

Biomasseforschung in der Schweiz

Energetische Optimierung der Abwasserreinigung mittels granulierter Biomasse

BFE Research and Development Project

RESULTS PRESENTATION

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BFE Bern, 10.05.2017

Project basis

- About 40% of the electricity for biological wastewater treatment is consumed for the aeration for the biological processes (i.e. biooxidation and nitrification)
- The electrical energy consumption of Swiss Waste Water Treatment plants (WWTP) is substantial, approximately 450 GWh per year.

The aim of the project was to evaluate the impact of Puratis aerobic granular biomass (ARGUS) on biological treatment of municipal wastewater and potential to reduce energy consumption for oxidative processes

The main project results

The results obtained on pilot plant can be summarized:

- Puratis aerobic granular biomass (ARGUS) improves the biological wastewater treatment process efficiency and reduces the process hydraulic time by 1/3
- Due to the faster oxidative processes (e.g. nitrification) of ARGUS granular biomass, the overall energy consumption is reduced up to 30%
- The energy consumption of ARGUS granular biomass is highly correlated with the type and quantity of microbial communities within the granular biomass, which has the main effect on energy efficiency

Project partners



Puratis Sàrl is Swiss R&D company active in domain of environmental biotechnology. Puratis develops and applies novel wastewater treatment processes for complex organic compounds removal.



BlueWatt Engineering Sàrl is exploiting and developing a state of the art physicals models library for the numerical simulation of Waste Water Treatment Plants.

Aerobic granulation

- Aerobic granules are considered to be a special case of biofilm, composing of self-immobilized cells (Tay et. al.)
- Biomass granulation was first described for strictly anaerobic systems in 1980 (Lettinga et. al.)
- A general definition of aerobic granular sludge was set at the first aerobic granular workshop (2004)

There are many theories how aerobic granular biomass is formed, but all have one in common i.e. the crucial component of aerobic granules are EPS (exopolymeric substances), which help to form and maintain granular structure

Our expertise in granulation

> 15 years of expertise

M. Glancer-Šoljan, S. Ban, T. Landeka Dragičević, V. Šoljan, V. Matić (2001). Granulated mixed microbial culture suggesting successful employment of bioaugmentation in the treatment of process wastewaters. Chem. Biochem. Eng. Q. 15, 87-94.

2004 the first application

Activity of the granulated biomass of the mixed microbial culture for highly efficient carbon and nitrogen removal in the process wastewaters. European Symposium on Environmental Biotechnology, ESEB 2004, Oostende, Belgium, 25.-28. April, 645-648.

