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Swedish Agency for Marine and Water Management

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PILOT PLANT IN SVEDALA

Michael Cimbritz and Åsa Davidsson
Lund University

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Background – R&D in Sweden

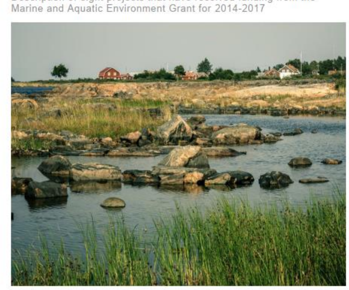
For four years, from 2014 to 2017, the Swedish Agency for Marine and Water Management was assigned by the government to promote advanced treatment of wastewater by supporting projects in order to develop treatment methods for municipal treatment plants.

[Treatment techniques for pharmaceuticals and micropollutants in wastewater - Publications - Swedish Agency for Marine and Water Management (havochvatten.se)]

Swedish Agency for Marine and Water Management

Treatment techniques for pharmaceuticals and micropollutants in wastewater

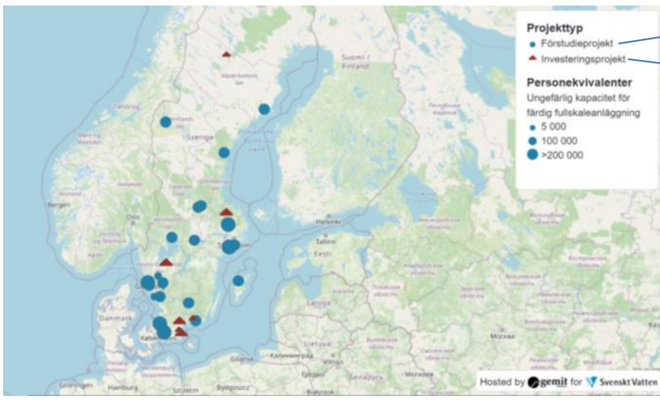
Description of eight projects that have received funding from the Marine and Aquatic Environment Grant for 2014-2017



Swedish Agency for Marine and Water Management report 2018:7

Background

Swedish EPA are supporting pre-studies and investments in full-scale plants



Feasibility studies

Full-scale investments

www.svensktvatten.se

Involved in Swedish pilot plant

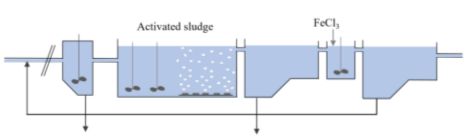
- Lund University, Department of Chemical Engineering
- Sweden Water Research AB
- Kristianstad University
- Svedala Municipality (hosting the plant)

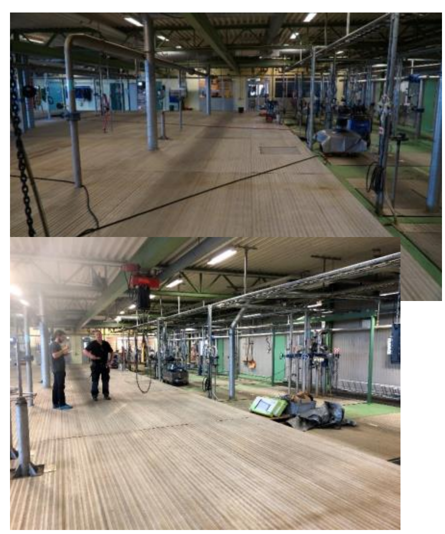
Wastewater treatment plant in Svedala

Loading: 12 000 PE (mainly domestic WW)
Biological and chemical wastewater treatment:

