Introduction on Aerobic Granular Sludge Technology:

Webinar Special Interest Group

Sjoerd Kerstens
May 30 2017
A Global Player

- working in more than 130 countries
Covering the whole water cycle
World class water solutions

*In partnership with research centres, universities and clients*

- Alginate recovery and reuse
- Carrousel®, ABR®, AB-Carrousel®, Carrousel® 1000
- Human Sensor, Humic Acid Technology
- Asset Information Management, Central Control Room
Aerobic Granular Sludge Technology

Fundamentals of the Nereda
Conventional wastewater treatment

- Activated sludge principles
- Over 100 years experience
- Good effluent quality
- Poor sludge settling quality
- Low biomass concentrations
- Significant footprint
- High energy consumption
- High chemical consumption
- Complex design & operation
In the mid 90’s the challenge was taken up….

It all started with a good discussion and collaboration between two professors at an October Fest.

Prof. Peter Wilderer  
TU Munich

Prof. Mark van Loosdrecht  
TU Delft
The ideal system

- Meet the most stringent effluent COD, N and P requirements
- Simple construction and operation
- Compact
- Low energy requirement
- Low cost
- Long retention time of biomass
- Use merits of CAS and Biofilm technologies
**Wastewater treatment with Nereda®**

- Natural way of treating wastewater using aerobic granular sludge with excellent settling properties

Flocs
- 4 g/l
- $\text{SVI}_5 > \text{SVI}_{30}$

Granules
- 8 g/l or more
- $\text{SVI}_5 \approx \text{SVI}_{30}$
Aerobic Granular Biomass

- Excellent settling properties
- Pure biomass
- No support media
- High MLSS levels (up to 15 g/L)
- Reliable and stable operation
- No bulking sludge
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Nereda® compared to Conventional Activated Sludge

Biological nutrient removal in activated sludge requires many compartments and circulation flows

Carbon, Nitrogen and Phosphorus removal in UCT configuration
Nereda® compared to Conventional Activated Sludge

Biological nutrient removal in activated sludge requires many compartments and circulation flows

Carbon, Nitrogen and Phosphorus removal in UCT configuration

- Raw sewage
- Influent
- Aeration
- Sludge Digestor
- Biogas
- Digested sludge
- Supernatant
- Thickened excess sludge
- Mixed liquor
- Final settler
- Effluent
- Return sludge
- Excess sludge (secondary sludge)
Nereda® compared to Biological Filter systems

Carbon, Nitrogen and Phosphorus removal in Biological Aerated Filter Technology

Denitrifying reactor

Nitrifying reactor

Fe-dosing

Dirty Backwash water

Backwash water

Influent

Process air

Effluent

Effluent

Process air
Nereda® compared to Biological Filter systems

Carbon, Nitrogen and Phosphorus removal in Biological Aerated Filter Technology
**Nereda® process cycle**

- Simple one-tank concept
- No clarifiers
- No moving decanter
- No mixers
- Extensive biological COD, N- and P-removal
- Low energy consumption
- Easy operation
- Low totex
Aerobic granules

- Extensive simultaneous biological COD, N- and P-removal

Aerobic zone:
- Oxidation of organic compounds
- Nitrification

Anoxic / anaerobic zone:
- Denitrification
- Phosphorus removal

Simultaneous Fill and Draw

Nereda® cyclus

Fast Settling

Aeration

Air
Micro-organismen in the granule

Activated sludge

Aerobic Granular Sludge

- Nitrifiers
- Denitrifiers
- Phosphate Accumulating Organisms (PAO’s)
- Glycogen Accumulating Organisms (GAO’s)

Courtesy Delft University of Technology
Aerobic granular biomass technology

Advantages
Key advantages of Nereda®

- Footprint
  - CAS
  - Nereda®

- Energy
  - CAS
  - Nereda®

- Costs
  - CAS
  - Nereda®
Footprint - Garmerwolde

Garmerwolde plant
140,000 p.e
347 l/s

Treating same flow
< 25% footprint
< 50% energy use
No chemicals
Footprint – Deodoro- Rio de Janeiro

Deodoro plant
360,000 p.e
750 l/s

Treating 2x flow
< 50% footprint

Deodoro old plant
170,000 p.e
360 l/s
Energy – Garmerwolde

Energy consumption

Specific energy consumption (kWh/m³)


Nereda  A/B system
# Chemicals A/B system vs Nereda

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Unit</th>
<th>A/B system</th>
<th>Nereda</th>
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<td></td>
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<tr>
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<td>C-source</td>
<td>m³</td>
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<td>600</td>
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Energy – Vroomshoop
Aerobic granular biomass technology

Current status
Implementation progress

2005: Vika, Netherlands, 5,000 PE

Today: Ringsend Dublin, PPS2, first cell; Ultimate capacity 2.4 million PE
Global Nereda® roll-out

