Deammonification in the Mainstream and Sidestream for Wastewater Works

Agenda

- DEMON & EssDe introduction
- Poole STW DEMON installation
- EssDe mainstream treatment

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Presented By

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ReGenerator Concept

The ReGenerator® Concept //

We are used to the term ‘Energy Factories’.

The ReGenerator® Concept =
(Energy + thermal + nutrients + water resource) factories + business change

ReGenerator® incorporates:
- Maximised OPEX savings and carbon footprint reduction.
- Sustainable integrated solutions.
- Grontmij tools to assist clients, suppliers and designers to change their culture/approach.
- RGC Roadmap/Blueprint for end users.
- Use of new technologies such as DEMON and EssDe
DEMEN® 10 yrs of Development to arrive at EssDe

**DEMEN Continuous Development:**

- **SHARON 1998**
- **DEMON 2004**
- **INCREASED CAPACITY**
- **CONTINUOUS FED 2011**
- **ESSDE 2012**

**DEMEN**

- De-ammonification of sludge high strength NH₄ liquors
- ReGenerator Principle: De-coupling of Carbon from NH₄ removal.
- 40% less energy costs since only 55% of NH₄ is oxidised to Nitrite.
- Zero Carbon source requirement.
- Zero Caustic Soda solutions available.
- No sensitivity to phosphate in liquors.
DEMON® & SHARON Installed Capacity
**DEMON® – Batch Vs Continuous**

**Oxygen control**
0.3mg/l O2

**pH control**
(Nitrite)

**Sludge age control**
Cyclone

**Process control**

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**DEMON Batch**
- 8hr Cyclic process (fill, intermittent aeration, settle, discharge.
- Need for Influent & effluent balancing tanks
- No (external) sludge settling or return
- Higher OC

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**DEMON Continuous**
- Higher volumetric loading (smaller tank)
- No influent/effluent buffer tank
- Sludge recycle required via settlement tank
- Lower OC
Energy Self Sufficient by De_mon (EssDE):

Main WWTP: inoculated with DEMON-sludge (AOB’s and de-ammonifiers)
De-ammonifiers are retained in main WWTP by cyclone in waste sludge line
De-ammonifiers outcompete NOB’s by reduced DO levels and increased WAS flows
Alternating oxic and anoxic conditions comparable to normal control of heterotrophic denitrification
Energy Self Sufficient by De-mon (EssDE):

- Low temperature / low ammonia concentration
- Biggest potential at low BOD/N-ratio in water line
- No BOD required, all available for digestion
- Increased nitrification capacity
- Smaller footprint because of lower SVI.
- Improved sludge settling
- 25 - 30% energy savings in nitrifying ASPs

Glarnerland (200,000PE)

<table>
<thead>
<tr>
<th>kWh/month per lane</th>
<th>Without EssDe</th>
<th>With EssDe</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>October 2008 – April 2010</td>
<td>May 2010 – September 2011</td>
</tr>
</tbody>
</table>

0 10,000 20,000 30,000 40,000 50,000 60,000

2010/2011 NO3-N effluent

1-Dec 31-Dec 29-Jan 29-Feb 29-Mar 29-Apr 29-May

nitrogen concentration (mg N/L)
**DEMON® Thermal Hydrolysis Installations - Inhibitors**

**Evidence**
- Washington DC Blue Plans WwTW scheme (Cambi THP with MAD and DEMON LTP) paper findings:
  - Inhibitors present caused by inert soluble COD.
  - Adaptation started to occur after 40 days.
  - Solution was to re-rate the DEMON NH₄ removal rate.
- Research by Innsbruck University concluded AOBs inhibited by volatile fatty acids (VFAs). Grontmij seen evidence of this at SHARON sites & bench tests with DEMON.

**Solutions**
- Dilution
- Oxidise the VFAs upstream of the DEMON.
- Modify the DEMON feed controls.
Mainland Europe 2013 installations - DEMON®

Amersfoort DEMON:
- Continuous feed design
- 700Kg/d NH3 removal
- Removal efficiency 85% on NH₄⁺
- Salsnes filter for centrate TSS peak shaving
- Stage 2 contract just awarded for THP using Lysotherm and Phosphorus recovery using PEARL technology.
- Stage 2 will create an energy positive ReGenerator site (2GWhpa elec export)

Other 2013 Schemes:
- SNB 1600kg N/d
- Echten 400kg N/d
- Nieuwveer 1000 kg N/d
- Velsen 180 kg N/d
- Attero Spinder (landfill leachate) 1111 kg N/d
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Poole STW – DEMON® Installation

 DEMON :
- Existing SBR.
- High Operational costs due to Caustic dosing.
- Operational issues due to solids wash out.