>50 laboratory testing

>15 pilot plant installations

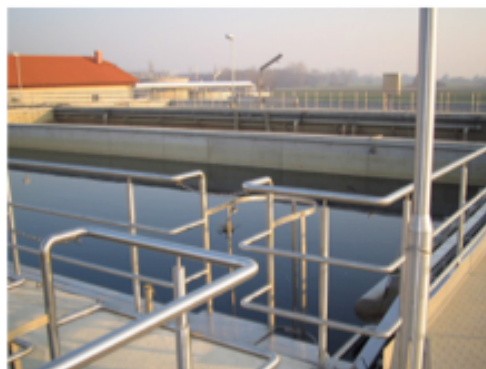
5 full-scale applications in industry

Industrial applications

WWTP
Pharmaceutical industry



WWTP
Pharmaceutical industry



WWTP
Pharmaceutical industry



WWTP
Landfill leachate



WWTP
Coke wastewater



ARGUS vs. NEREDA

ARGUS GRANULAR BIOMASS

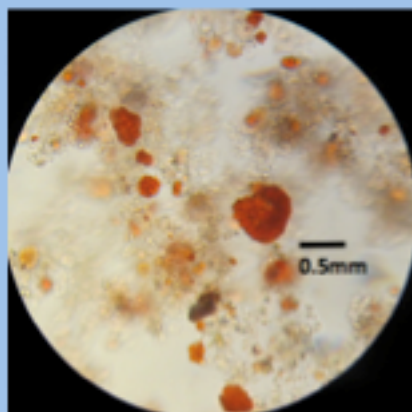


Figure 1. Light microscope image of the ARGUS granular sludge 400x*

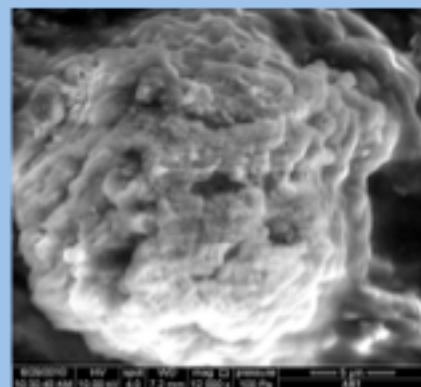


Figure 2. SEM image of the ARGUS aerobic granule 12000x

NEREDA GRANULAR BIOMASS

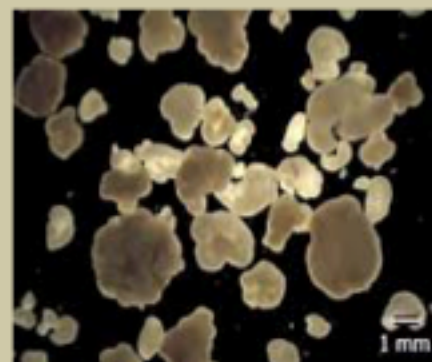


Figure 3. Light microscope image of the NEREDA granular sludge 400x

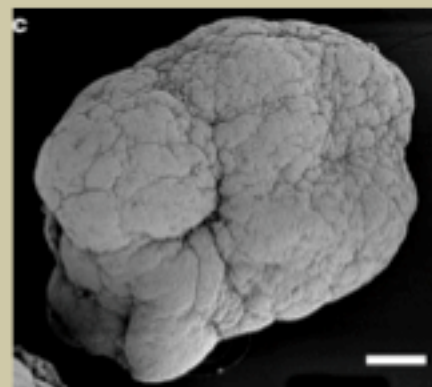


Figure 4. SEM image of the NEREDA aerobic granule 12000x

ARGUS vs. NEREDA

ARGUS GRANULAR BIOMASS

Application domain:
Existing (and new) WWTPs

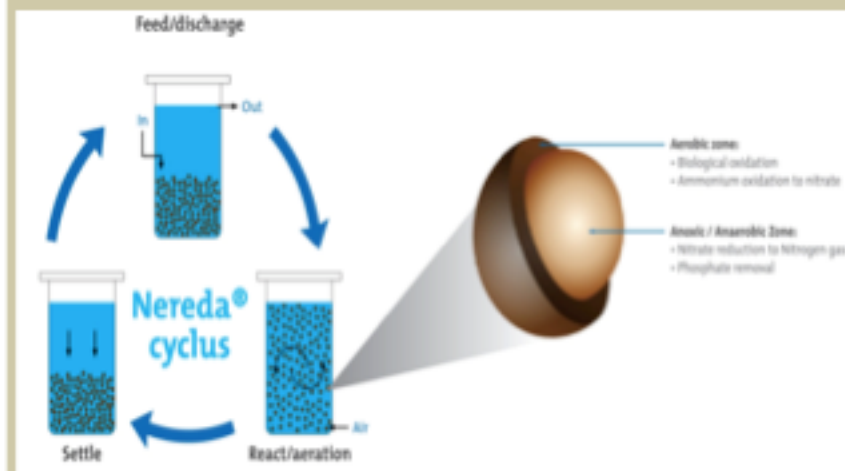
Principle of Application



NEREDA GRANULAR BIOMASS

Application domain:
New WWTPs or complete reconstruction of WWTP

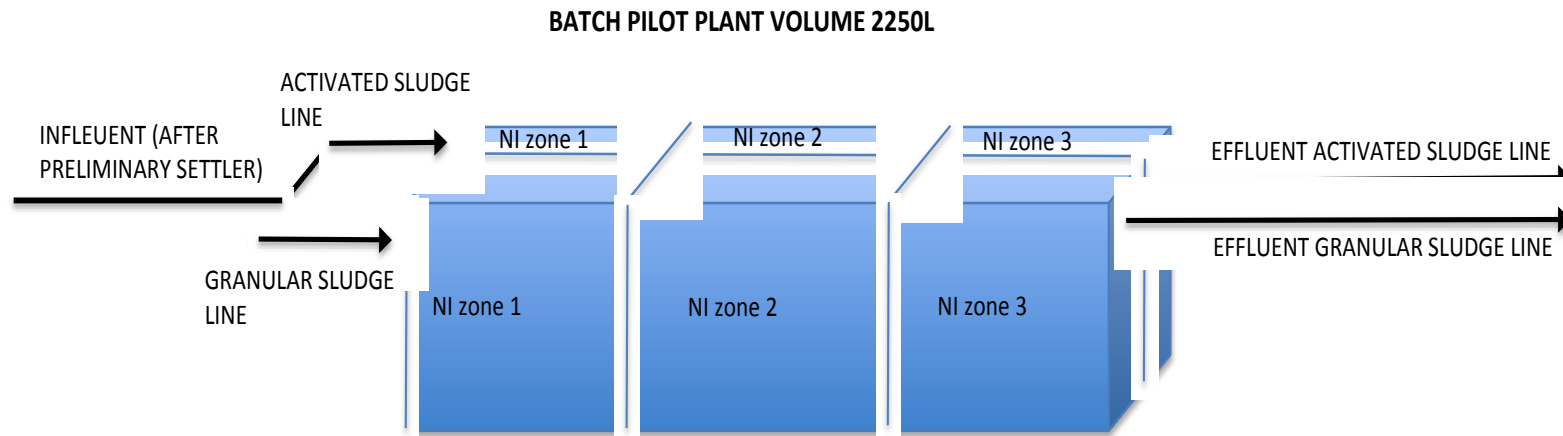
Principle of Application



Main outcomes of the pilot plant tests

Pilot plant tests set up

Pilot tests were carried out in parallel in two process lines, comparing granular biomass (GB) with the existing activated sludge (AS)