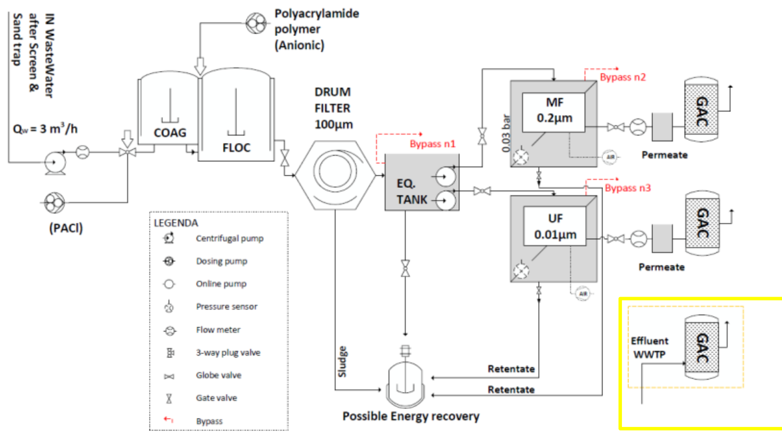
- No primary treatment
- Activated sludge (pre-denitrification)
- Post precipitation ($FeCl_3$) and tertiary settling

No anaerobic digestion of sludge





Pilot plant in Svedala



Two test lines:

1) Influent wastewater to direct membrane filtration (DMF) + GAC
2) Biologically treated wastewater to sand filter + GAC

Direct membrane filtration and GAC in Svedala

Membrane unit

GAC columns

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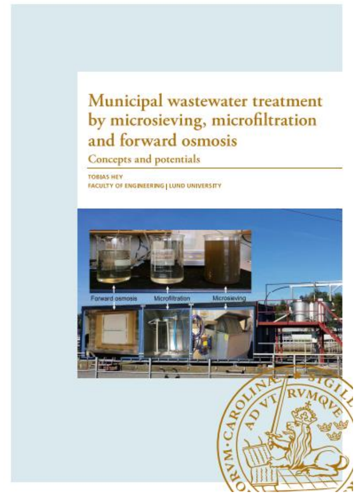
Direct membrane filtration and GAC in Svedala

By introducing microsieving and membranes early in the process line an improved treatment process and enhanced potential for reuse of energy and water could be expected

- Wastewater treatment ➔ high energy consumption
- Adding removal of organic micropollutants ➔ even higher energy consumption

Instead: separate organic matter and use it for generation of energy (biogas production)

and add GAC at the end



Technical data

		Direct membrane filtration + GAC	Effluent GAC-filtration
Chemically Enhanced Primary Treatment (CEPT with filtration)	Coagulation tank (m^3)	0.2	
	Flocculation tank (m^3)	0.8	
	Coagulant dosing	In pipe (5-15 mg Al^{3+}/L)	
	Coagulant[a]	Polyaluminium chloride	
	Polymer dosing	Overflow to floc. tank (1-4 mg/L)	
	Polymer[b]	Anionic	
	Drum filter[c] area (m^2)	0.33	
	Pore filter opening (um)	100	
	Filtration rate[d] (m/h)	8-9	
	Equalization tank volume (m^3)	0.6	
Direct Membrane Filtration	Membrane tank dimensions (m)	H: 2.35, W: 0.5, D: 1.5	
	Membrane surface area (m^2)	40	
	Cut-off (MWCO) UF[e] (Da)	10 000	
	Pore size MF[f] (µm)	0.2	
	Design flux[d] (L/m^2h^{-1})	25	
GAC Filtration	GAC column height (m)	0.54	0.54
	GAC column volume (L)	19	19
	GAC cross section area (m^2)	0.04	0.04
	Mass of carbon[g] per column (kg)	5.98	5.98
	EBCT[d] (min)	10	10

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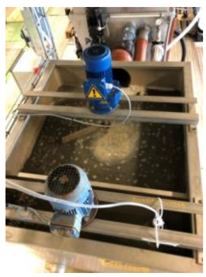
Chemically Enhanced Primary Filtration

CEPT based on microsieving previously developed (in cooperation) at Lund University

