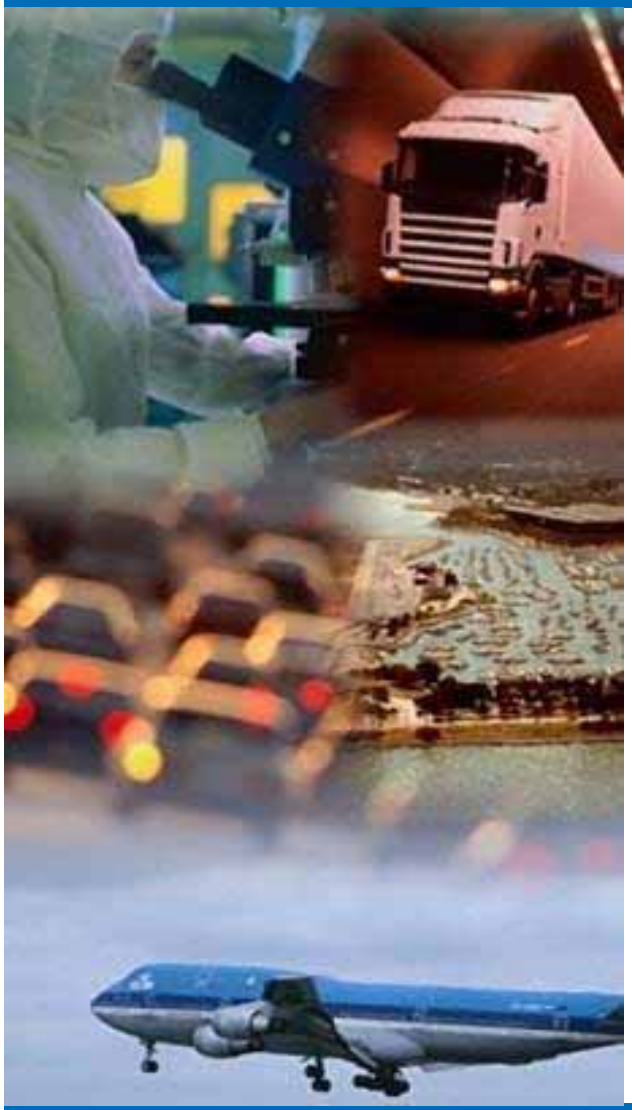
Nereda®

Aerobic Granule Technology

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

DHV
Consultancy and Engineering

Consultancy and Engineering



- 4,700+ staff

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

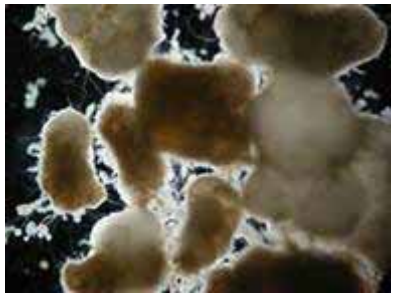
- Services
  - Consultancy and advisory services
  - Design and engineering
  - Project and contract management
  - Operations management
  - Total solutions

Instead of

activated sludge

use

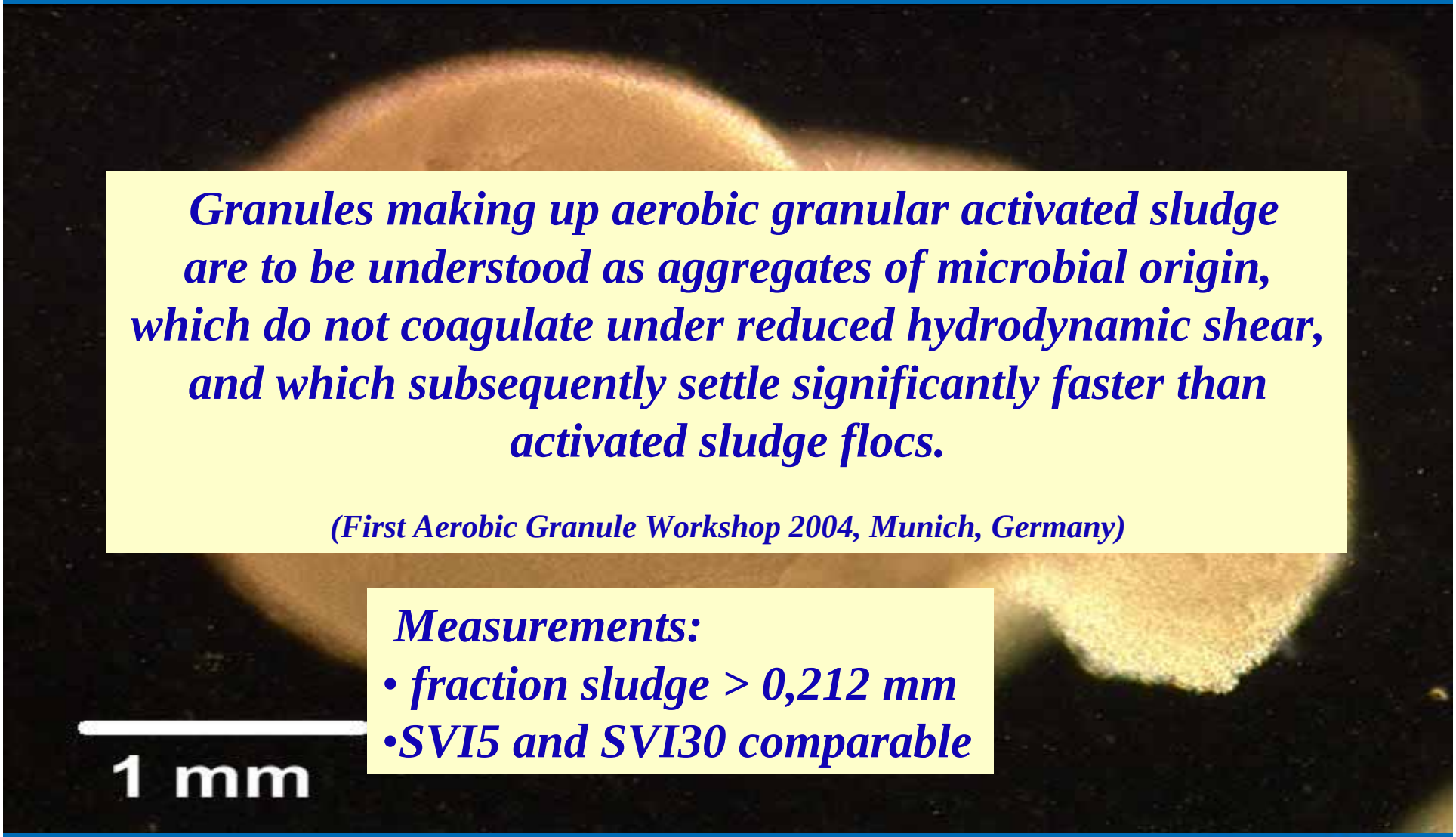
aerobic granules



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.

