INTERREG 2 SEAS NEREUS PROJECT

1st of June 2021
Veerle Depuydt

New Energy and REsources from Urban Sanitation

Programme priority: 4. Resource efficient economy

Programme priority specific objective: Increase the adoption of new circular economy solutions in the 2Seas area

PROJECT DURATION: 1/10/2017 – 31/12/20201

TOTAL PROJECT BUDGET: +/- 6.9 million €(48,10% ERDF cofinancing)

OVERALL OBJECTIVE

Is to increase **the reuse of resources, water and energy from waste water** by boosting the adoption of technologies that recover resources, water and energy from wastewater **in urban areas**

- Demonstration framework and institutional framework

FOCUS


Water reuse
Nutrient recovery
Energy recovery
Decision Support Tool
Community Acceptance
Strategies & Business Models

Circular economy

Who?

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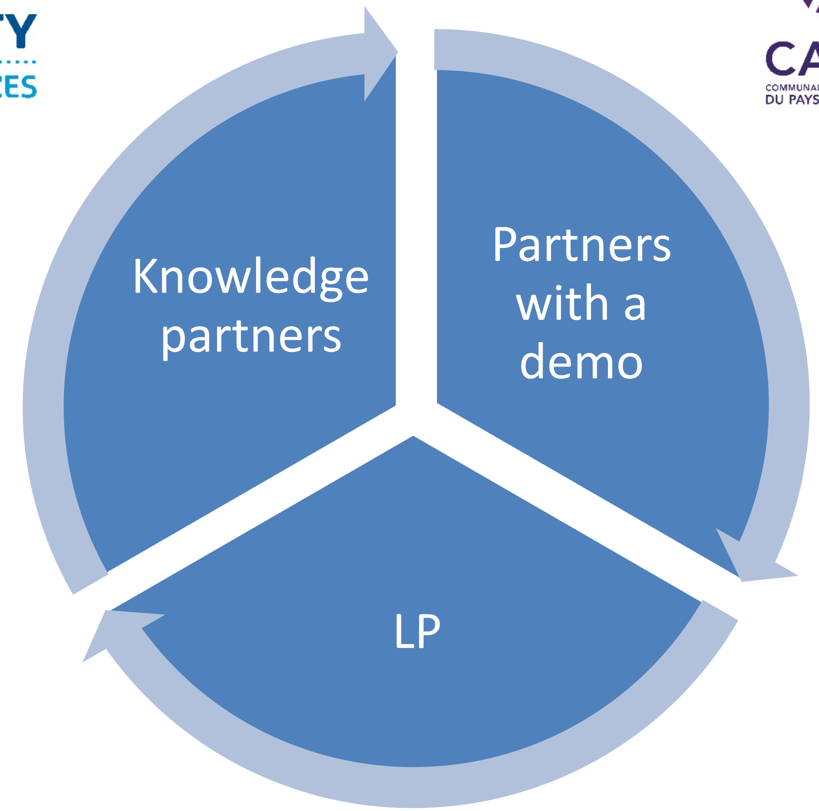
NEREUS
European Regional Development Fund

HZ UNIVERSITY OF APPLIED SCIENCES

UNIVERSITY OF PORTSMOUTH



CAPSO
COMMUNAUTÉ D'AGGLOMÉRATION DU PAYS DE SAINT-OMER

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water-link

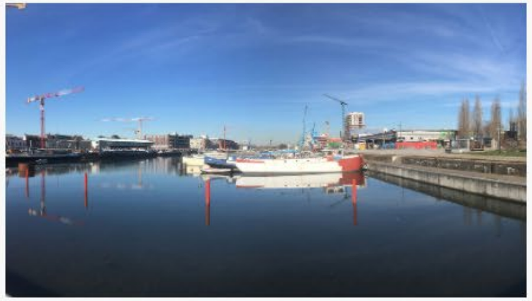
DuCoop

WATER for LIFE from Southern Water

vito

Demonstrations

Antwerpen Nieuw-Zuid, BE
water-link



Nieuwe Dokken Gent, BE
Ducoop

Saint-Omer WWTP, FR
CAPSO

Rotterdam/Delft, NL
Evides

Peel Common WWTP, UK
Southern Water

Circular economy

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www.NEREUS-project.eu

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EUROPEAN UNION
2 Seas Mers Zeeën
European Regional Development Fund