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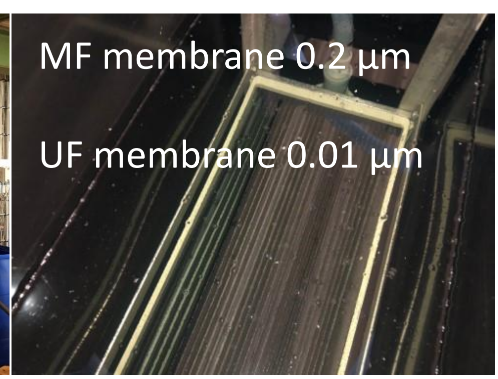
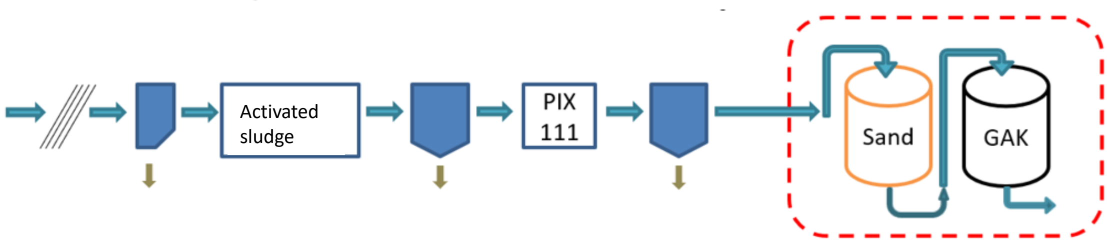
Membrane filtration

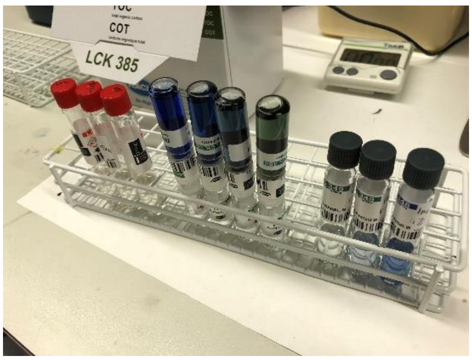
GAC columns


Effluent WW ➔ Sand filter + GAC



Analyses

Pharmaceuticals, biocides and other organic micropollutants – reflecting Watch lists and other compilations of relevant indicators



Ämnen för utvärdering av avancerad reningsteknik

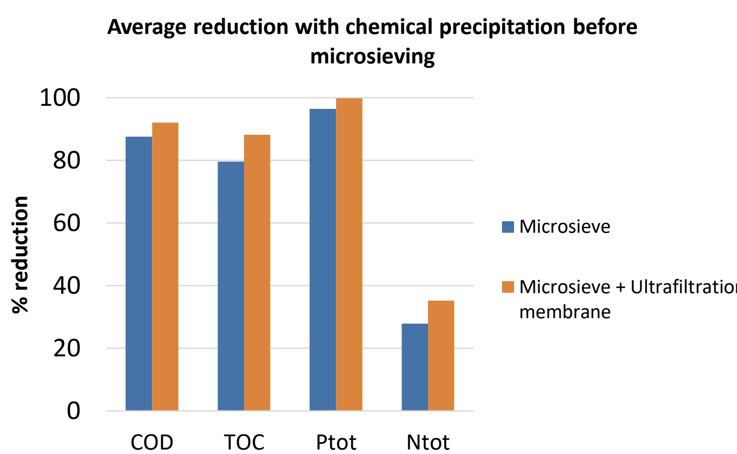
Listan är baserad på ämnen upptagna på EUs 1st Watchlist och Läkemedelsverkets lista från 2015. Ämnesurvalet täcker väl in en rad aspekter som är viktiga vid utvärdering av avancerad rening såsom; halter (hög och låg), varierade kemiska egenskaper och relevans ur ett miljö- och hälsoperspektiv.

