ECONOMIC AND ENVIRONMENTAL ASSESSMENT OF SLUDGE TREATMENT IN REED BED SYSTEMS

28 YEARS OF EXPERIENCE

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New Zealand Land Treatment Collective
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SLUDGE TREATMENT IN REED BED SYSTEM (STRB)

Large scale system and experience through 28 years

Helsingø Sludge Treatment Reed Bed System

28 Years of experience with Sludge Treatment Reed Bed Systems (STRB)

- 42,000 PE
- 630 tons ds per year
- Activated sludge
- 14 Basins
- Greenhouse/Stockpile area
- Into service
  - 10 Basins (1996)
  - 4 Basins (2013)
- 2.2 Ha

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- STRB experience: 28 years (employed in Orbicon for 28 years)
- International papers: more than 30 papers
- Member of IWA - Group: Wetland Systems for Water Pollution Control
- Member of: The scientific comity for 16. Conference Wetland Systems for Water Pollution Control
- Member and one of the founding fathers of GWT: Global Wetland Technology
- Responsibilities and key tasks
  - 1. Product development and research
  - 2. Dimensioning, Design, Construction, Running in and Operations
  - 3. Publications and Conferences
  - 4. Sales and marketing

References:
- More than 50 systems in Denmark, Sweden, Norway and England
- World largest system for treatment of water works sludge (Hanningfield (UK)
- Research projects with Danish DEPA and with more than 5 International Universities incl. cooperation with a number of research institutions and to supervise researchers and PhD students.
System Process and Product

Long-term sludge reduction in reed beds
Overall functionality
- Dewatering
  - Draining
  - Evapotranspiration
- Aeration
- Mineralisation

Sizing
- Sludge production (tonnes of dry solids per year)
- Sludge quality (fat-content, CST)
- Sludge type (type of production)
- Climate (evaporation)
- Periods of operation
- Area loading rate
- Number of basins Basin capacity

Loading pipes
Aeration Pipes

VALVE BUILDING

BUFFER TANK

Pump

- Pump capacity
- Sludge distribution (hole surface)
- Batch size
- Quota
- Basin area (no. of loading pipes)
THE REEDS
- Quality of the reeds
- Establishment of the reeds
- Weed control
- Effect of sludge

Operations and Control

Scada
- Management/Regulation
- Monitoring/Supervision
- Data handling

OPERATION AND CONTROL
Overview
Helsingé STRB - Sludge residue height

Sludge residue height in Basin #1, 1997-2011 - Yearly growth of 13-15 cm

Generel Maintenance

- General areas (green keeping)
- Scale Poles
- Ventilation
- Equipment
- Sludge pump
- Fences, Buildings, Valve, Wells, pumping stations
- Weeds

Winter Operation
Tidaholm STRB (Sweden)

- Physical frames
- Operation
- Effect of frost

Quality of the sludge after treatment
### Legislation on heavy metals and hazard organic compound in sludge for agricultural use

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td><strong>Heavy metals</strong></td>
<td>(mg pr. Kg DS)</td>
<td>(mg pr. Kg DS)</td>
<td>(mg pr. Kg TP)</td>
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<tr>
<td>Cadmium</td>
<td>20</td>
<td>10</td>
<td>-</td>
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<tr>
<td>Copper</td>
<td>185-1750</td>
<td>1500</td>
<td>150</td>
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<tr>
<td>Nickel</td>
<td>300-650</td>
<td>350</td>
<td>30</td>
</tr>
<tr>
<td>Lead</td>
<td>750-1600</td>
<td>150</td>
<td>1500</td>
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<tr>
<td>Zinc</td>
<td>260-480</td>
<td>2900</td>
<td>680</td>
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<tr>
<td>Mercury</td>
<td>15-25</td>
<td>10</td>
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<table>
<thead>
<tr>
<th>Organic contaminants</th>
<th>(mg pr. Kg TP)</th>
<th>(mg pr. Kg EF)</th>
<th>(mg pr. Kg TC)</th>
<th>(mg pr. Kg TF)</th>
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<tbody>
<tr>
<td>LAS</td>
<td>-</td>
<td>2600</td>
<td>1500</td>
<td>-</td>
</tr>
<tr>
<td>PAH</td>
<td>-</td>
<td>8</td>
<td>9</td>
<td>-</td>
</tr>
<tr>
<td>NPE</td>
<td>-</td>
<td>30</td>
<td>10</td>
<td>-</td>
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<tr>
<td>DEHP</td>
<td>-</td>
<td>190</td>
<td>90</td>
<td>-</td>
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</table>

### Sludge residue quality parameters prior to emptying (± standard deviation) and Danish legal limits.

The data presented are average values based on 8-10 pooled samples.