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Democase Den Hoorn

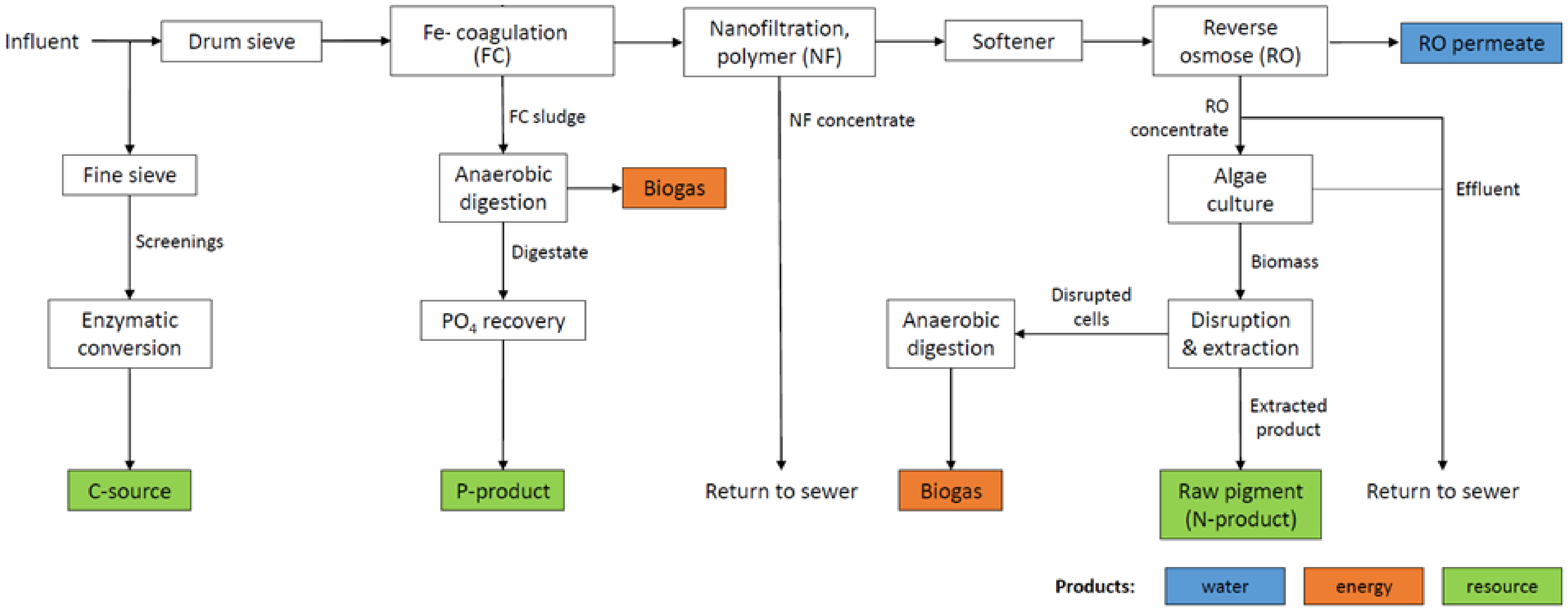
Results on Resource recovery from municipal wastewater

T.Steenbakker

Democase Den Hoorn

- Contents
  - NEREUS democase Den Hoorn; The process
  - General
  - Resource recovery

NEREUS democase Den Hoorn



General

- Focus on resource recovery.
- Gained operational experience.
- Fe-Elektrocoagulation:
  - Switch to Fe-coagulation;
  - Requirements nanofiltration.
- Nanofiltration:
  - Operational challanges;
  - Biological active water.
- Reverse osmosis:
  - No challanges.

Team NEREUS

• David Moed	Teamleider R&D
• Paula van den Brink	Projectleider/procestechnoloog
• Han van de Griek	Procestechnoloog
• Tessa Steenbakker	Procestechnoloog
• Salah Alzuhairy	Procestechnoloog
• Vincent Eckhardt	Procestechnoloog
• Ruben Kok	Procestechnicus
• Siem Eerden	Stagiair TU Delft