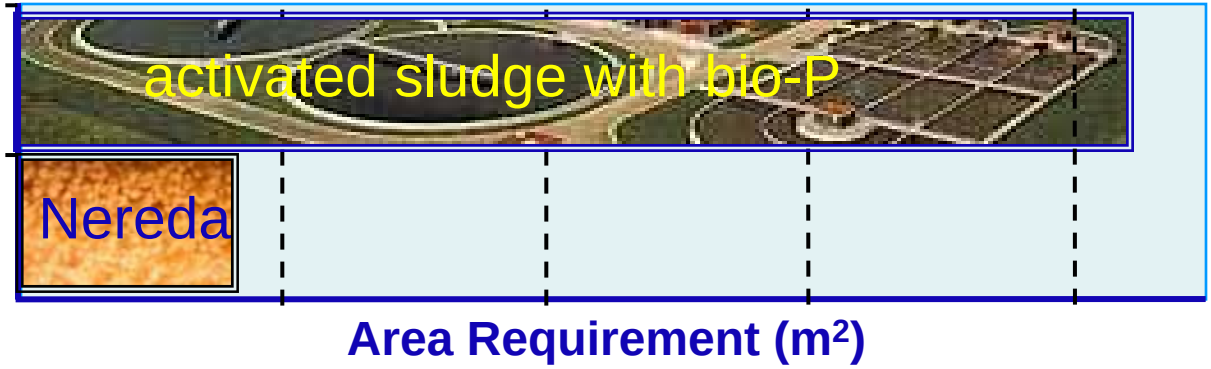
(First Aerobic Granule Workshop 2004, Munich, Germany)

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



Courtesy Merle de Kreuk-TUD

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Consultancy and Engineering

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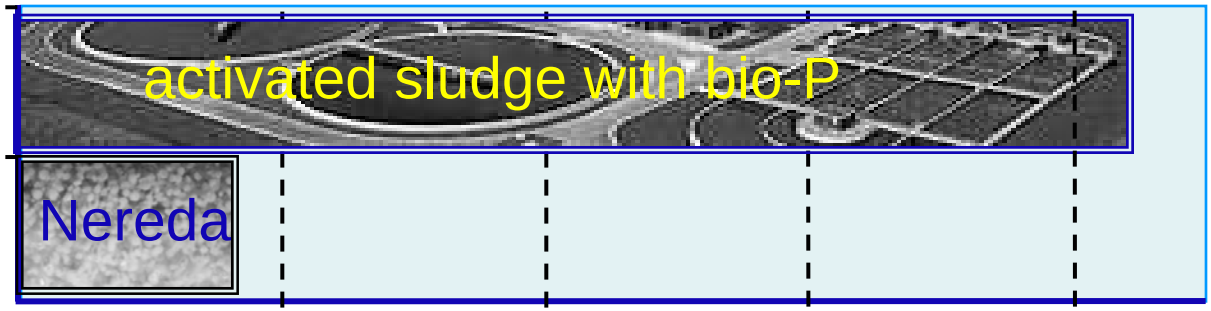
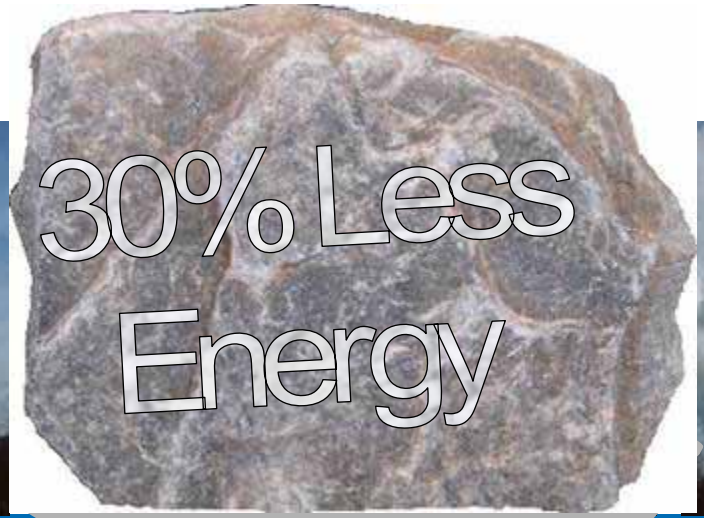


- >25-35% energy savings:
  - less rotary equipment
  - efficient aeration



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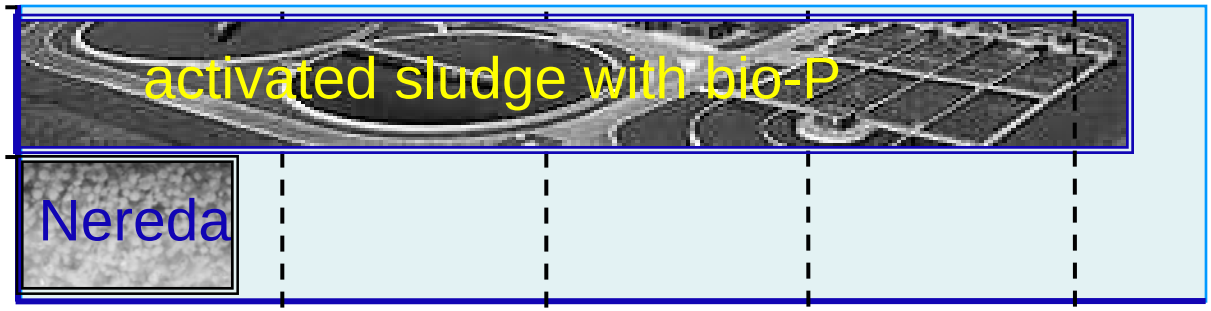


- >25-35% energy savings:
  - less rotary equipment
  - efficient aeration

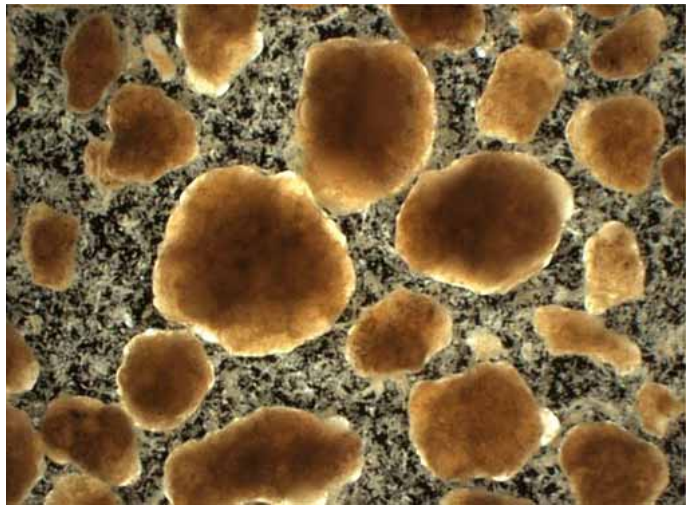
- lower construction & operation costs

Increased sustainability

- Less energy consumption
- Improved water quality
- Extensive nutrient removal
- Less construction material
- No chemicals
- Less area consumption

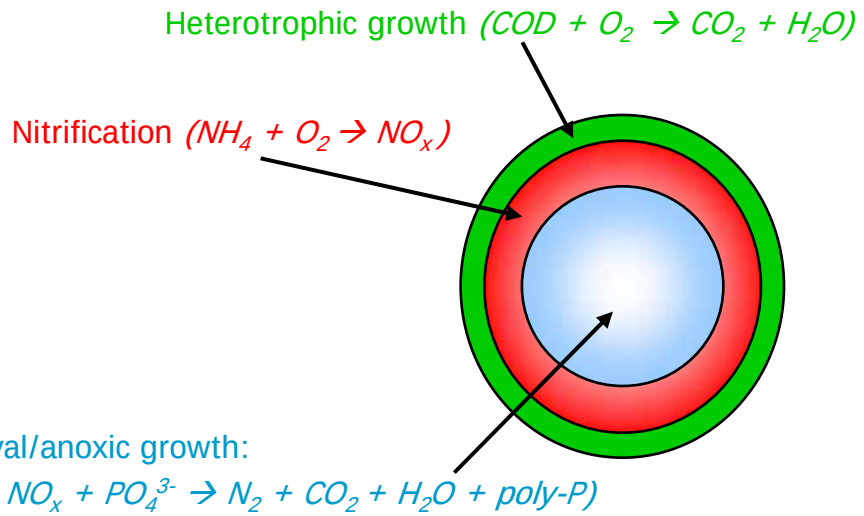
Courtesy Merle de Kreuk-TUD

How to make granules?