Each pilot plant line has 1125 L

Pilot plant tests set up

Each line was inoculated with 2.5 g/L of activated sludge and granular biomass respectively

Batch cycles (aeration): 4-8 hours (6 h in average)

Sedimentation	Decanting	Filling	Aeration
30 min	15 min	5 min	6 hours

Process parameters:

- temperature 18-25 oC
- pH 6.8-7.5
- MLSS 2.5-3.2 g/L
- VER 30-50%

Abbreviations: MLSS: mixed liquor suspended solids; VER: volume exchange rate

Pilot plant installation



Pilot plant installation



On-site cultivation and adaptation of granular biomass



Aerobic granular line



Activated sludge line

Pilot plant control and monitoring

Three main targets:

1. Process efficiency and operational parameters
2. Morphological changes of aerobic granular biomass
3. Energy consumption

Pilot plant control and monitoring

Process efficiency and operational parameters

Comparison of the granular biomass (GB) and the existing activated sludge (AS) efficiency of COD and NH₄-N oxidation

A-line Activated sludge line	B-line Granular biomass line
Reduction COD _{tot} %	Reduction COD _{tot} %
43	50

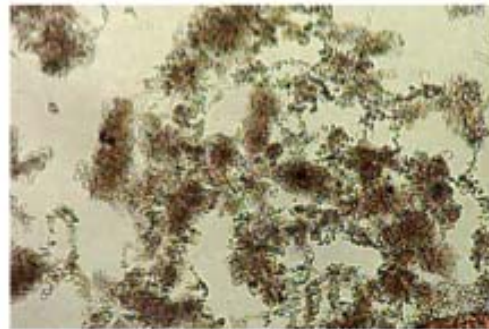
A-line Activated sludge line	B-line Granular biomass line
Reduction NH ₄ -N %	Reduction NH ₄ -N %
71	95