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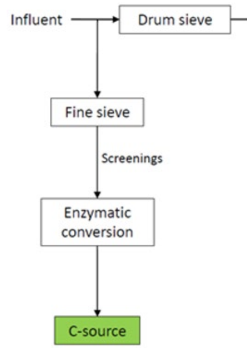
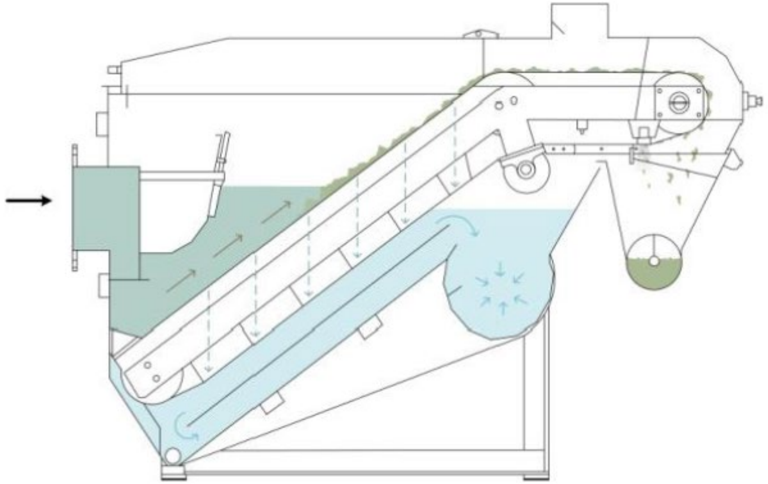
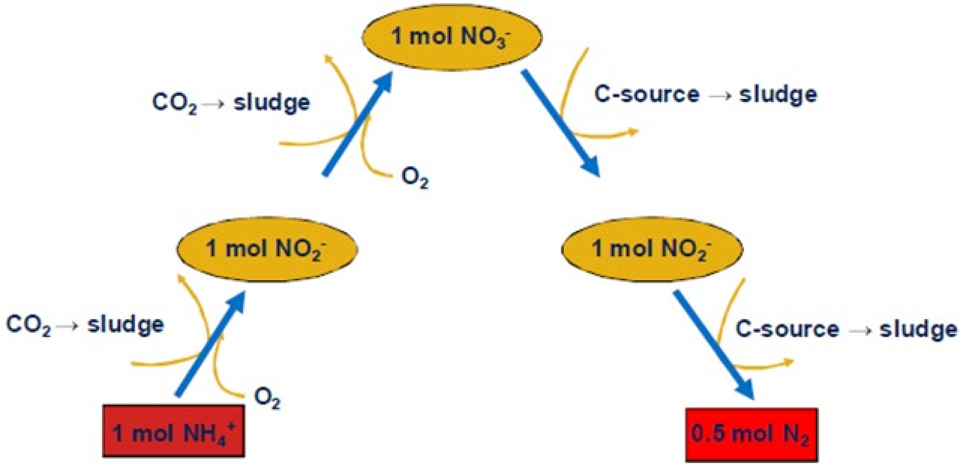
Cellulose to C-source



- Cellulose from toilet paper.
- C source is needed for denitrification.
- In the event of a lack of influent > purchase methanol or glycerin.
- Great impact on CO² footprint.
- Possible to enzymatically convert fine sieves into C-source?





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Cellulose to C-source

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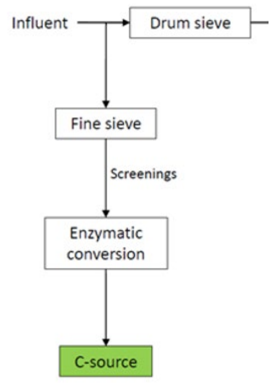
- Enzyme performs best in acidic environment
- Several experiments on lab- and pilot scale:
    - Optimise conversion;
    - Use of the product;
    - Use of the ‘leftovers / waste’ of the conversion.