- Operational plants
- Plants under construction
- Pilots
- Partners

United Kingdom & Ireland
Nereda KPI collection and cycles

Daily calculated KPI’s

Daily cumulative batches
Nereda® in different climates

- Lisbon, Portugal, 44,000 PE
- Garmerwolde, NL, 140,000 PE
- DEO Rio d Jn, Brazil, 480,000 PE
- Kingaroy, Australia, 11,000 PE
- Ryki, Poland, 43,000 PE
Nereda® in different climates

Retention of nitrifiers in AGS assures nitrification at low temperatures, similar to biofilms
Aerobic granular biomass technology

Some references
First industrial references

2005 cheese products

2006 ready-made food

2007 edible oil

2009 ready-made food
Nereda® Westfort Meatproducts
The Netherlands, 2015

- **Client:** Westfort Meatproducts
- **Wastewater type:** Industrial
- **Capacity:** 1,400 m³/day, 43,000 p.e.
- **Pre-treatment:** drum filter and FFU (Flocculatie-Flotatie Unit).
- **Specifics:** 11.3 meter deep with technical facility and parking deck on top
Nereda® Epe
The Netherlands, 2011

- **Client:** Water Authority Veluwe
- **Wastewater type:** Municipal & Industrial
- **Capacity:** 8,000 m³/day (41,000 p.e. inclusive 13,750 p.e. from industrial discharges)
- **Peak flow:** 1,500 m³/hour
- **Pre-treatment:** screening, sand trap and oil & grease removal (to cope with slaughterhouse emissions)
- **Post-treatment:** sand filtration
Nereda® Frielas, Lisbon

Portugal, 2012

- **Client:** Agua de Portugal – Simtejo
- **Wastewater type:** Municipal & Industrial
- **Capacity demo:** 3,000 m$^3$/day (11,111 p.e.)
- **Capacity full scale retrofit:** 12,000 m$^3$/day (44,444 p.e.)
- This upgrade makes the Frielas WWTP able to meet the current discharge requirements and operates as a hybrid Nereda plant.
Nereda® Kloten/Opfikon
Switzerland, 2019

- **Client:** WABAG / ARA Opfikon Kloten
- **Wastewater type:** Municipal
- **Capacity:** 26,000 m³/day (125,000 p.e.)
- **Peak flow:** 2,850 m³/hour
Nereda® Wemmershoek
South Africa, 2015

- **Client:** Stellenbosch Municipality
- **Wastewater type:** Municipal
- **Capacity:** 5,000 m$^3$/day (40,000 p.e.)
- **Peak flow:** 468 m$^3$/hour
- **Effluent,** with quality significantly better than Standard Limits, is reused
Nereda® Highworth

UK, 2017

- **Client**: Thames Water
- **Wastewater type**: Municipal
- **Average capacity**: 1,444 m³/day (10,000 p.e.)
- **Peak flow**: 197 m³/hour
Nereda® Clonakilty
Ireland, 2015

- **Client:** EPS / Irish Water
- **Wastewater type:** Municipal
- **Capacity:** 5,000 m³/day (23,278 p.e.)
- **Peak flow:** 626 m³/hour
- **Pre-treatment:** Combined screening, grit and FOG removal
**Nereda® Ringsend**  
*Ireland, 2021*

- **Client:** Irish Water  
- **Wastewater type:** Municipal  
- **Capacity:** 600,000 m$^3$/day (2,400,000 p.e.)  
- **Peak flow:** 50,000 m$^3$/hour  
- Significantly more biological treatment capacity by retrofit existing SBR
Nereda® Kingaroy
Australia, 2016

- **Client:** Aquatec Maxcon / South Burnett Regional Council
- **Wastewater type:** Municipal
- **Capacity:** 12,500 p.e. (11,000 p.e.)
- **Peak flow:** 450 m³/hour
- This Nereda plant upgrade provides the Kingaroy community with water which can also be re-used to irrigate sporting grounds in the area
Nereda® Deodoro, Rio de Janeiro
Brazil, 2016

- **Client:** Odebrecht Ambiental / Foz Aguas 5
- **Wastewater type:** Municipal
- **Capacity:** 86,400 m$^3$/day (480,000 p.e.)
- **Peak flow:** 6,120 m$^3$/hour
- **Pre-treatment:** grease & grit removal, screening.
Aerobic granular biomass technology

Outlook to the future
Biopolymer in granules

- Granules contain 15-25% of structural gel, mainly alginate like polysaccharides
- Easy to harvest
- High market value
- Preparing development project to recover biopolymer and upgrade into non-food applications
Nereda® Alginate Factory Zutphen

The Netherlands, 2018

- **Client**: Water Authority Rijn en IJssel
- Dairy industry to treat wastewater AND produce ALE;
- Two additional full scale Alginate extraction units are now constructed
Discussion
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