag as a phosphorus sorbent

- Finished project
- Batch, column and pilot experiments

- Interesting results
  - Phosphorus sorption capacity strongly correlated to age of slag (exposed to precipitation and weathering processes)
  - Leakage of sulphuric compounds



Sustainable and cost efficient small wastewater treatment systems in Northern Sweden

- 2010-2011
- Region Västerbotten
- Guidance for supervisory authorities to handle SEPA:s guidelines for small scale wastewater treatment systems
  - ”Normal och hög skyddsnivå”
  - Improved routines for good infiltration systems
  - One master thesis project with “phosphorus traps”

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“Phosphorus trap” project

Experimental set-up

- Existing system
- Grab sampling
  - Influent & effluent
- Total P concentrations

Results

- Higher effluent concentrations than influent concentrations
- Even if limited study, that P trap seemed not to be efficient

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Possibilities – Up-grading existing on-site sanitation systems

Aim:

Increase the P removal capacity of the system
Design a system which facilitate reuse of P

- Sand filter beds are most suitable to up-grade
  - Pre-treatment step
- Prefabricated units
- Robust system – limited supervision – “almost as before”

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Limitations - existing systems

- Still about 25 % of on-site sanitation systems only consist of a septic tank
  - These can not be up-graded without a pre-treatment unit
  - Clogging problems
- Sand filtration beds are easiest to up-grade
  - Status of existing system important
  - Hydraulic aspects (clogging or infiltration)
- Approximately 10 % of existing systems can be up-graded with reactive filters
- Existing systems can be *exchanged* by new system, e.g. reactive filter systems.

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Limitations – materials and reactors

- Few materials are commercially available
- High “laboratory” P sorption capacity
- Reactor design seems to be important
  - Necessary to investigate the performance of the materials with the intended reactor
  - Especially important when materials and reactors are developed by different actors

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Limitations – Cost & performance

- Large filter systems (40 m^3)
  - expensive but robust
- Small filter systems (~1 m^3)
  - cheaper
  - shorter retention time – not as stable removal P process
  - More supervision

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Operating routines?

Up-grade of existing on-site system

- Smaller/cheaper filter units (”P-traps”)

- Filter material P saturation occur rather often (<1 year to 3-5 years)
- When exhausted?
  - pH for Ca-based filter materials?
  - More research is needed to verify this methodology in relation to P reduction in practice

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Operating routines and organisation?

- Service contract?
- Delivery of fresh reactive filter materials
- Infrastructure for exhausted materials
  - Reuse
  - Health aspects?
  - Municipalities' responsibility?

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Can small-scale wastewater treatment system be up-graded with reactive filters?

If sustainable…

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Sustainable?

High P removal potential

Environment

esource efficiency

ife cycle perspective

Material production

Reuse of P

Technically possible

Bioavailability

rge systems robust – User friendly

gh pH – hygienic aspects ~ OK

Social

Development of more robust small reactive filter systems

*Hydraulic development
*Secondary materials
*Regeneration of filter material

”Cheap” / expensive

Economic

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