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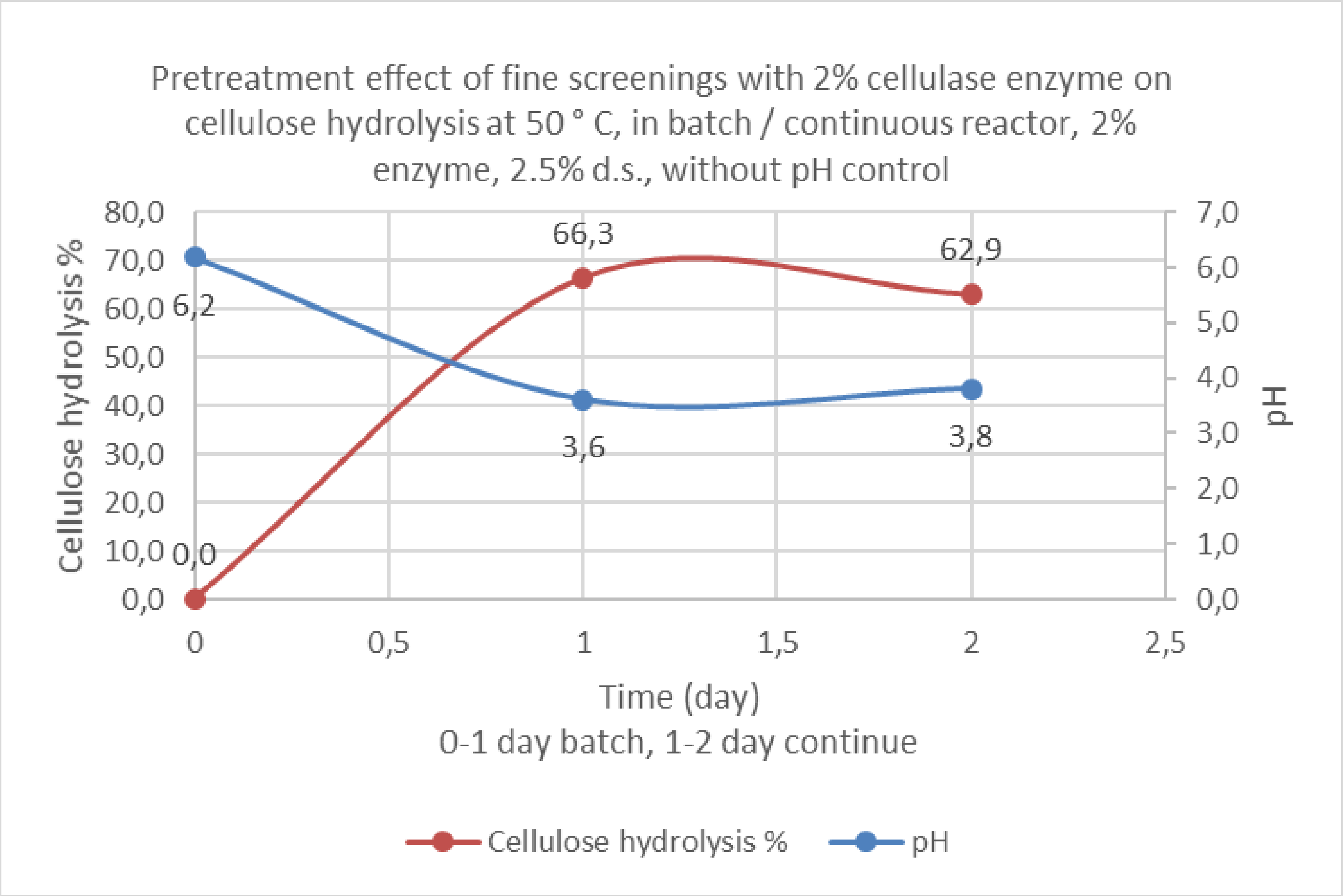
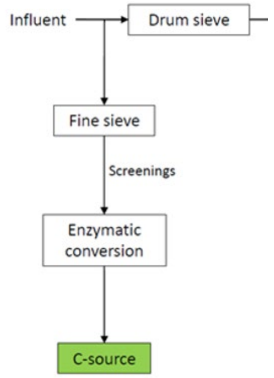
Cellulose to C-source





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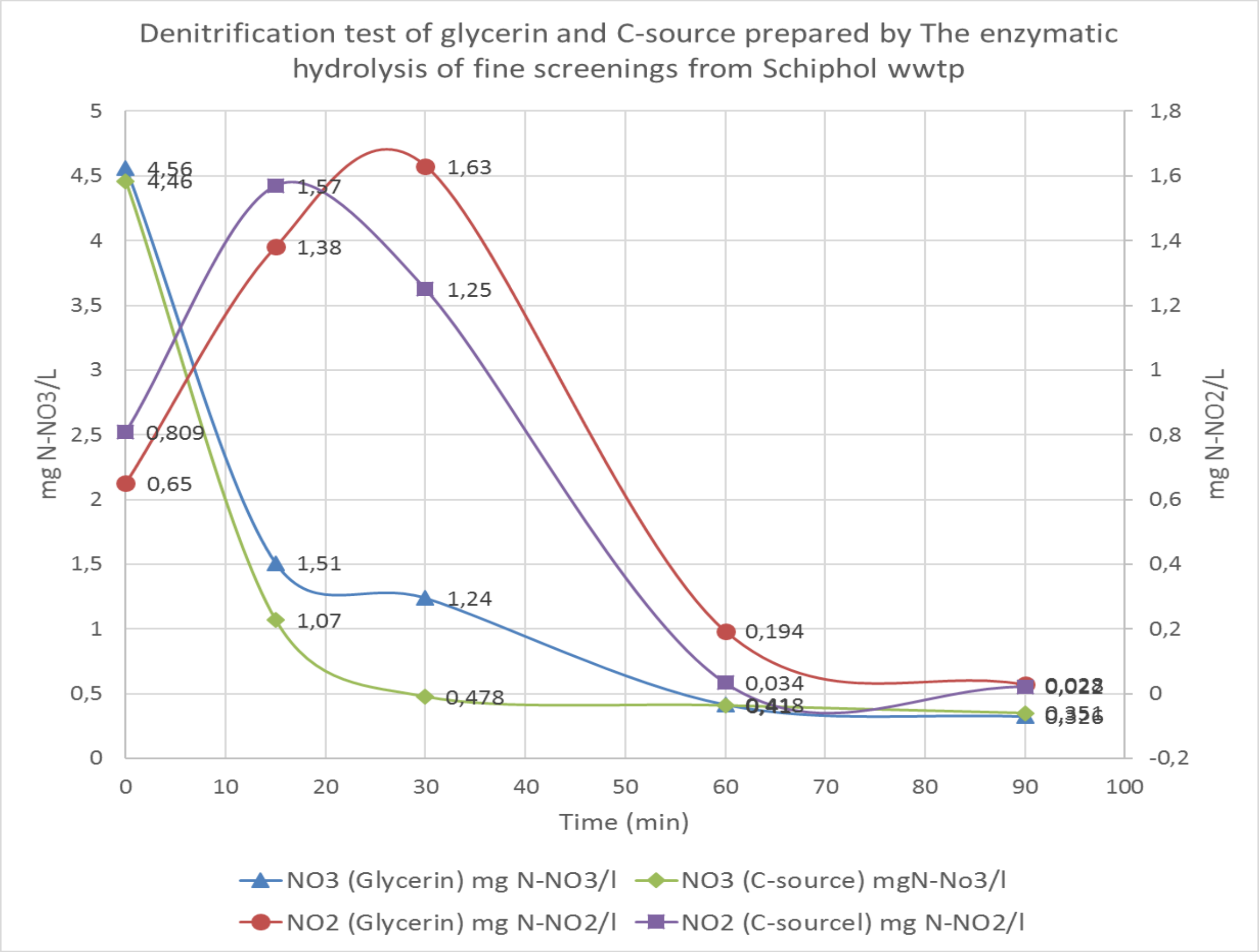
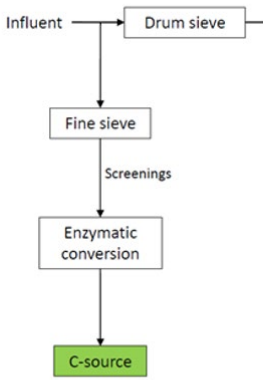
Cellulose to C-source