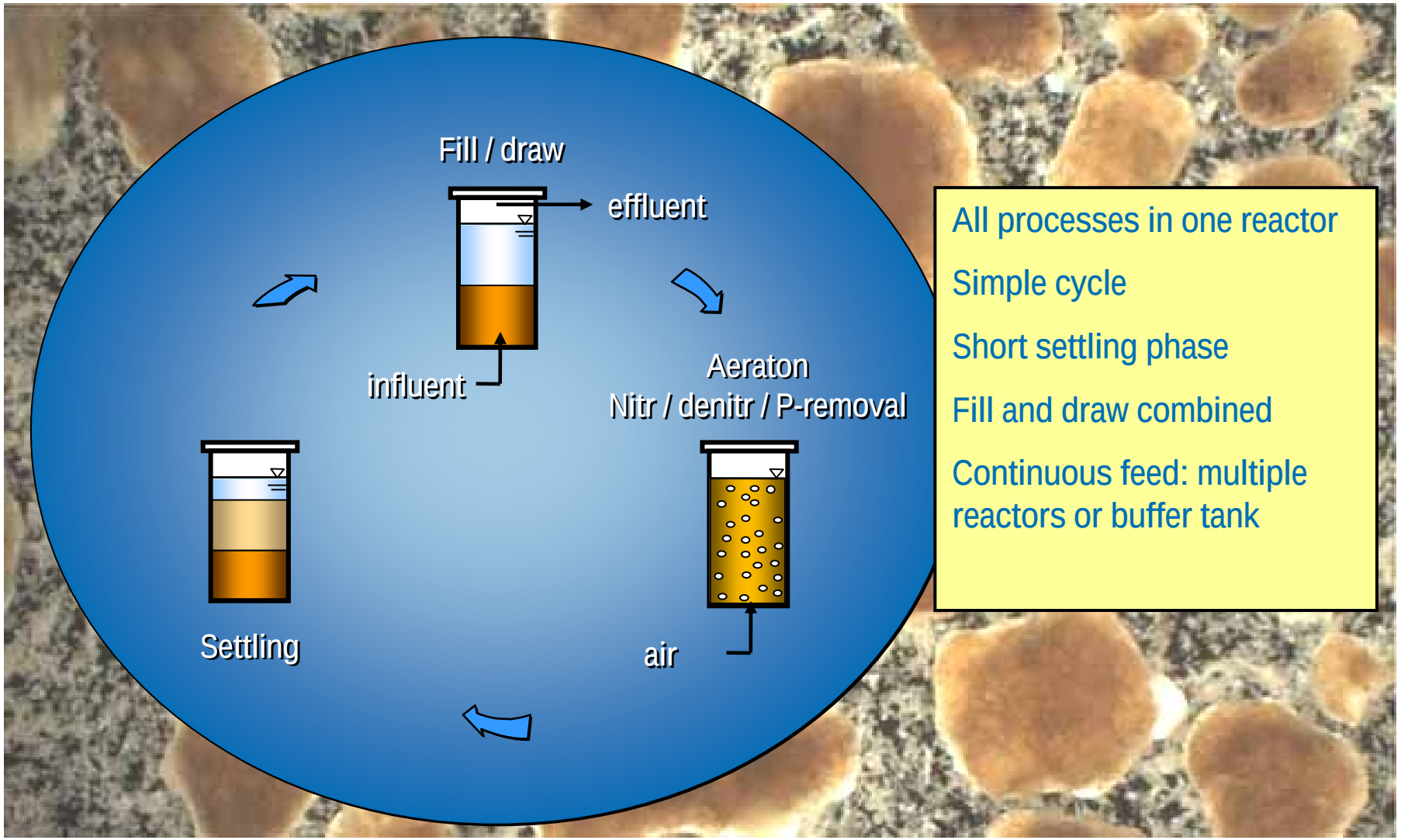
Selection mechanism:

settling pressure and/or short decant phase



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

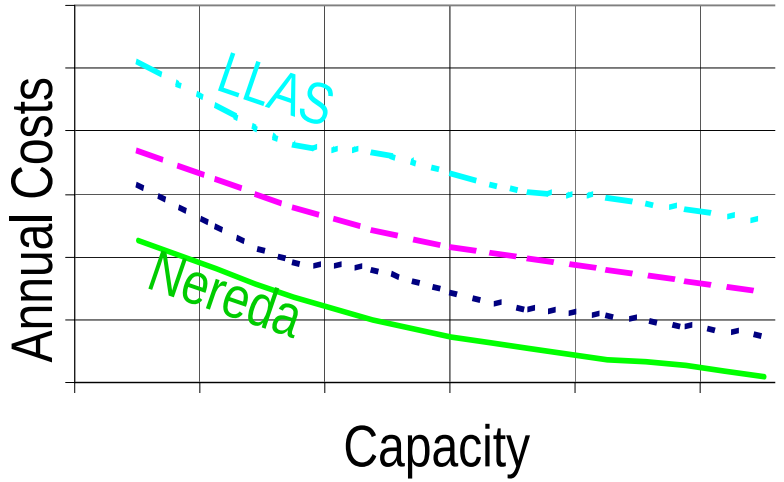
Nereda™ process



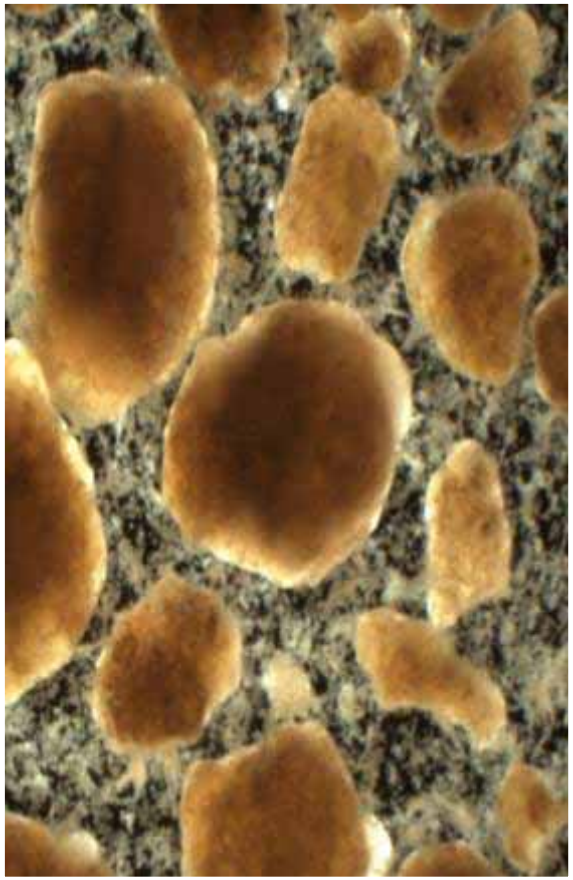
- All processes in one reactor
- Simple cycle
- Short settling phase
- Fill and draw combined
- Continuous feed: multiple reactors or buffer tank