Ammonia oxidation for B-line 24% higher
COD oxidation for B-line 7% higher

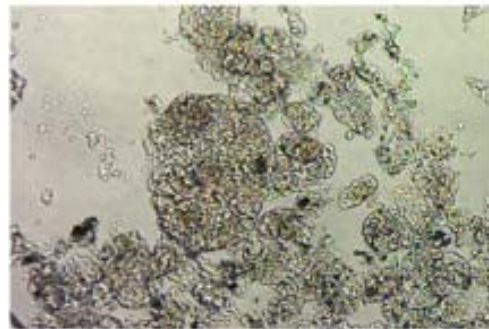
Pilot plant control and monitoring

Morphology of the AS and GB during the pilot plant tests

Pilot plant
test start

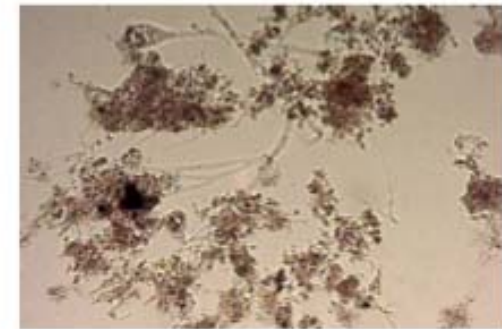


Activated sludge

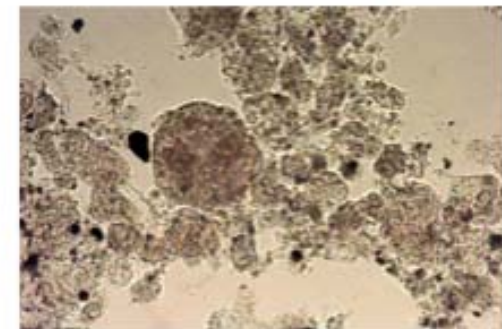


Granular biomass

Pilot plant
test end



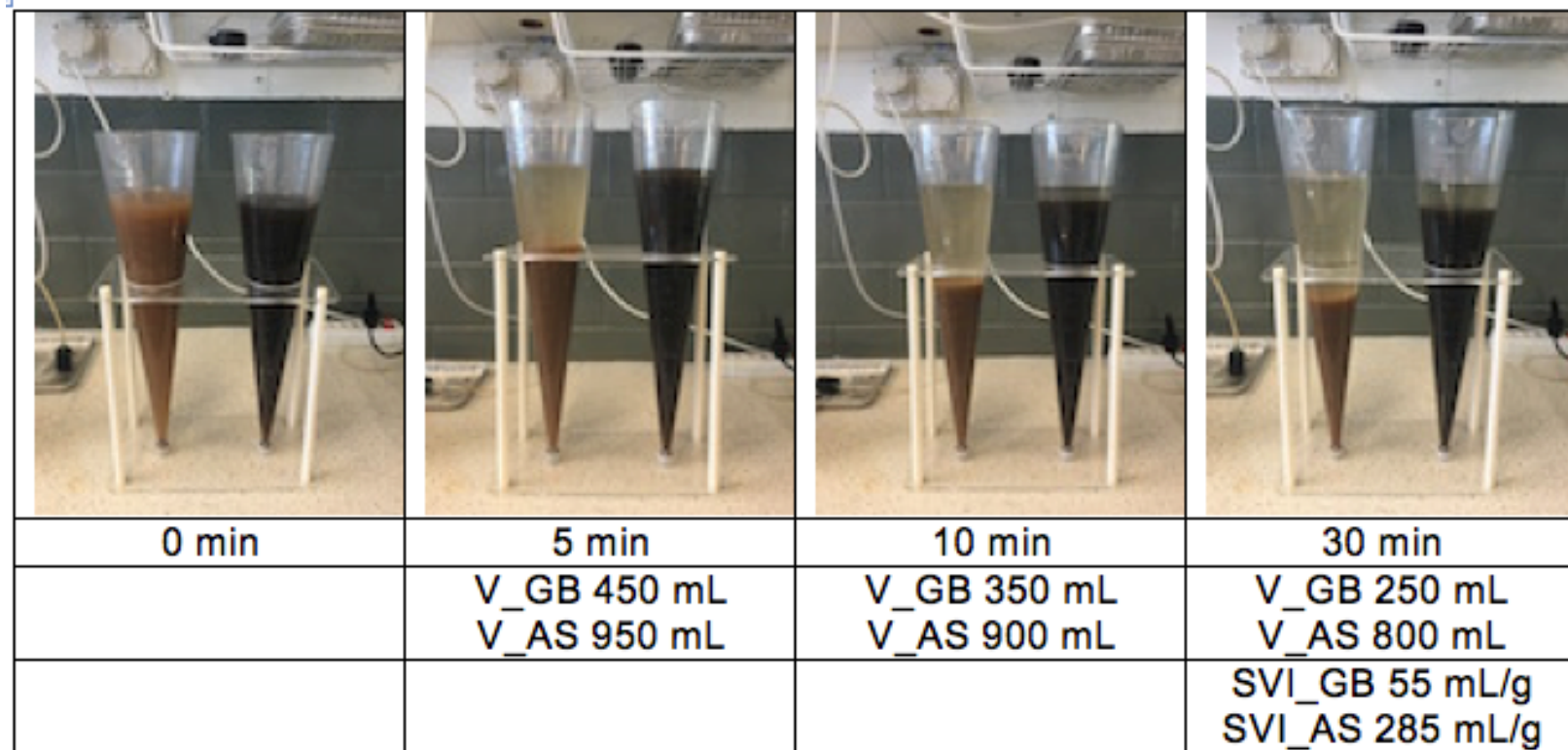