EXP: Denitrification test of glycerin and C-source produced from screenings of wwtp. HNP and Schiphol

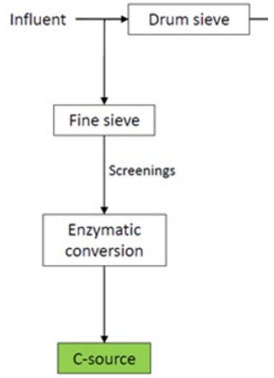


Cellulose to C-source

- Bio-Methane potential test (BMP) of the leftovers after the cellulose hydrolysis

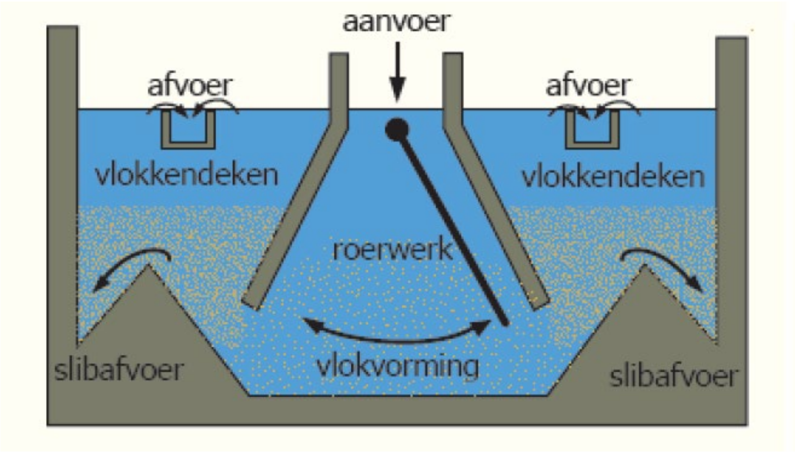
- Methane productivity per gram of organic material:
  - Filtered leftovers: 384.4 ml/g o.m.
  - Primary sludge from Harnaschpolder wastewater treatment plant: 360 ml/g o.m.

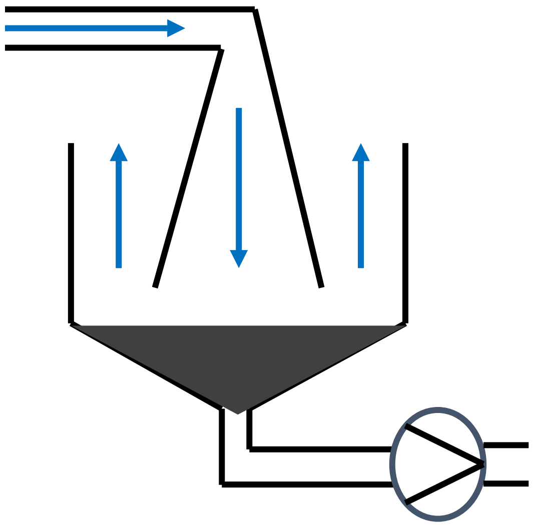
- This means that the leftovers can be anaerobically converted to methane.