1 Acetamiprid
2 Atenolol
3 Bisphenol A
4 Carbamazepine
5 Ciprofloxacin
6 Citalopram
7 Clarithromycin
8 Diclofenac
9 Erythromycin
10 Estrone
11 Fluconazole
12 Furosemide
13 Ibuprofen
14 Imidacloprid
15 Ketoconazole
16 Losartan
17 Methotrexate
18 Metoprolol
19 Naproxen
20 Oxazepame
21 Paracetamol
22 PFOA
23 PFOS
24 Propranolol
25 Sertraline
26 Sulfamethoxazole
27 Tramadol
28 Trimethoprim
29 Venlafaxine
30 Zolpidem

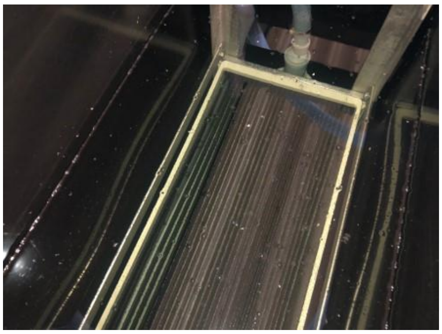
MoLab, Högskolan Kristianstad
Ola Svahn och Erland Björklund

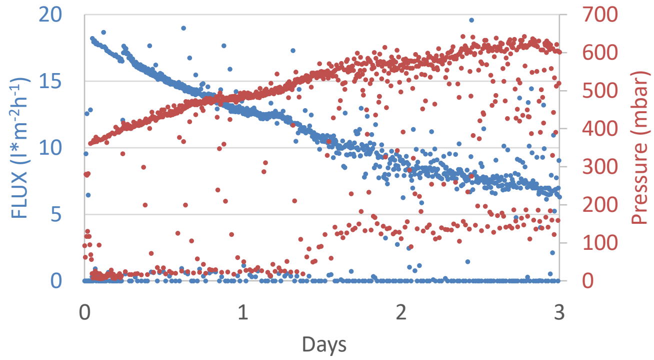
Results DMF line

- High reduction of organic matter and phosphorus
- Moderate reduction of nitrogen
- Coagulation/flocculation + microsieving is very efficient

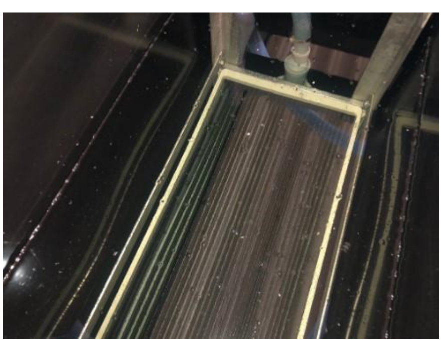


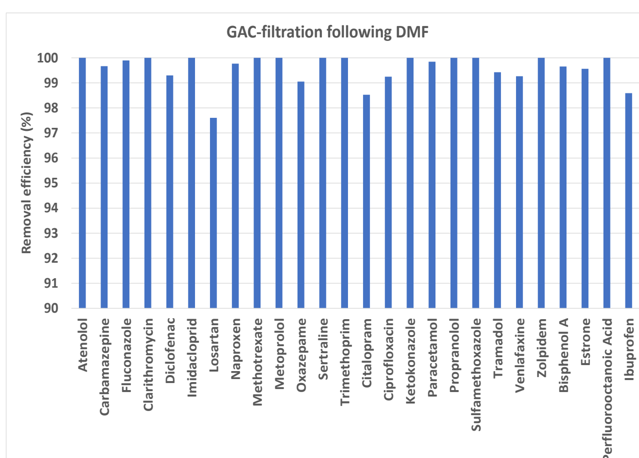
Fouling of membranes ➔ no long-term operation of GAC