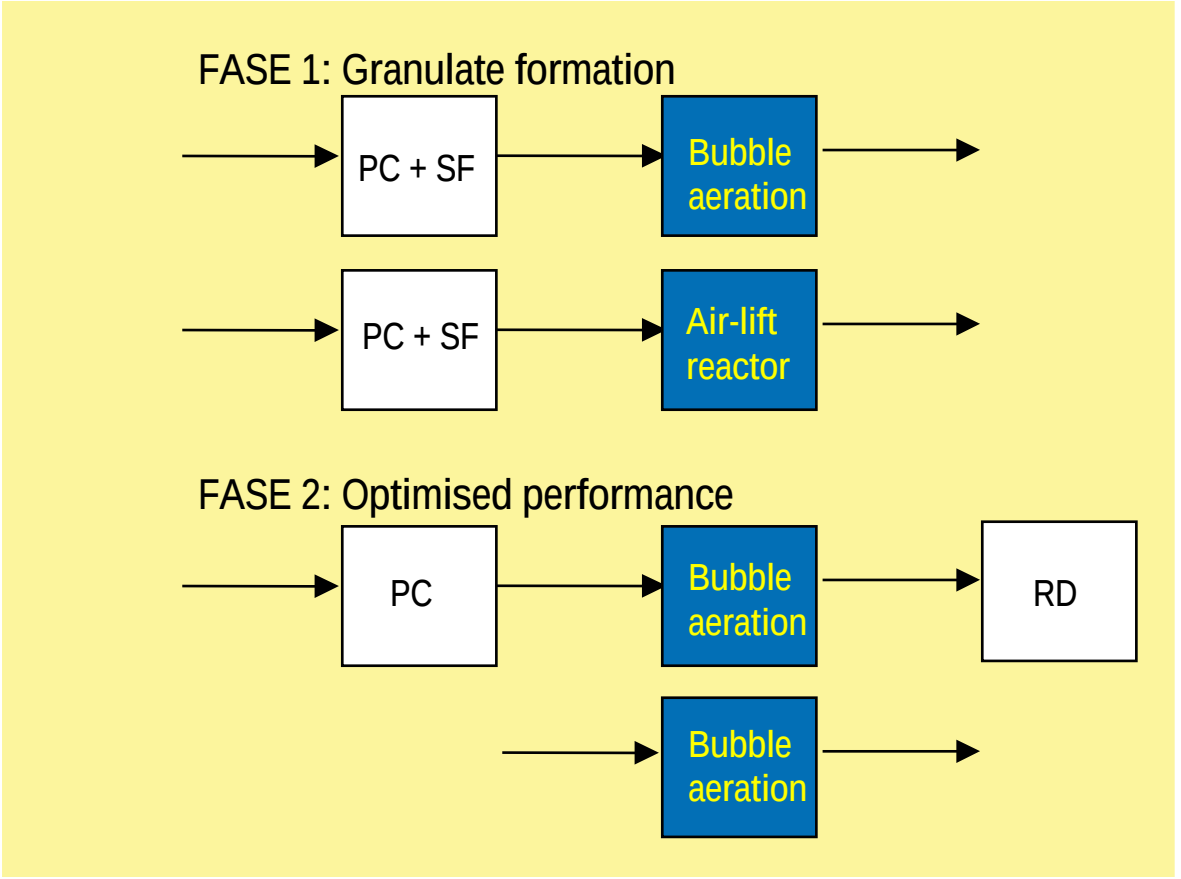
History

- Research by Delft University of Technology (DUT) since mid ’90s
- close co-operation DUT / DHV since 2000
- Stable granulation, extensive N- en 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)



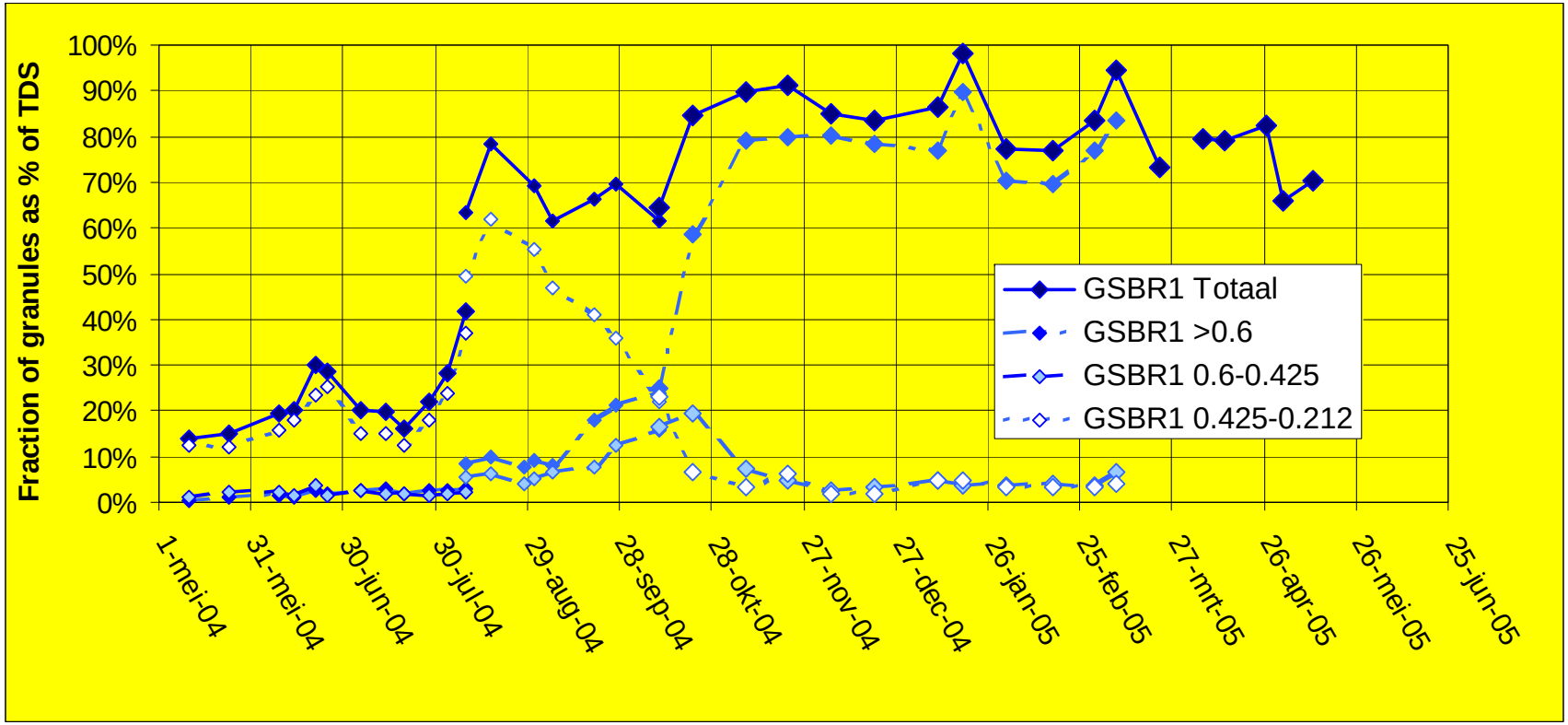
Set-up pilot Ede STP





Granule formation Ede STP

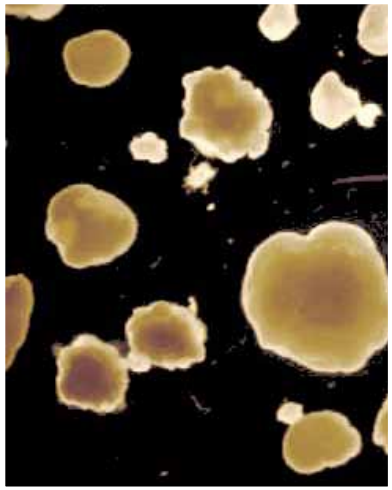
- natural selection of granules:



- increased start-up by use of granules

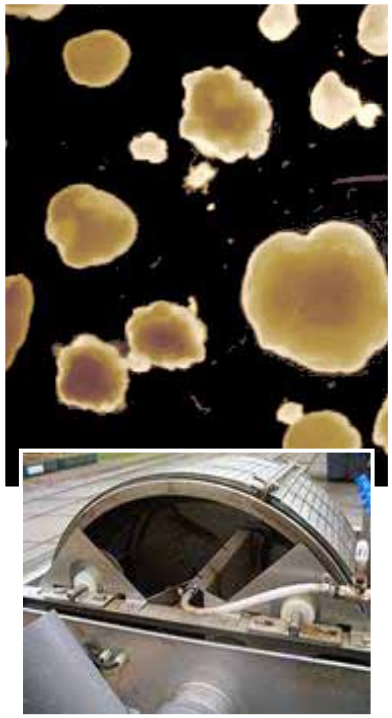
Definition: granule if d >212 µm

Process Conditions Ede STP



- 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

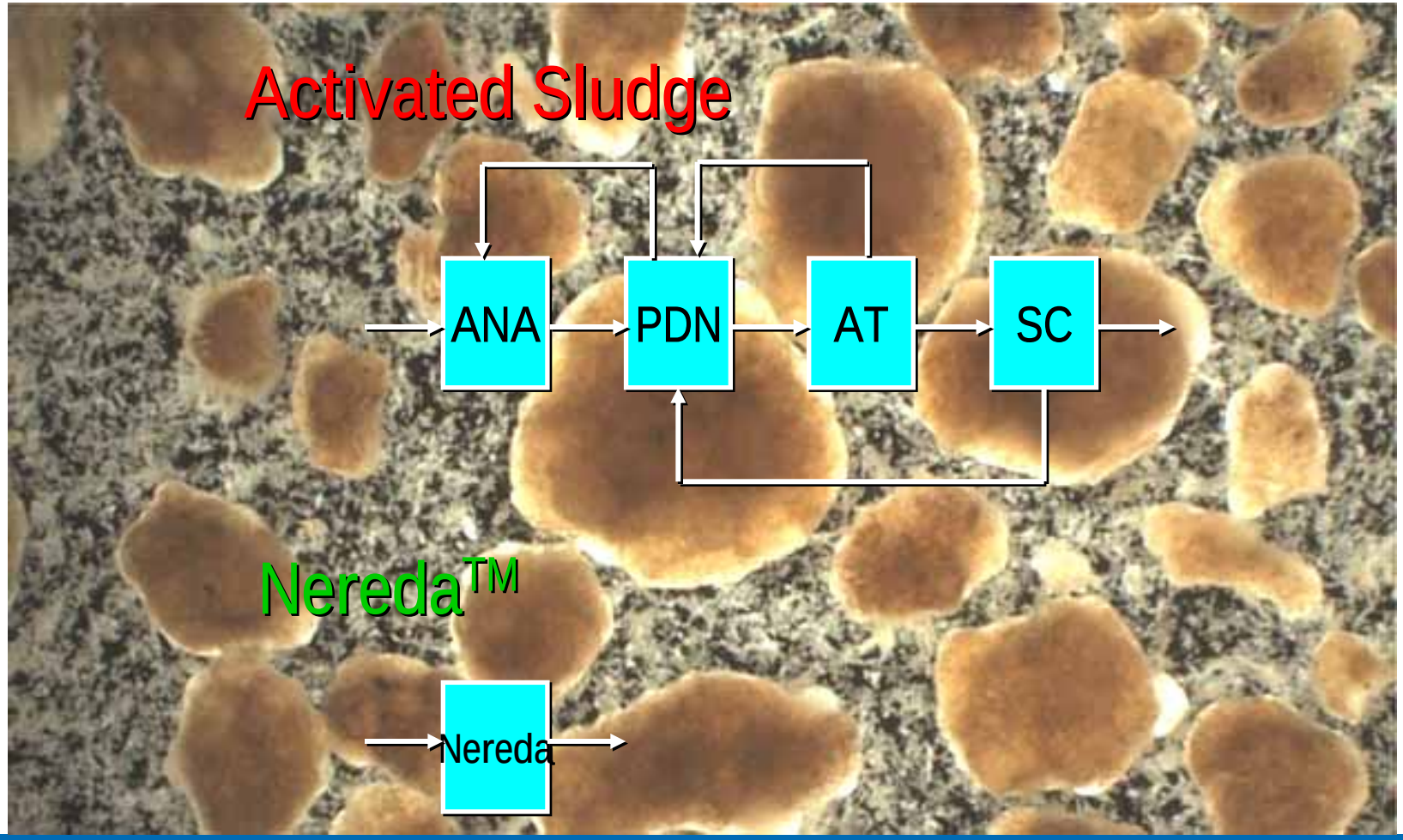
Performance Ede STP



- 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*

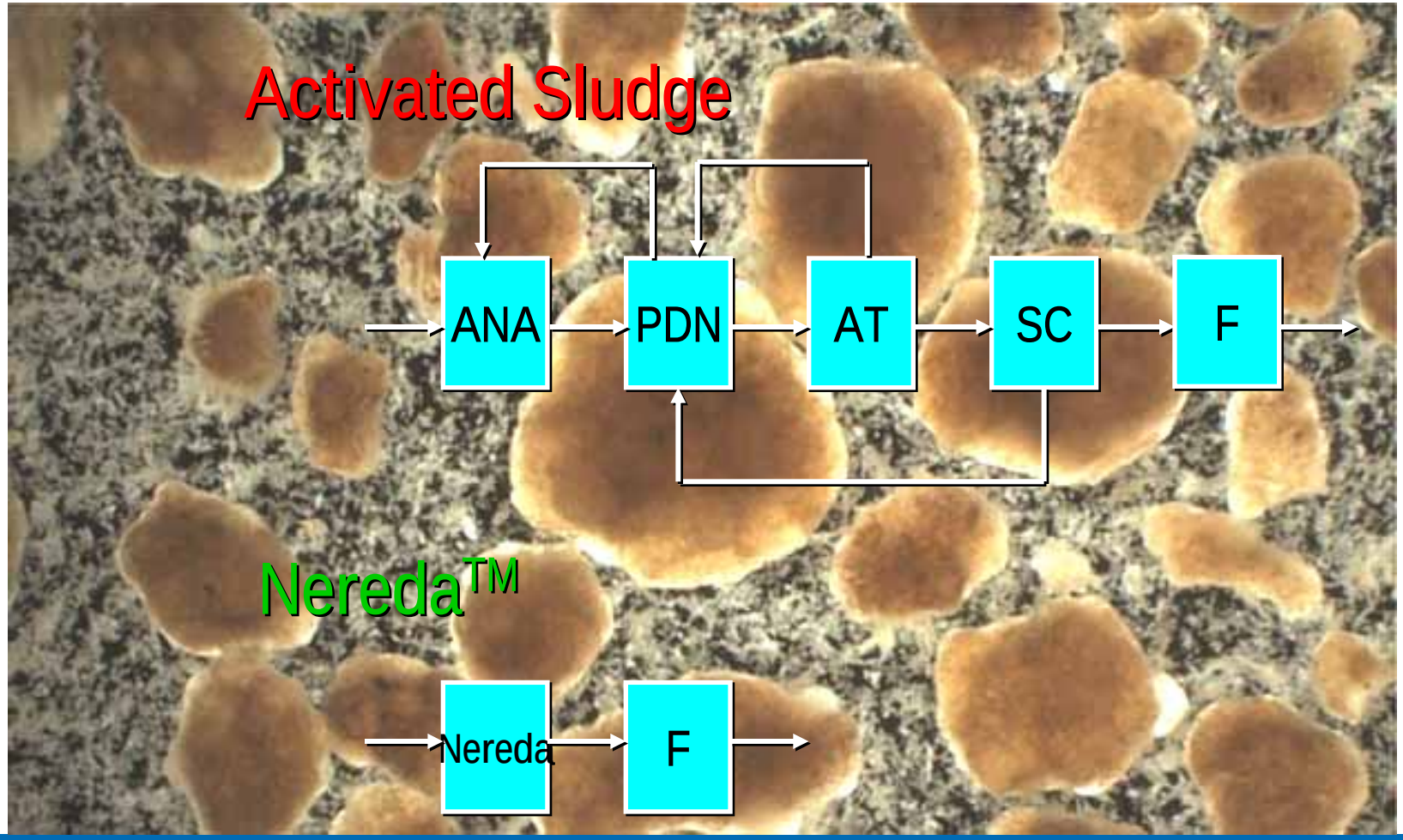
Nereda™ process configuration

EU-discharge regulations



Nereda™ process configuration

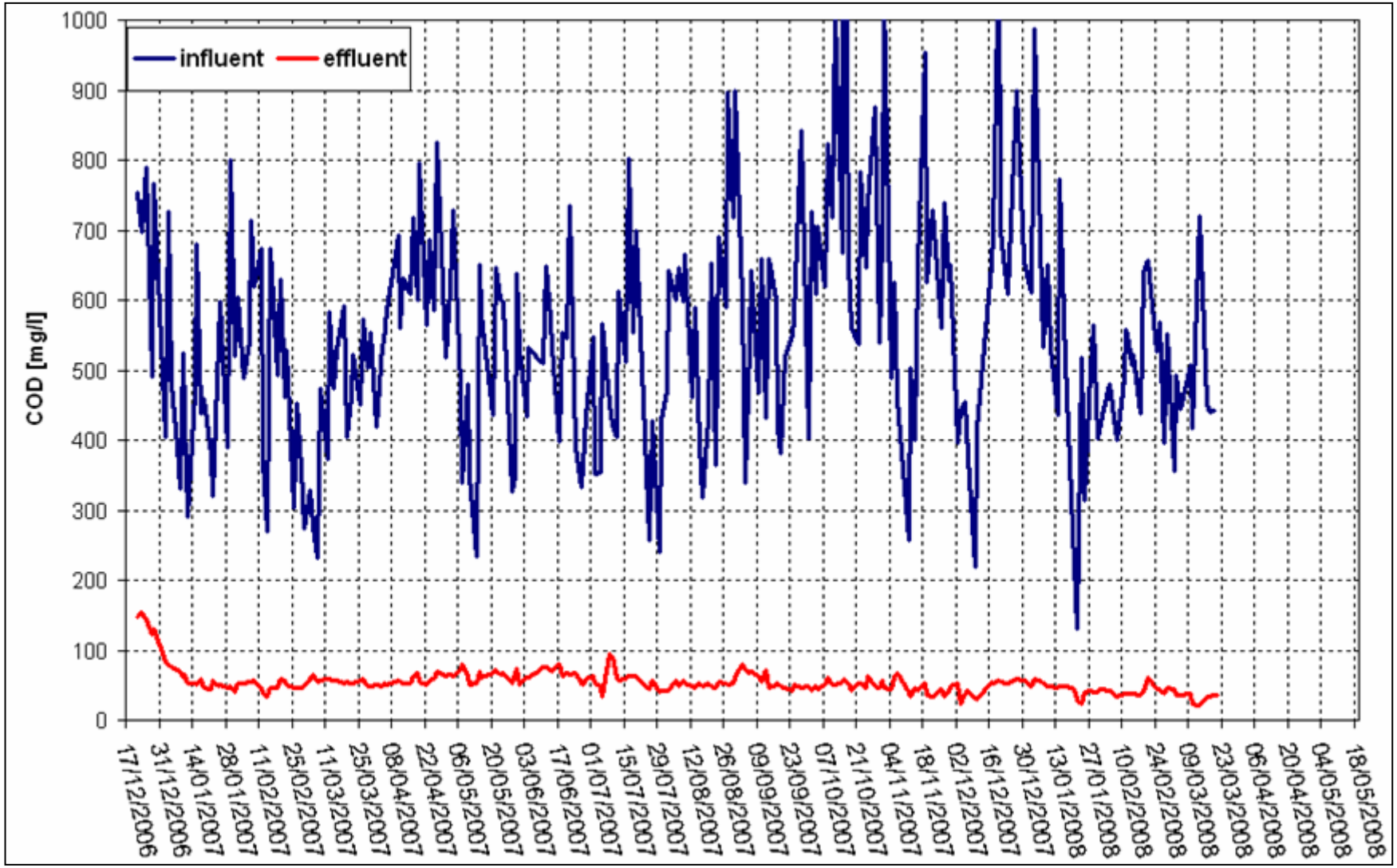
new EU-discharge regulations



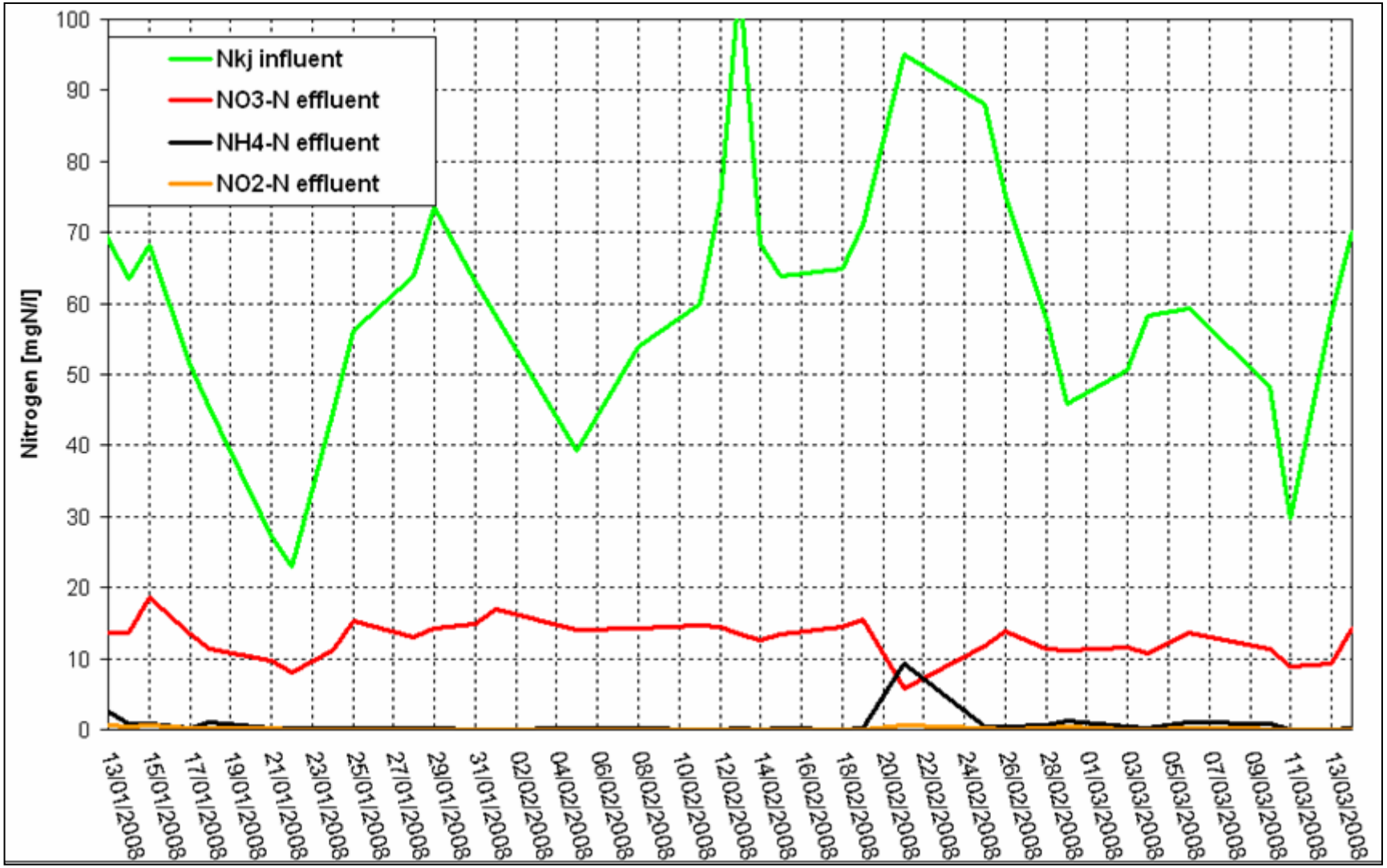
Current technology status

- 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

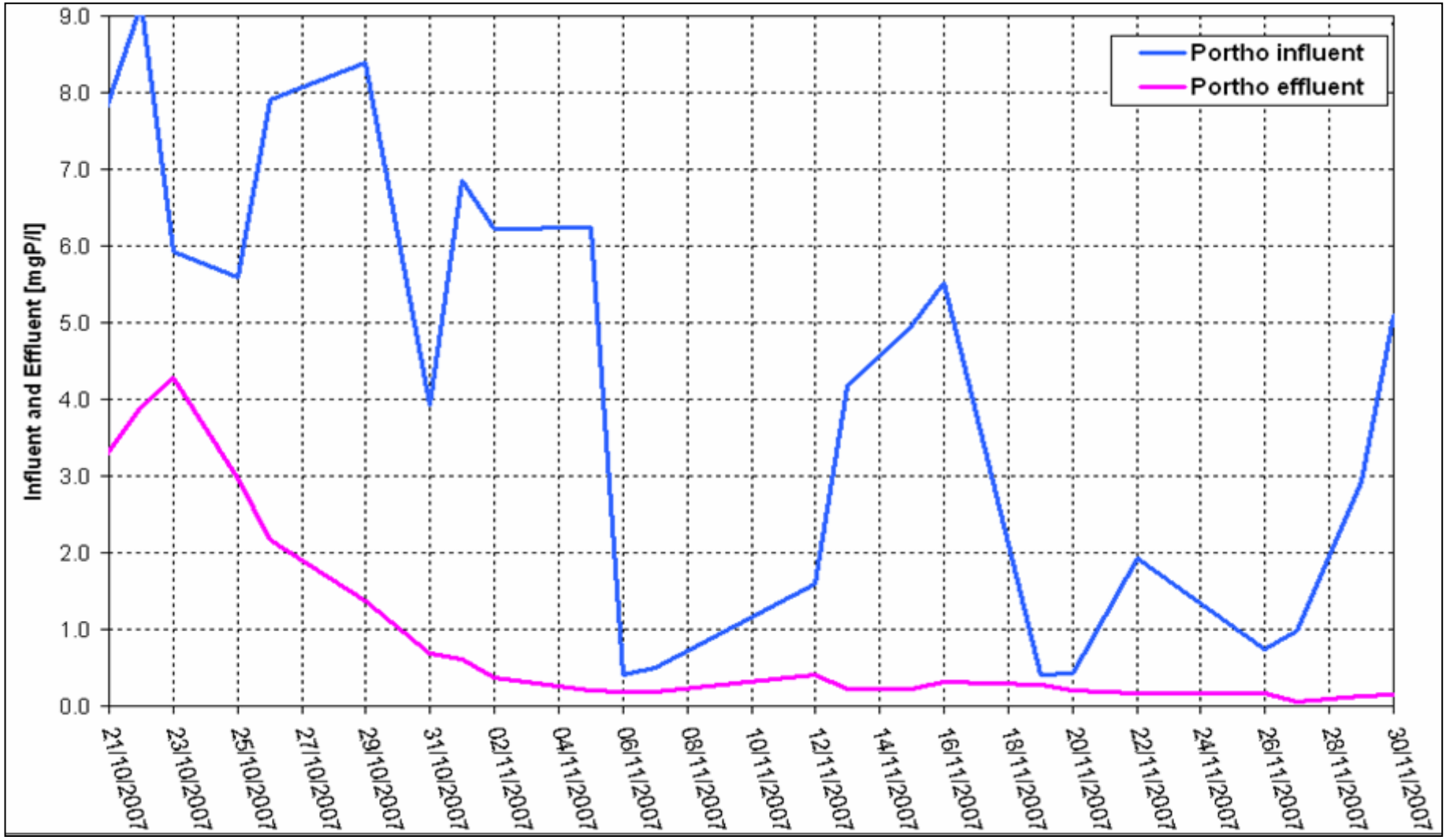
Epe STP


influent
effluent
COD [mg/l]
1000
900
800
700
600
500
400
300
200
100
0
17/12/2006
31/12/2006
14/01/2007
28/01/2007
11/02/2007
25/02/2007