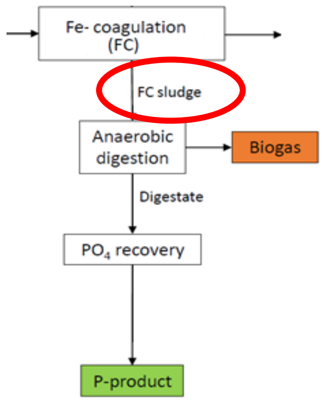


Fe-coagulation

- Removal of:
  - Suspended solids; 90%
  - Chemical oxygen demand; 71%
  - Total fosfor; > 77%
  - Orthophosphate; > 69%
  - Total nitrogen; 29%
  - Total iron; 92%



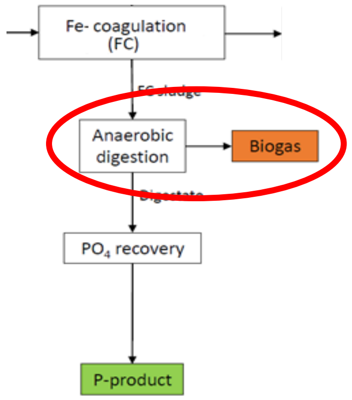




Fe-coagulation; Biogas production

- Experiments on anaerobic digestion to produce biogas:
  - Compare FC-sludge to primary sludge of HNP.

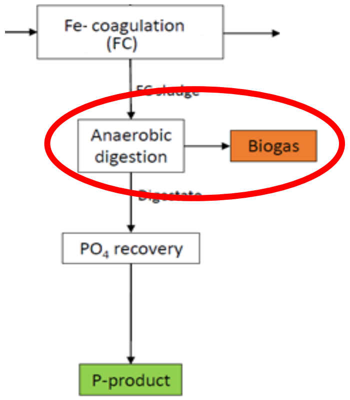
Sample	Methane productivity (mL/g o.m.)
Fe-coagulation-sludge	362
HNP primary sludge	329



Fe-coagulation; Biogas production

- Experiment to optimise biogas production:
  - Related to pH (pre-treatment increase pH).

Sample	Methane productivity (mL/g o.m.)
FC-slib, pH 7	362
FC-slib, pH 8	479
FC-slib, pH 9	586
FC-slib, pH 10	0



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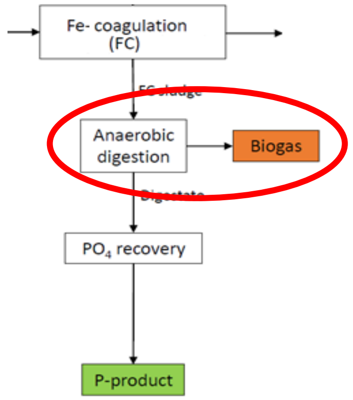
Fe-coagulation; biogas production

- Digestor design:
  - Residence time 15 days
  - 17,1 kg TSS/day
  - ➢ 8.9 m^3 reactor volume

- With pH 9-yield: 5.8 m^3/day

➢ 0.65 m^3 gas/m^3 reactor/day

- Compared to HNP digestor: 0.54 m^3 gas/m^3 reactor/day

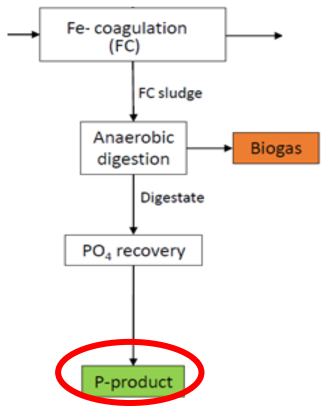


Fe-coagulation; P-recovery

- From digestate anaerobic digestion.
- Daily 403,2g P in sludge.
- Struvite production could be 3,2 kg per day.

- Heavy metals in sludge!

	Measured value	**Allowed**
	mg/kg DS	mg/kg DS
Copper	547,2	75
Lead	2036,3	100
Zinc	1606,4	300



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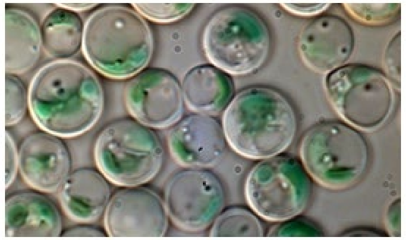
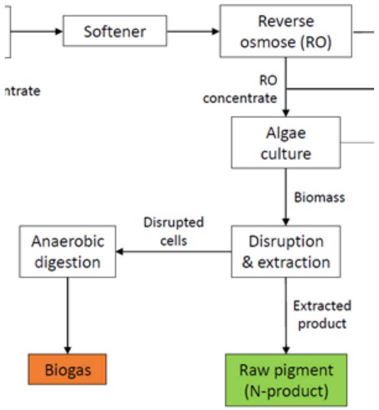
Algae culture