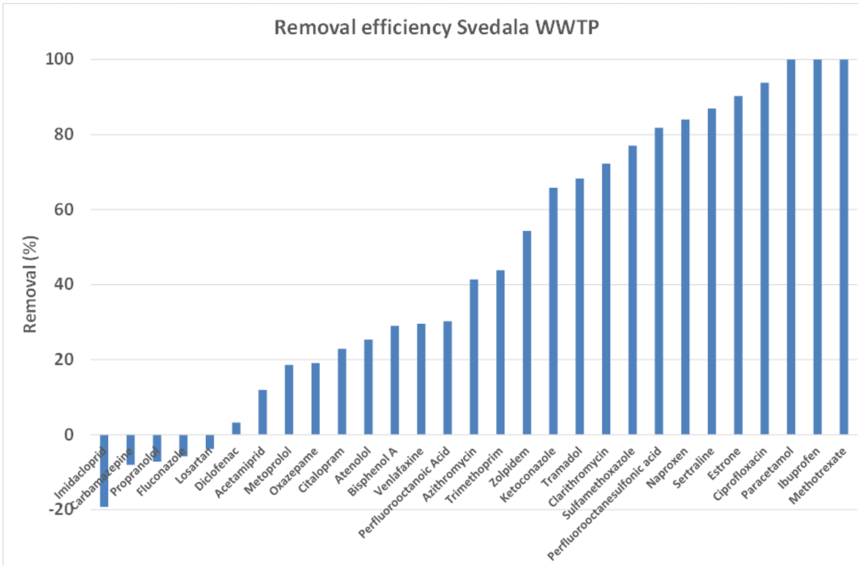


Short-term operation of GAC after UF





Short-term GAC after UF ➔ 98-100% removal of organic micropollutants
No removal in membrane filtration part



Results – effluent GAC

	3000 BV	8000 BV	18000 BV	22600 BV
Metoprolol	96%	97%	81%	50%
Losartan	84%	72%	42%	27%
Atenolol	97%	97%	75%	48%
Diclofenac	87%	74%	47%	27%
Tramadol	96%	94%	60%	37%
Carbamazepine	95%	91%	63%	40%
Venlafaxine	96%	92%	58%	38%
Oxazepame	93%	86%	60%	34%
Citalopram	99%	98%	88%	71%
Naproxen	86%	80%	48%	25%
Erythromycin	100%	69%	29%	-18%
Trimethoprim	97%	97%	91%	51%
Bisphenol A	79%	87%	71%	35%
Sulfamethoxazole	84%	60%	17%	-44%
Propranolol	98%	98%	94%	74%
Fluconazole	79%	65%	38%	19%
Sertraline	100%	100%	100%	100%
Ketokonazole	100%	100%	100%	85%
Imidacloprid	91%	93%	65%	38%
Clarithromycin	100%	80%	72%	-13%

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Supplementary studies

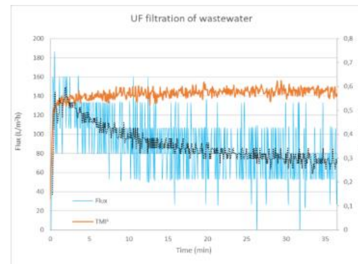
Differentiation between adsorption and degradation

Competition for adsorption onto activated carbon

In-depth of a GAC filter

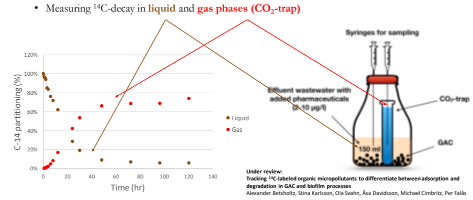
Evaluation of energy re-use

Water re-use potential



Degradation or adsorption in GAC?

- Measuring ^{14}C-decay in liquid and gas phases (CO_2-trap)



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QUESTIONS?

CONTACT

LUND UNIVERSITY

LEAD PARTNER
Lund University

Åsa Davidsson
asa.davidsson@chemeng.lth.se

Michael Cimbritz
michael.cimbritz@chemeng.lth.se