



N-terugwinning en N₂O-reductie met een ByoFlex[®] stripper

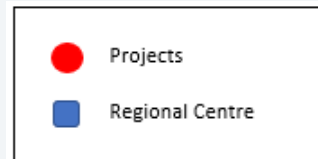
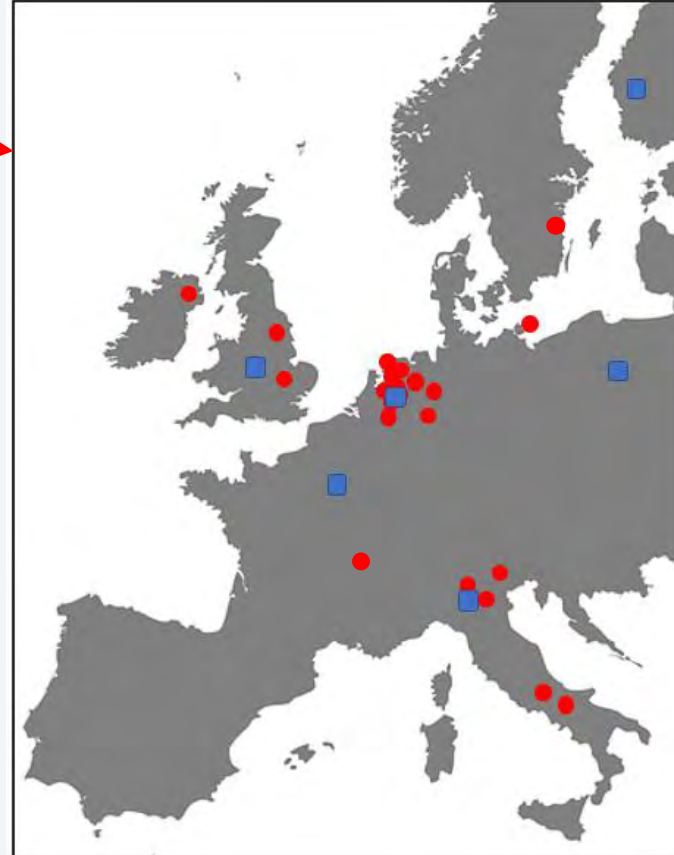
Het Lot van de N – Symposium over stikstofterugwinning – KNW Themagroep
Circulaire Watertechnologie

12 maart 2024, Amersfoort

Gertjan Buffinga, NSI Byosis BV

About Byosis

Global presence



Est'd
2009

>14 years of
expert know-how



Office
The Netherlands,

Subsidiary of
Nijhuis Saur industries,
part of SAUR
with > 11.000 FTE



> 20
Countries
Active

Introduction ammonia stripping & recovery with ByoFlex[®]

01

AMMONIA STRIPPING

AMMONIA RECOVERY

HEAT RECOVERY

About Byosis

Our core technologies – *ByoFlex*[®]

ByoFlex[®]

NH₃-Stripper

Unique standard & custom-built system for polluted substrates; energy efficient; heat recovery; no alkaline agent necessary



