Waste Water to Resource Recovery

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Envirogen
Envirogen Group

Profile
• Annual Turnover
  – $100M
• Head count
  – Circa 200
• Offices
  – UK
    • Ledbury
    • Alfreton
  – Italy
    • Milan
  – USA
    • Houston
    • Philadelphia
    • Los Angeles

Envirogen Group

Envirogen USA
  • Basin Water
  • Biggler Associates

Envirogen Europe
  • EWS
  • Puresep
  • Fluxa
  • Derwent

AQANA
Processes & Technologies

- **Separation**
  - Cartridge filtration
  - Membrane filtration

- **Biological**
  - Aerobic
    - MBBR
    - MBR
  - Anaerobic
    - DACS
    - DANA

- **Physico/Chem**
  - DAF
  - IX/Evaporation
  - Reverse Osmosis
Waste Water
Waste Water

- Cleaning Processes
  - CIP Systems
  - Wash Down

- In-Process
  - Carrier
  - Material Preparation
  - Condensate

Daily Composite SCOD Load

kg SCOD per day
Waste Water Disposal

- **Mogden Formula**
  - Mechanism used to charge for industrial waste water discharged to sewer
  - Polluter pays principle, the more concentrated the waste, the higher the charge

\[ C = R + V + (V_B \text{ or } V_M) + \frac{(O_t/O_S)}{B} + \frac{(S_t/S_S)}{S} \]

- **Road Tankers**
  - To dispose of high strength waste water
  - Where no consent to discharge to sewer
Resource Recovery

Treatment Options
Four Key Treatment Stages

• **Pre-Treatment**
  – Protect downstream equipment
  – Simple screening, flow balancing

• **Primary Treatment**
  – Generally gross solids removal

• **Secondary Treatment**
  – Biological treatment
    • Anaerobic
    • Aerobic

• **Tertiary Treatment**
  – Final polishing
## Biological Treatment

### Process Options – Biological Treatment

<table>
<thead>
<tr>
<th>Anaerobic Treatment</th>
<th>Aerobic Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversion &gt; 90% COD into biogas</td>
<td>Converts &gt; 95% COD into CO₂ &amp; biomass</td>
</tr>
<tr>
<td>Low parasitic energy option</td>
<td>Higher parasitic energy option</td>
</tr>
<tr>
<td>Requires aerobic ‘polishing’</td>
<td>Requires sludge disposal</td>
</tr>
<tr>
<td>Small footprint</td>
<td>Medium to large footprint</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Process Options</th>
<th>100 kg COD</th>
<th>100 kg COD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biogas CH₄ 28 Nm³</td>
<td>CO₂ 9 Nm³</td>
<td>Carbon Dioxide</td>
</tr>
<tr>
<td>90% Biogas (80% Methane)</td>
<td>15 kg COD</td>
<td>Biomass</td>
</tr>
<tr>
<td>Sludge 5 kg COD</td>
<td>Aeration 100 kwh</td>
<td>Sludge, 30-60 kg COD</td>
</tr>
<tr>
<td>1 kg COD removed ≈ 0.35 Nm³ CH₄ ≈ 3.8 kWh</td>
<td>Heat loss 2-10 kg COD</td>
<td></td>
</tr>
</tbody>
</table>

1 kg COD removed ≈ 0.35 Nm³ CH₄ ≈ 3.8 kWh
### Biological Treatment

#### Process Options – Biological Treatment

<table>
<thead>
<tr>
<th>Feature</th>
<th>Anaerobic</th>
<th>Aerobic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Consumption</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>• Biogas Production</td>
<td>• Air or Oxygen input</td>
</tr>
<tr>
<td></td>
<td>• 0.07 – 0.1 kWh/kgCOD</td>
<td>• 0.7 – 1 kWh/kg COD</td>
</tr>
<tr>
<td>Sludge Production</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>• 0.03 – 0.05 kg ds/kg COD</td>
<td>• 0.2 – 0.6 kg ds/kg COD</td>
</tr>
<tr>
<td></td>
<td>• Potential value to sludge</td>
<td>• Disposal cost</td>
</tr>
<tr>
<td>Loading Rates</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>• 2 – 25 kg COD/m³ day</td>
<td>• 0.5 – 2 kg COD/m³ day</td>
</tr>
<tr>
<td>Surface Area</td>
<td>High rate process</td>
<td>Low rate process</td>
</tr>
<tr>
<td></td>
<td>• Compact design</td>
<td>• Large footprint</td>
</tr>
</tbody>
</table>
DACS Anaerobic Technology
Anaerobic DACS Technology

