Nereda®
Aerobic Granule Technology

Experience with sustainable and cost-effective wastewater treatment using aerobic granules
DHV Consultancy and Engineering

- 4,700+ staff

- Markets
  - Aviation
  - Building and Manufacturing
  - Metal & Mining
  - Spatial Planning and Environment
  - Transportation
  - Water

- Services
  - Consultancy and advisory services
  - Design and engineering
  - Project and contract management
  - Operations management
  - Total solutions
Aerobic granules

Characteristics:
- Excellent settling properties
- Pure biomass, no support media required
- High biomass concentration
- Simultaneous extensive biological N- and P-removal
- Simple one-tank concept (no clarifiers)
- Small footprint
- Simple and easy operation
- Sustainable technology
- Low costs
Granules making up aerobic granular activated sludge are to be understood as aggregates of microbial origin, which do not coagulate under reduced hydrodynamic shear, and which subsequently settle significantly faster than activated sludge flocs.

(First Aerobic Granule Workshop 2004, Munich, Germany)

Measurements:
• fraction sludge > 0,212 mm
• SVI5 and SVI30 comparable
Key advantages Nereda

- 75% smaller footprint:
  • high biomass concentration
  • no selectors, no anaerobic tanks, no clarifiers

Activated sludge with bio-P

Area Requirement (m²)

Gateway to solutions
Key advantages Nereda

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- >25-35% energy savings:
  - less rotary equipment
  - efficient aeration
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- lower construction & operation costs
Increased sustainability

- Less energy consumption
- Improved water quality
- Extensive nutrient removal
- Less construction material
- No chemicals
- Less area consumption
How to make granules?

Selection mechanism:
settle pressure and/or short decant phase

Nitrification \( (\text{NH}_4^+ + \text{O}_2 \rightarrow \text{NO}_x) \)

Heterotrophic growth \( (\text{COD} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}) \)

P-removal/anoxic growth:
\( (\text{COD} + \text{NO}_x + \text{PO}_4^{3-} \rightarrow \text{N}_2 + \text{CO}_2 + \text{H}_2\text{O} + \text{poly-P}) \)

Oxygen gradient in granule enables simultaneous COD, P and N-removal
Nereda™ process

- All processes in one reactor
- Simple cycle
- Short settling phase
- Fill and draw combined
- Continuous feed: multiple reactors or buffer tank
History
- Research by Delft University of Technology (DUT) since mid '90s
- Close co-operation DUT / DHV since 2000
- Stable granulation, extensive N- and P-removal in DUT lab (2002)
- Feasibility study with great potential (2002)
- Large pilot-research at Ede STP (2003-2005)
- Start-up industrial launching customer (end 2004)
- Industrial units (2006)
- Design/construction municipal units (2006/2008)
Set-up pilot Ede STP

FASE 1: Granulate formation
- PC + SF → Bubble aeration
- PC + SF → Air-lift reactor

FASE 2: Optimised performance
- PC → Bubble aeration → RD
- Bubble aeration
Granule formation Ede STP

- natural selection of granules:

- increased start-up by use of granules

**Definition:** granule if $d > 212 \, \mu m$
- Untreated raw wastewater
- Stable granulation with 70 – 90% granules
- Concentration 10-12 kg/m$^3$ MLSS
- Loading 0.05 – 0.06 kg BOD/(kg$_{DS}$.d)
- Specific loading 0.81 – 1.05 kg COD/(m$^3$.d)
- Sludge characteristics
  - $SVI_{30} = 50 - 60$ ml/g (130 for conventional)
  - $SVI_5 / SVI_{30} = 1.1$
Performance Ede STP

- Stable granulation
- Effluent quality
  - without post treatment:
    - Portho < 1 mg/l (no chemicals)
    - (NH$_4$ + NO$_3$)-N < 10 mg/l (13 °C)
    - SS < 30 mg/l
  - with post treatment
    - SS < 5 mg/l
- Recent improved operation results in lower SS
Nereda™ process configuration

EU-discharge regulations

Activated Sludge

ANA → PDN → AT → SC

Nereda™
Nereda™ process configuration

new EU-discharge regulations

Activated Sludge

Nereda™

ANA → PDN → AT → SC → F

Nereda → F
Current technology status

- Industrial units in operation since 2005
- Two municipal units under construction (start-up: May 2008 and July 2008)
- Approx. 6 others in various preparatory state (pilot validation → detailed design → tender)
- National Nereda Research Alliance
Epe STP
Epe STP
Nereda is a breakthrough.....
- Simple
- Compact
- Sustainable
- Low investments
- Low operating costs
- Simultaneous biological organic, N and P- removal
- Good or Excellent effluent quality

.....and shows serious action:
- First industrial applications are running
- Many others and municipals will follow soon
More information?

www.DHV.com

www.nereda.net
More information?

www.DHV.com

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## Comparison

<table>
<thead>
<tr>
<th>Parameter</th>
<th>BNR</th>
<th>Activated Sludge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effluent quality</td>
<td>good</td>
<td>similar or better</td>
</tr>
<tr>
<td>Process stability</td>
<td>good</td>
<td>similar or better</td>
</tr>
<tr>
<td>Footprint</td>
<td>100%</td>
<td>25%</td>
</tr>
<tr>
<td>Energy consumption</td>
<td>100%</td>
<td>&lt; 65-75%</td>
</tr>
<tr>
<td>Sludge production</td>
<td>100%</td>
<td>similar or lower</td>
</tr>
<tr>
<td>MLSS in reactor</td>
<td>3-5 kg/m³</td>
<td>10-15 kg/m³</td>
</tr>
<tr>
<td>CAPEX</td>
<td>100%</td>
<td>significantly lower</td>
</tr>
<tr>
<td>OPEX</td>
<td>100%</td>
<td>significantly lower</td>
</tr>
</tbody>
</table>
SVI and DS

Total DS-concentration (kg/m³)

SVI (ml/g)

DS-concentratie  SVI 5  SVI30  10 per. Mov. Avg. (DS-concentratie)
N-removal

- NH$_4$N + NO$_3$N (mg/l)
- Reactor 1
- Reactor 2
- Pre-settled
- Raw wastewater

Graph showing the NH$_4$N + NO$_3$N concentrations for Reactor 1 and Reactor 2 over the period from 01-12-04 to 29-07-05.