Activated sludge



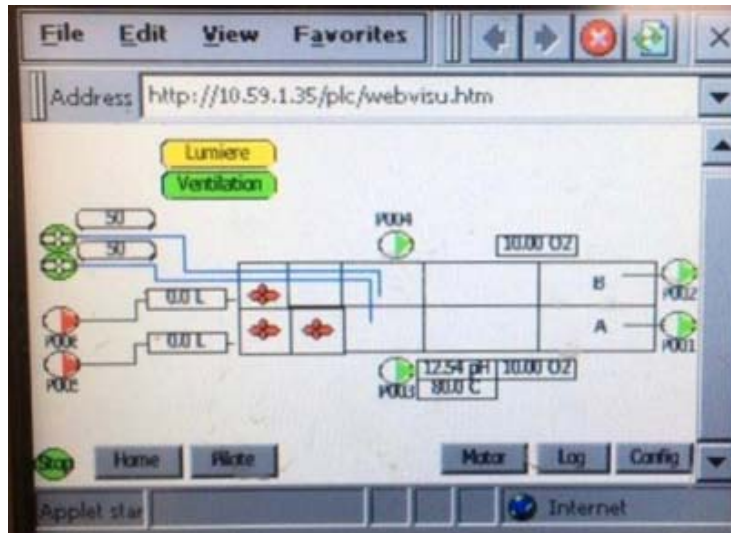
Granular biomass

Pilot plant control and monitoring

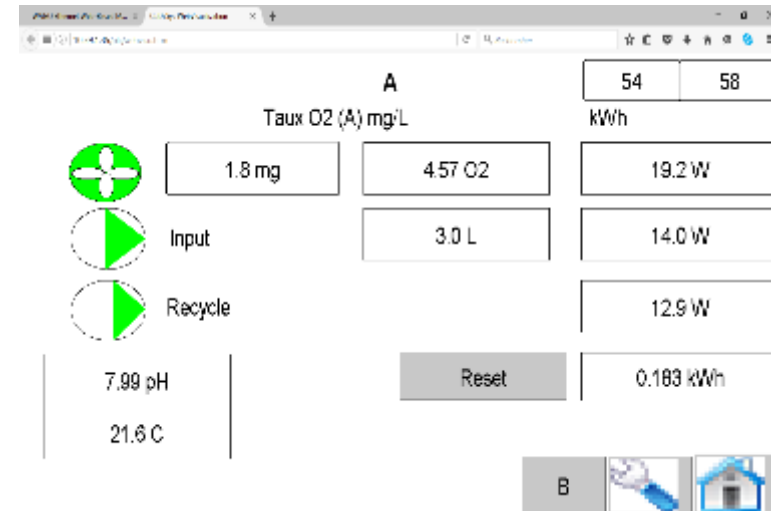
Sedimentation test



Energy consumption control



Monitor of pilot plant unit



Control of energy consumption

The average energy consumption measured:

A-line 11.94 kWh (activated sludge line)

B-line 7.6 kWh (ARGUS granular biomass line)