Anaerobically Treat Waste Water
- **Downflow Anaerobic Carrier System**
  - Anaerobic conversion of substrates
    - >90% reduction in TCOD
  - Biogas converted in CHP engine to:
    - Biogas
    - Electricity (FiT) / Heat (RHI)

- **Process Security**
  - High rate flocculated biomass
    - Captured in floating carriers – complete biomass retention
  - Gas tight

- **Low OPEX**
  - Gravity flow through carriers and reactor
    - Very low parasitic energy requirement
    - Minimises H₂S and CO₂ in biogas

- **Simplicity of Design**
  - Small footprint
  - No moving parts
    - Simple to operate & maintain
Waste Water to Energy Plant

- Wastewater from Brewery Sump
- Wastewater from Casking Line

Diagram showing the process:
- Screen
- Balance Tank
- Conditioning Tank
- DACS
- Aeration Tank
- Gas Burner
- Gas Buffer
- CHP

Outputs:
- Electricity
- Heat
- Sewer
Water Recovery
Waste Water Recovery Technologies

- **Reverse Osmosis**
  - Physical barrier
  - High quality water

- **Activated Carbon**
  - Remove any organic contamination

- **Evaporation**
  - Recovers water leaving salt residue

- **Disinfection**
  - Provide sterilisation of the recovered water
Case Studies
North East Brewery

**Flow**
- Daily 1,323 m³

**COD**
- Load 6,243 kg/day

**Biogas**
- Volume 2,185 Nm³/day
  - Consumed in site boiler
  - 763 kW\textsubscript{thermal}
Distillery – Biorefinery

- **Distillery**
- **Waste Streams** → **Dewatering and water treatment**
- **Biogas Biomass** → **CHP/Biomass Boiler** → **Steam** → **Turbine**
- **Grain, Yeast and Water** → **Recovered Water**
- **Recovered Water** → **Electricity**
- **Heat for Distilling Process**

**System Descriptions:**

- **Dewatering and water treatment:** Processes for removing water and solids from waste streams.
- **Biogas Biomass:** Utilized for generating steam.
- **CHP/Biomass Boiler:** Converts biomass into heat and power.
- **Steam:** Used for various processes within the distillery.
- **Turbine:** Converts steam into electricity.

**Processes Explained:**

- **Distillery Waste Streams:** Returned to the dewatering and water treatment.
- **Recovered Water:** Reused in processes or stored.
- **Grain, Yeast and Water:** Converted into biofuels or distilled products.
- **Electricity and Heat:** Generated from biogas and biomass.
Bio-refinery of Spent Wash

• **Energy Recovery**
  – Target to achieve 98% of thermal requirements and 80% electrical demand

• **Water Recovery**
  – 50% reduction in discharge volume

• **Process Blocks**
  – Biomass preparation
    • Fluidised bed boiler
  – Anaerobic treatment
    • Biogas
  – Ultrafiltration membranes and RO
    • Water recovery
Hall and Woodhouse Brewery

**Hall and Woodhouse**

- **Water Purification Plant**
  - New plant to replace old
    - Flow
      - Average 360 m³/day
    - COD
      - Average 6,000 mg/l
    - Gas Production
      - Average 760 Nm³/day
      - Energy recovery
Hall and Woodhouse Brewery

Hall and Woodhouse

- Water Purification Plant
  - New plant to replace old
    - Flow
      - Average 360 m$^3$/day
    - COD
      - Average 6,000 mg/l
    - Gas Production
      - Average 760 Nm$^3$/day
      - Energy recovery
Thank You

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