11/03/2007
25/03/2007
08/04/2007
22/04/2007
06/05/2007
20/05/2007
03/06/2007
17/06/2007
01/07/2007
15/07/2007
29/07/2007
12/08/2007
26/08/2007
09/09/2007
23/09/2007
07/10/2007
21/10/2007
04/11/2007
18/11/2007
02/12/2007
16/12/2007
30/12/2007
13/01/2008
27/01/2008
10/02/2008
24/02/2008
09/03/2008
23/03/2008
06/04/2008
20/04/2008
04/05/2008
18/05/2008

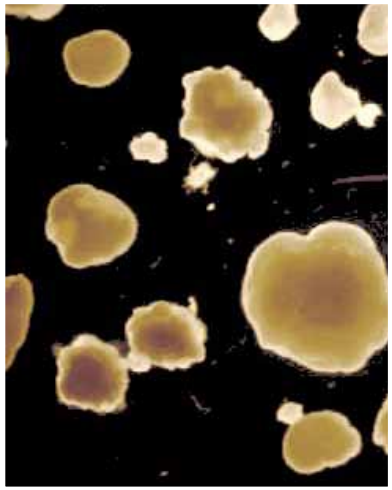
Epe STP


Nkj influent
NO3-N effluent
NH4-N effluent
NO2-N effluent
Nitrogen [mgN/l]
100
90
80
70
60
50
40
30
20
10
0
13/01/2008
15/01/2008
17/01/2008
19/01/2008
21/01/2008
23/01/2008
25/01/2008
27/01/2008
29/01/2008
31/01/2008
02/02/2008
04/02/2008
06/02/2008
08/02/2008
10/02/2008
12/02/2008
14/02/2008
16/02/2008
18/02/2008
20/02/2008
22/02/2008
24/02/2008
26/02/2008
28/02/2008
01/03/2008
03/03/2008
05/03/2008
07/03/2008
09/03/2008
11/03/2008
13/03/2008

Epe STP


Portho influent
Portho effluent
Influent and Effluent [mgP/l]
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
21/10/2007
23/10/2007
25/10/2007
27/10/2007
29/10/2007
31/10/2007
02/11/2007
04/11/2007
06/11/2007
08/11/2007
10/11/2007
12/11/2007
14/11/2007
16/11/2007
18/11/2007
20/11/2007
22/11/2007
24/11/2007
26/11/2007
28/11/2007
30/11/2007

Summary



Nereda is a breakthrough.....

- Simple
- Compact
- Sustainable
- Low investments
- Low operating costs
- Simultaneous biological organic, N and P- removal
- Good or Excellent effluent quality

Ingenuity award 2005

Process Innovation award 2006

DOW energy award 2007

Simon Stevin Gezel Award 2007

.....and shows serious action:

- First industrial applications are running
- Many others and municipals will follow soon

Water Quality & Safety award 2007

More information?