<table>
<thead>
<tr>
<th>Sludge residue after final treatment</th>
<th>Hadsund (lat)</th>
<th>Hadsund (lon)</th>
<th>Halsborg (lat)</th>
<th>Halsborg (lon)</th>
<th>Kolding (lat)</th>
<th>Kolding (lon)</th>
<th>Average (lat)</th>
<th>Average (lon)</th>
<th>Danish limit</th>
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<tbody>
<tr>
<td>Chlorides</td>
<td>895</td>
<td>276</td>
<td>601</td>
<td>784</td>
<td>547</td>
<td>338</td>
<td>773</td>
<td>227</td>
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<tr>
<td>Phosphates</td>
<td>200</td>
<td>300</td>
<td>400</td>
<td>500</td>
<td>600</td>
<td>700</td>
<td>550</td>
<td>650</td>
<td>000000</td>
</tr>
<tr>
<td>Organic contaminants</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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</tbody>
</table>
Reduction of pathogenic micro-organisms
Section of sludge residue and sampling sites

Salmonella (CFU/g ds)
Depth: 0 – 10

Enterococci (CFU/g ds)
Depth: 0 – 10

E. Coli

Salmonella : 0 - 10 cm
(Helsinge Sludge Reed Beds - basin no. 8)

Enterococci (CFU/g ds)
Depth: 0 – 10

E. coli : 0 - 10 cm
(Helsinge Sludge Reed beds - basin no. 8)
Mineralisation of digested sewage sludge
Kallerup STRB (Denmark)

NPE (Nonyl Phenol Ethoxylate)
- Loaded mass (kg) 0.3
- Remaining mass (kg) 0.02
- Reduction (%) 94

LAS (Linear Alkylbenzene Sulfonate)
- Loaded mass (kg) 24.5
- Remaining mass (kg) 0.4
- Reduction (%) 98

Environmentally friendly operation

- Operational reliability
- Long-term sludge solution
- Flexible operation
- No problems with winter operation
- Very low operational costs and low energy
- Release of waste water treatment capacity
- No use of chemicals (polymers) for dewatering

Environmentally friendly operation

- Better working environment
- Non-polluting dewatering
- Reduction of CO2 and NOx emission
- Reduction of transportation costs
- Mineralisation of Hazardous Organic Compounds
- Good reduction of the Pathogenic micro-organisms
- Recycling of the sludge residue

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Emptying
Re-generation of the reeds
recycling/reuse
Skovby STRB (Denmark) - Emptying

- Emptying

Skovby STRB (Denmark) – Regrowth of reeds


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Nordborg STRB (Denmark) - Emptying May 2011

Nordborg STRB (Denmark) Emptying (May 2011)

Steen Nielsen (smn@orbicon.dk)
Nordborg STRB (Denmark) – Stock Pile area
Recycling in August/September 2011

Emptying
Re-generation of the reeds recycling/reuse

Helsinge STRB (Denmark)
Green house – Solar Drying of Sewage Sludge

- 42,000 PE
- 630 tons ds per year
- Activated sludge
- 14 Basins
- Greenhouse/Stockpile area
- Into service
  - 10 Basins (1996)
  - 4 Basins (2013)
- 2.2 Ha

Dehua Site Visit
Helsinge STRB (Denmark)
20 years of experience with the emptying and recycling of STRB-biosolids

More than 30 systems and 200 basins have been emptied

Over 130,000 tonnes of biosolids from STRBs have been spread onto nearly 10,000 hectares of Scandinavian agricultural land over the past 20 years.

No reports of disturbances to natural wildlife, fauna or agriculture (no regrowth of reeds)
Life cycle

Combined system and Test system

Kallerup STRB (Denmark)
Sludge Treatment and Storm Water Basin

Kristianstad STRB (Sweden) – Trial System
Treatment of Water Works sludge

Hanningfield Water Works system (UK)

Reservoir Facts
• Capacity: 27 billion litres/year
• Maximum depth: 17 metres
• Surface area: 354 hectares

Water Works Facts
• Water production: 150 million litres/day
• Product of sludge: 1,275 tonnes ds per year
Hanningfield (England – Water Works Sludge)
Sludge treatment Reed bed System

References

Greve STRB (Denmark)
60,000 PE
1,000 tonnes of dry solids per year
10 basins (3.3 ha)
Kolding STRB (Denmark)

- 125,000 pe – 2,200 tonnes ds/year
- Activated sludge 66% - Digested sludge 33%
- Into service 1998 and 13 basins - 6.2 Ha

Skøvde STRB (Sweden)

Skøvde Sludge Treatment Reed bed System
1,200 tonnes of dry solids per year - 10 basins

Sorø STRB (Denmark)

Sørø Sludge Treatment Reed bed System
550 tonnes of dry solids per year - 10 basins

Helsinge STRB (Denmark)

Helsinge Sludge Treatment Reed bed System
630 tonnes of dry solids per year - 10 basins
Rudkøbing STRB (Denmark)

Esbjerg STRBs (Denmark)

Economy
Thank you for your attention

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