Principal control parameter was ammonia oxidation

Comments on results

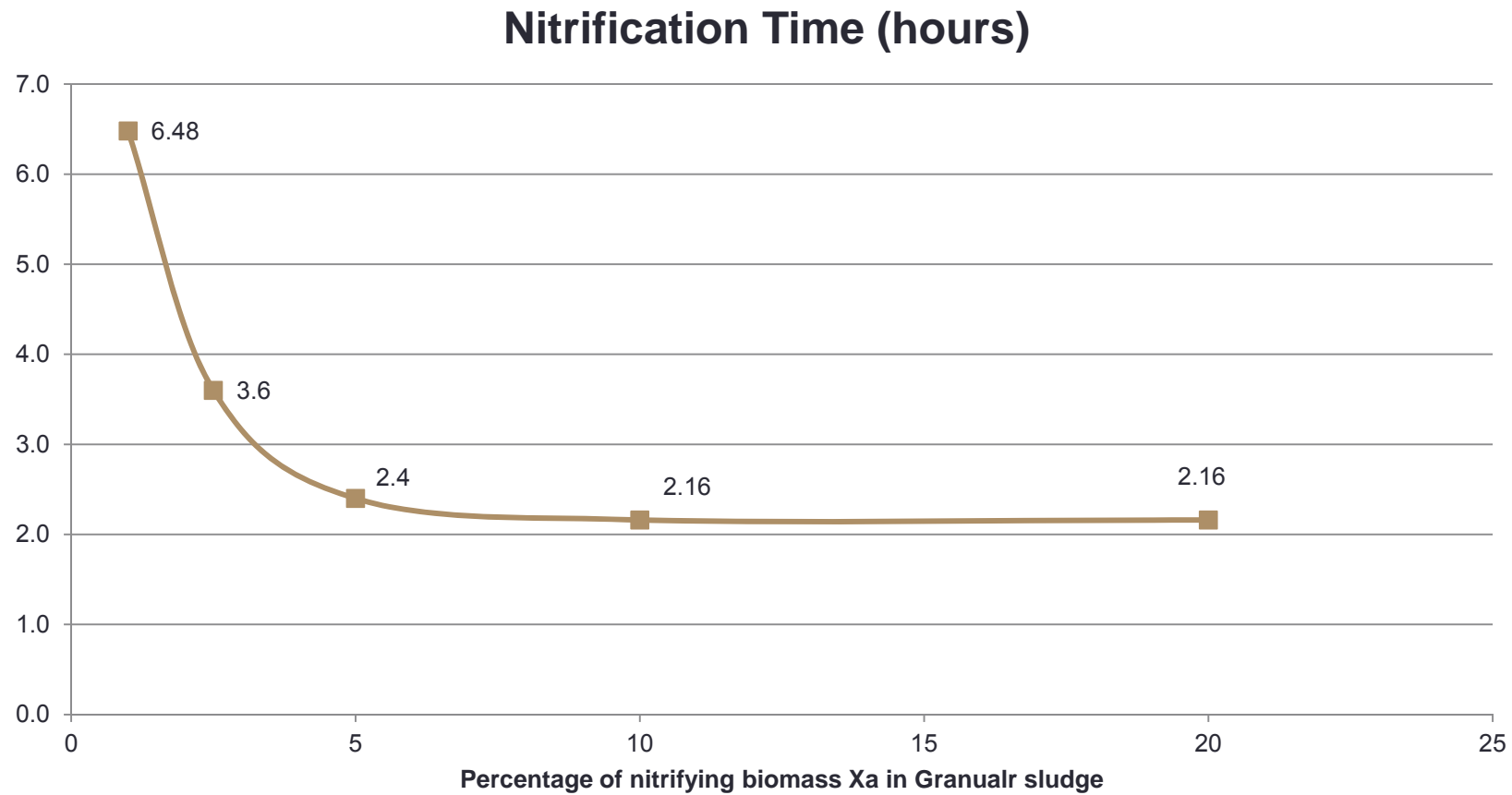
1. ARGUS granular biomass (GB) is more efficient on ammonia oxidation comparing with the existing activated sludge (AS)
2. The structure and morphology of GB remained stable during the period of pilot plant tests
3. The sedimentation of GB is superior comparing with the existing AS
4. Specific energy consumption is similar as activated sludge, but due to the faster nitrification process, GB process uses overall less energy (used for the aeration) than AS

Energy optimization potential

Reduced energy consumption of ARGUS granular sludge is based on microbiological characteristics of ARGUS granular biomass.

Comparing to NEREDA process, ARGUS granular biomass has increased percentage of nitrifying microorganisms, thus faster oxidative processes can be achieved.