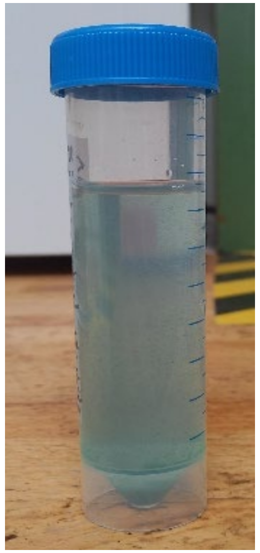
- Tubulaire photobioreactor (PBR)
  - Continuous culture
  - Autotrophic growth
- N-removal: ends up in algae biomass:
  - Valuable pigment: Phycocyanin

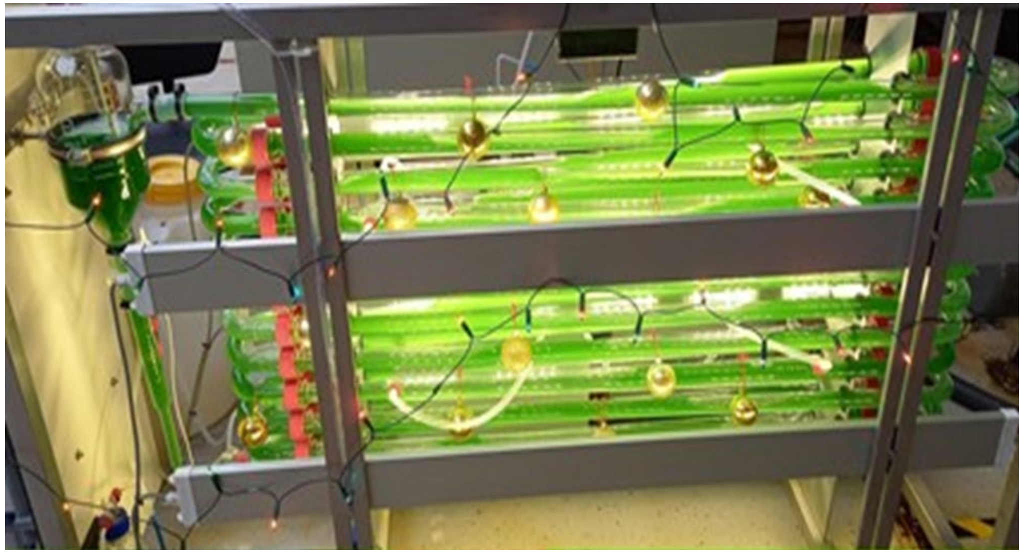


Galdieria sulphuraria

pH 1 - 6
Produces C-Phycocyanin (pigment) ~80€/mg







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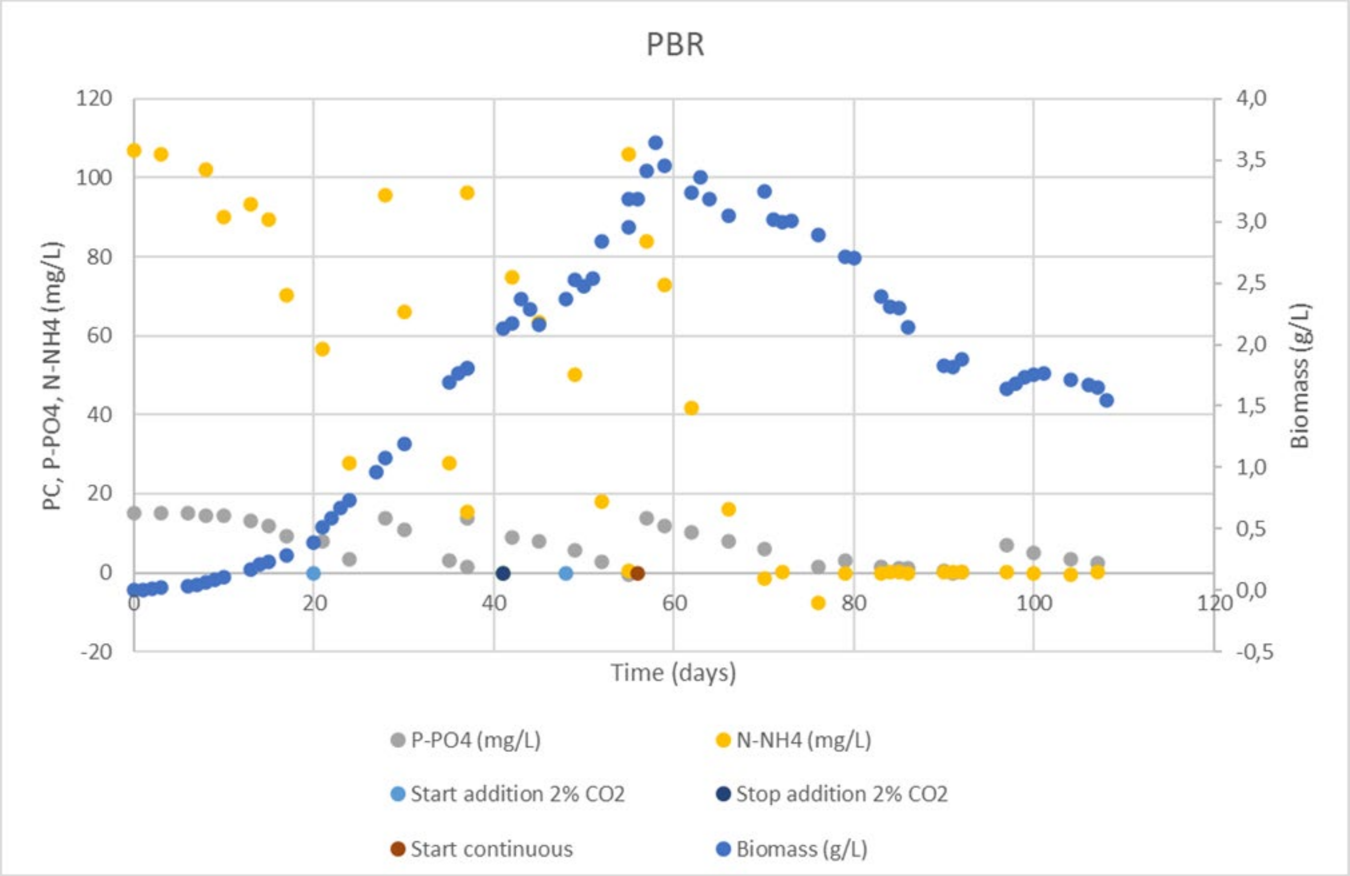
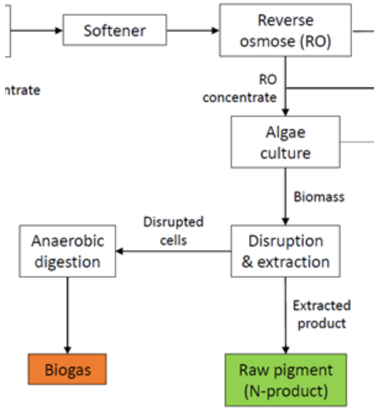
Algae culture



- PBR, continue, autotrophic, synthethic medium
- Limited by N-NH_4
- Light intensity of 80 µmol photons m^{-2} s^{-1}

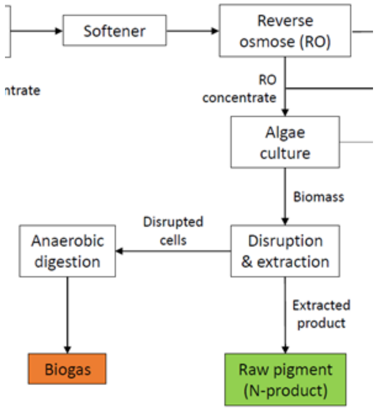


Algae culture

- Needed reactor volume for removal of 5 g NH_4-N/uur (50 L/uur RO concentrate).