Financial:
- Retrofit 1st UK Site.
- CAPEX £600,000 including local improvements
- Opex reduction from £0.91/kg to £0.10/Kg NH₃
- Payback 4yrs
Poole STW – DEMON® Installation

Key process parameters
- Loads: 305 kg/d NH$_4$-N to 459 kg/d NH$_4$-N
- Flow: 709 m$^3$/d to 907 m$^3$/d
- Temperature: 25°C
- Influent alkalinity 1.3 mol/mol
- Reactor volume 2500 m$^3$ (required 600 m$^3$)
- Influent Bal Tank 1800 m$^3$ (required 150 m$^3$)
- Effluent Bal tank 320 m$^3$ (required 320 m$^3$)
- Design efficiency 85% NH$_4$ removal
## Poole STW – DEMON® Installation

<table>
<thead>
<tr>
<th>Item</th>
<th>SBR</th>
<th>DEMON</th>
<th>Changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instruments</td>
<td>MLSS, pH, DO, NH₃</td>
<td>pH, DO, NH₃, NO₂</td>
<td>New instruments</td>
</tr>
<tr>
<td>Flow Meter</td>
<td>Centrate, SAS, discharge</td>
<td>Centrate, SAS, discharge</td>
<td>Re-programmed</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>VSDs required</td>
</tr>
<tr>
<td>PLC</td>
<td>SBR</td>
<td>DEMON</td>
<td>De-rated blowers</td>
</tr>
<tr>
<td>Centrate feed pumps</td>
<td>350m³/hr</td>
<td>65m³/hr</td>
<td>De-rated</td>
</tr>
<tr>
<td>Blowers</td>
<td>3,500Nm³/hr</td>
<td>900Nm³/hr</td>
<td>New cyclone</td>
</tr>
<tr>
<td>SAS pump</td>
<td>90m³/hr</td>
<td>20m³/hr</td>
<td></td>
</tr>
<tr>
<td>Cyclone</td>
<td>Not required</td>
<td>20m³/hr</td>
<td></td>
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</table>
Deammonification in the Mainstream and Sidestream for Wastewater Works

Poole DEMON® - Commissioning

**Reactor and liquor temperature**

- **Ideal** reactor liquor temperature \( \pm 25 ^\circ C \)
- **Historically** SBR liquors post secondary digestion with washwater \( 17 ^\circ C \)
- **Actual** reactor liquor temp during initial commissioning \( 11 ^\circ C \).

= very slow De-ammonification growth

**Solution**

- Temporary reactor heating required
- Possible assisted heating required in extreme future winter conditions.

**Lessons learnt** – commission with warm liquors, consider heat losses through digestion and dewatering plant for impact on liquor temp.
Poole DEMON® - Commissioning

**Balancing tank Mixing**
- Recorded increase in NO₂⁻ during non aeration
- Physically impossible
- **Explanation** – consequence of air mixing causing partial nitrification in Balancing tank
- **Lesson learnt** – do not re-use air mixing in balancing tank

**Operation**
- Wessex Water needed Process Scientist on site to operate and maintain the DEMON process
- Provided Process training & remote SCADA access for trend explanation assistance.
- Wessex Water on a journey to match mainland Europe approach needing 0.2FTEs.
Poole DEMON® - Performance

Plant Performance
- In full auto mode receiving all flows since July 2013
- Plant Take-over Oct 2013
- Mechanical problem with sizing of the SAS pumps.
- Treating loads >15% above max design loads.
- Consistently achieving 93% removal efficiency.
- OPEX costs reduced by a further 20% over forecast
- Payback reduced from 4yrs to 3.5yrs.
EssDe Interest in the UK

Can we install EssDe in Poole STW?

- Secondary treatment 3 nitrifying streams:
  - BAFF 59%
  - Eastern & Western streams 41% with ASPs by surface aeration
- Tertiary treatment is by sandfilters to achieve Ntotal 10mg/l yearly average.
- EssDe installed in the Eastern and Western streams would:
  - Save 30-35% aeration energy costs.
  - Enable 41% of flows to bypass the sandfilters.
  - Reduce the load on Sandfilters saving methanol and pumping costs.
- Poole currently requires 91.5kWh/PE and generation only achieves 23% energy neutrality.
- EssDe has the ability to make significant changes to the site.
- There is interest in EssDe from several water utilities.
Deammonification in the Mainstream and Sidestream for Wastewater Works

**Summary**

- Use of De-ammonification bacteria is on a journey. More to come with EssDe.
- Poole STW DEMON has been commissioned
- There are more opportunities for Poole to improve its energy neutrality figures.
- There are LTPs being built across mainland Europe.
- AMP6 will require more liquor treatment plants
Thank You

Any Questions?
Deammonification in the Mainstream and Sidestream for Wastewater Works

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