ARGUS granular biomass

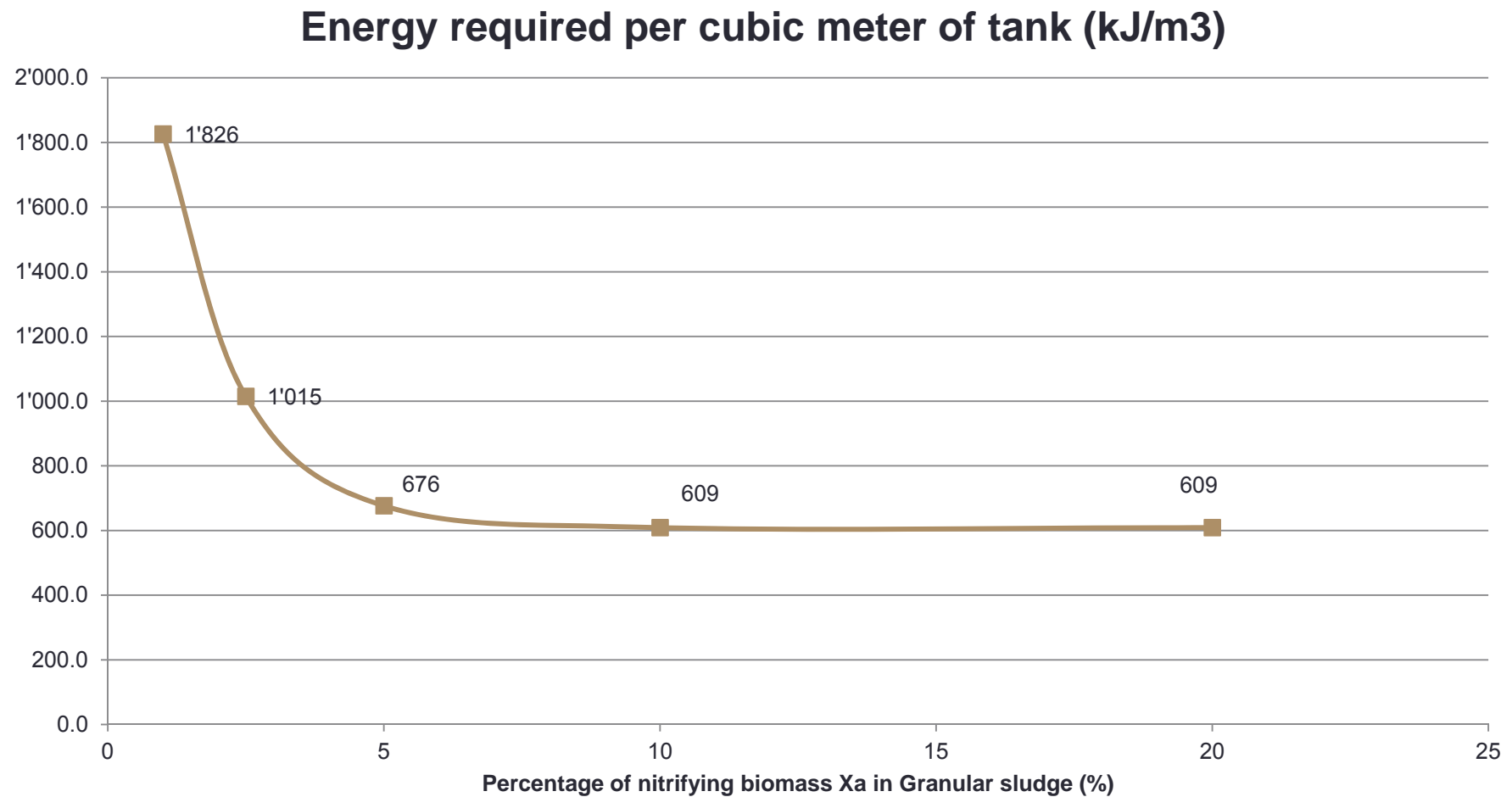


Modeling by BlueWatt Engineering Sàrl

I would put the graphs into the written results section (this slide + next slide)