- Adding CO_2 essential.
- 16 m^3 reactor needed to remove N.

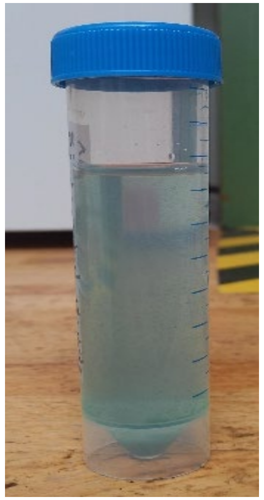
- Growth rate not high enough: add C-source?
  - 600L reactor volume limited on growth rate.
  - Enhance pigment production.

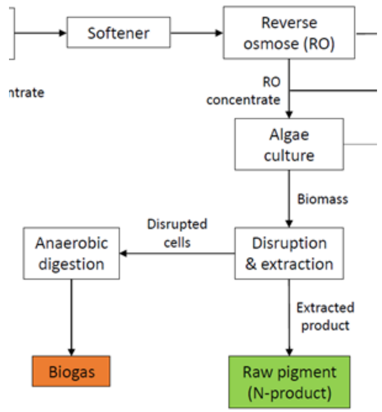


Algae culture

- Experiments with pigment extraction from algae:
  - Beadmill, drying & freezing, pre-treatments, disruption techniques etc..
  - Pigment extraction is hard to acomplish (very strong algae).
- Enhance pigment production with mixotrophic culture.
  - Tests with different C-sources: glucose proved best.

- BMP tests on algae biomass succesfull (biogas production).





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