www.DHV.com

www.nereda.net

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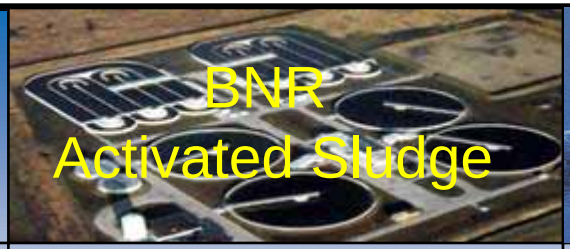
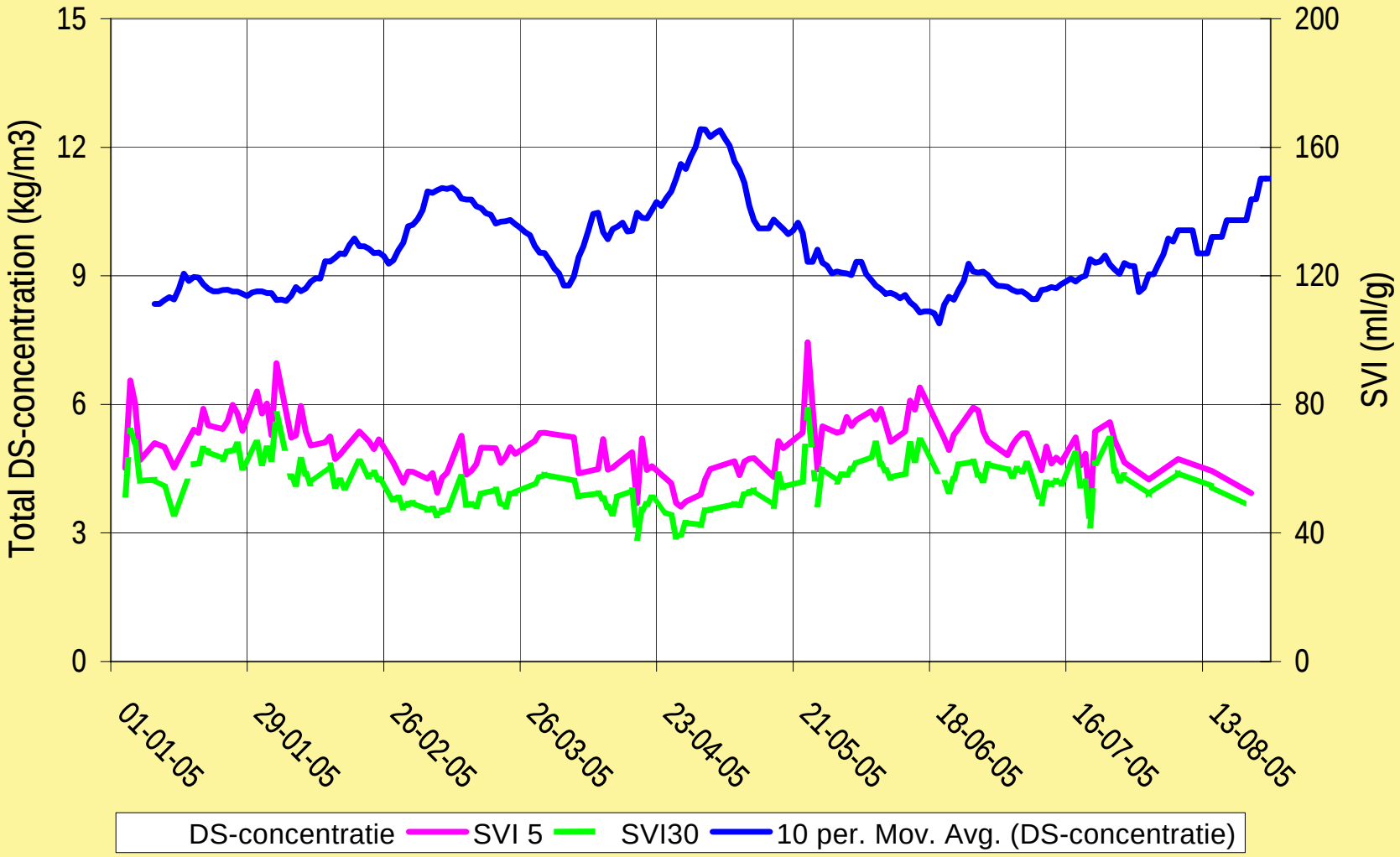
www.nereda.net

Comparison

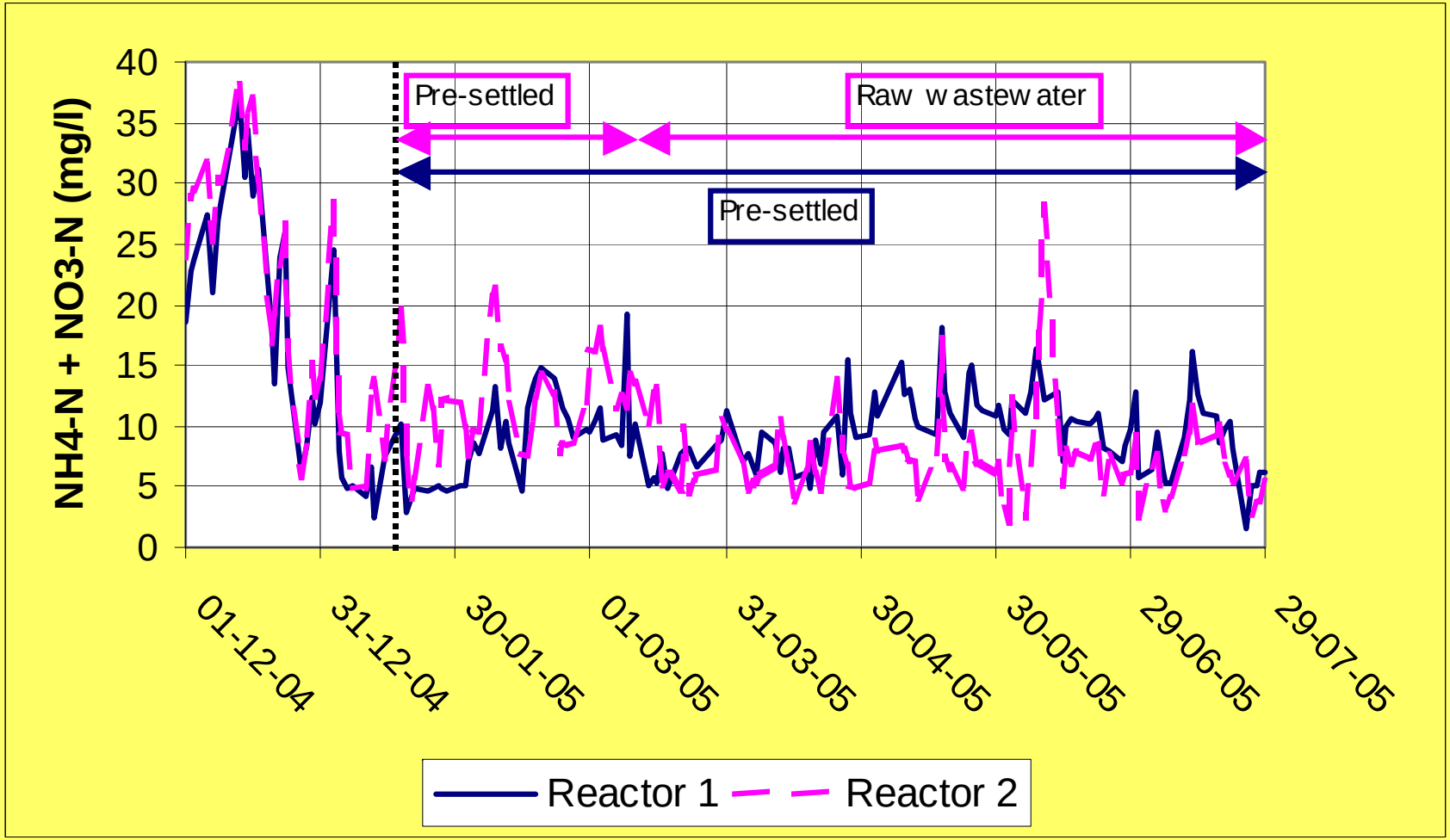
Consultancy and Engineering

parameter		
effluent quality	good	similar or better
process stability	good	similar or better
footprint	100%	25%
energy consumption	100%	< 65-75%
sludge production	100%	similar or lower
MLSS in reactor	3-5 kg/m3	10-15 kg/m3
CAPEX	100%	significantly lower
OPEX	100%	significantly lower

SVI and DS


Total DS-concentration (kg/m3)
SVI (ml/g)
15
12
9
6
3
0
200
160
120
80
40
0
01-01-05
29-01-05
26-02-05
26-03-05
23-04-05
21-05-05
18-06-05
16-07-05
13-08-05
DS-concentratie
SVI 5
SVI30
10 per. Mov. Avg. (DS-concentratie)

N-removal


NH4-N + NO3-N (mg/l)
40
35
30
25
20
15
10
5
0
Pre-settled
Raw wastewater
Pre-settled
01-12-04
31-12-04
30-01-05
01-03-05
31-03-05
30-04-05
30-05-05
29-06-05
29-07-05
Reactor 1
Reactor 2