Hermle Sandra BFE; 02.05.2017

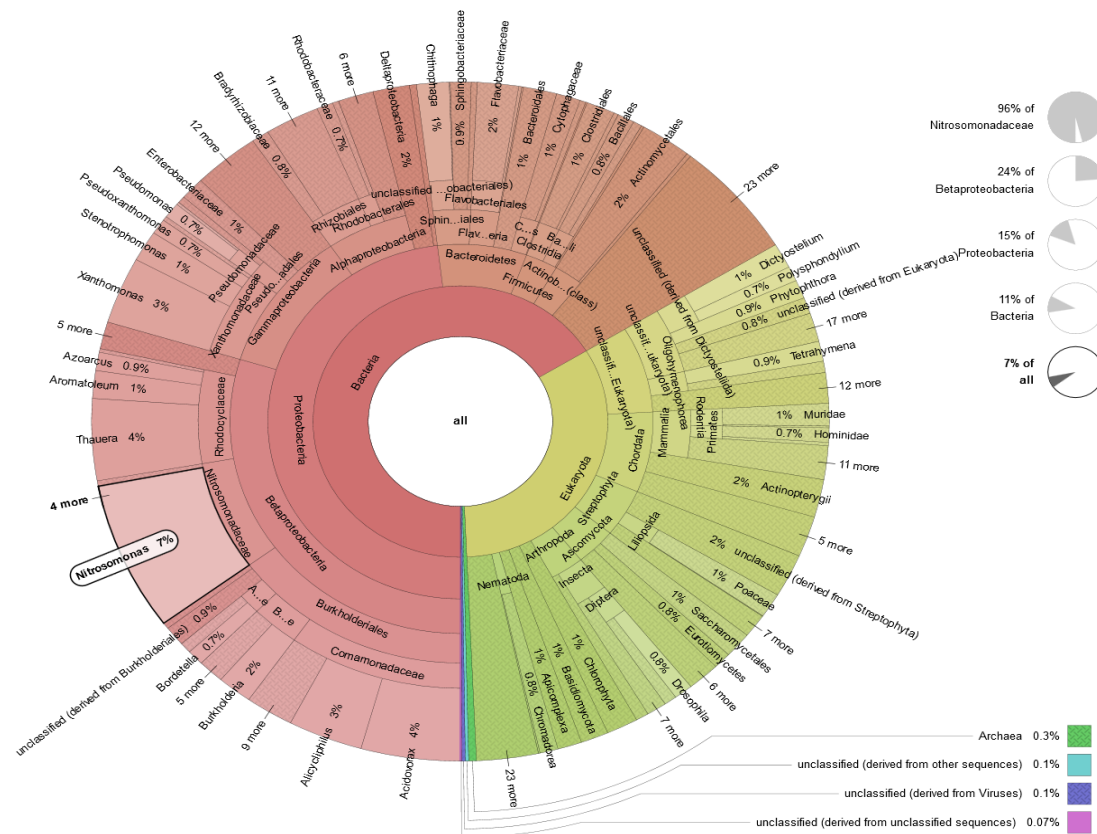
Project basis



Modeling by BlueWatt Engineering Sàrl

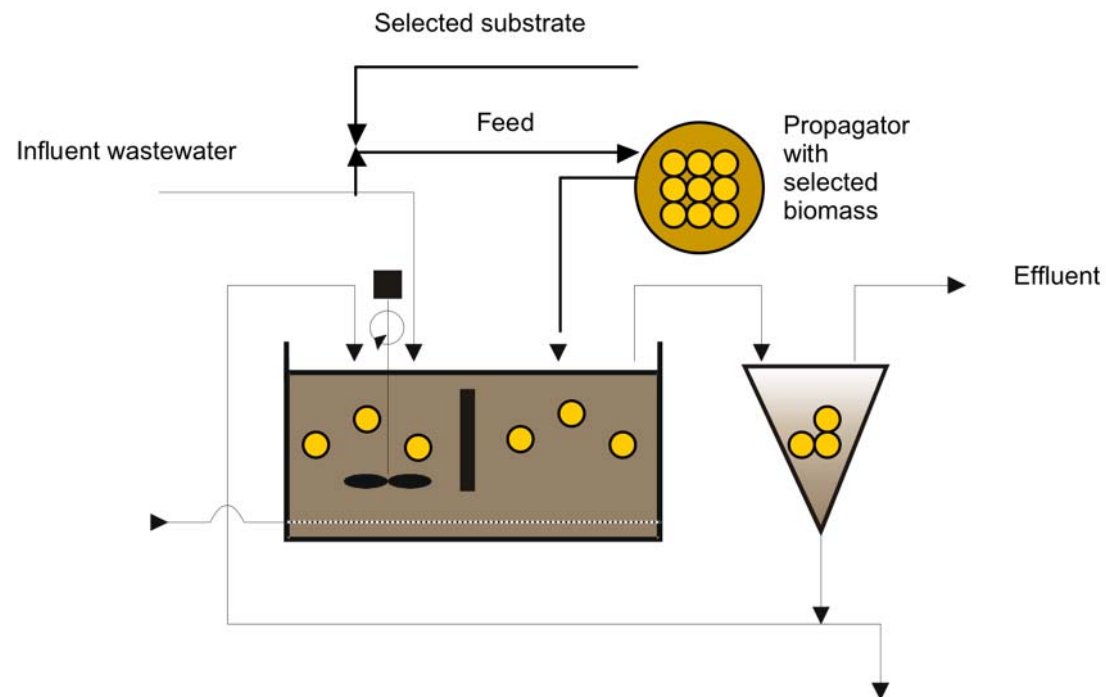
Molecular basis of ARGUS

Concentration of target microbial groups (nitrifying bacteria)



Microbial community analysis of activated sludge enhanced by ARGUS granular biomass (analyses performed by HEPIA Lullier)

ARGUS process application



Simplified ARGUS granular biomass application in wastewater treatment plant



THANK YOU

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