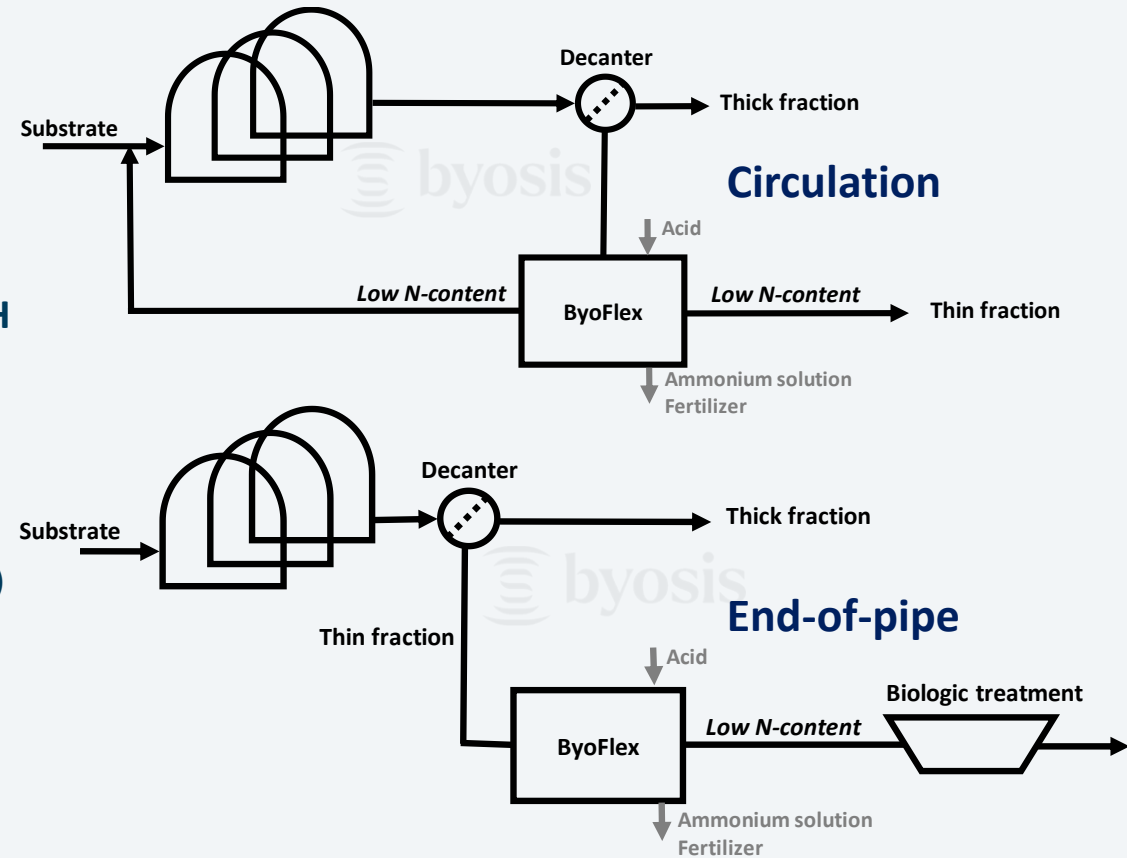
N-NH₄- strip-efficiency

- < 85% No alkaline agent
- > 85% With alkaline agent

Transparent, liquid fertilizer pH

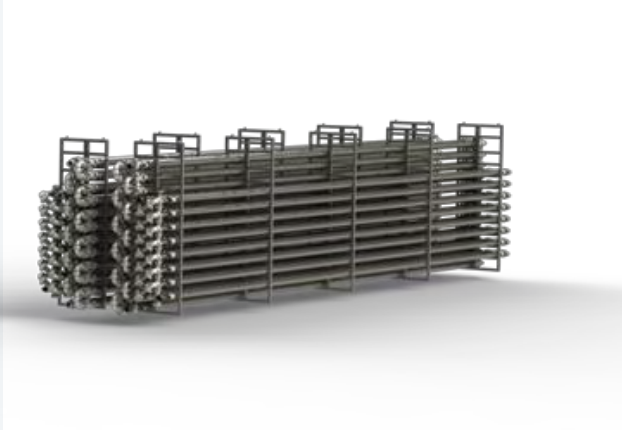
- Using acid as binding agent
- ASL= ammonium sulphate liquid
- ANL= ammonium nitrate liquid

⇒ CE-certificate via Regulation (EU) 2019/1009; Fertilisation Product Regulation (FPR)



About Byosis

Our core technologies – Additional items

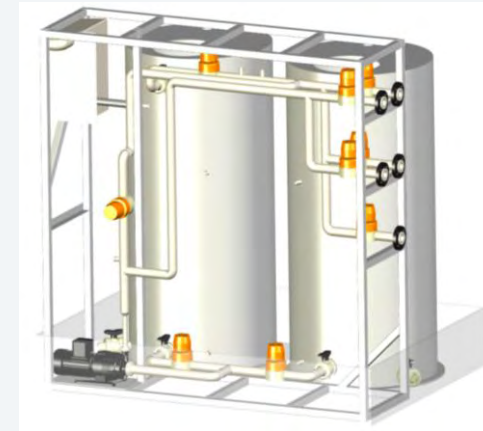


Tube-ex[®]

Heat exchangers

For polluting substrates/high viscosity
100% demountable and expandable

- Heat exchanger/ heat recovery
- Coolers/Condenser/Evaporator



CIPr

Clean-In-Place Systems

Add-on to heat exchangers

- For nitric, phosphoric & organic acids
- Fully automated
- Integrated option or on separate skid

Markets

Waste to Energy and Industrial/Municipal Wastewater

02

WASTE TO ENERGY

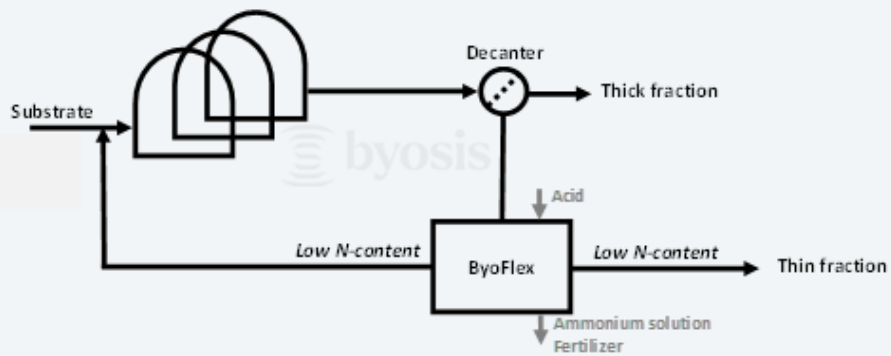
MUNICIPAL WASTEWATER

INDUSTRIAL WASTEWATER

Project Reference Waste to Energy

Wijster, NL

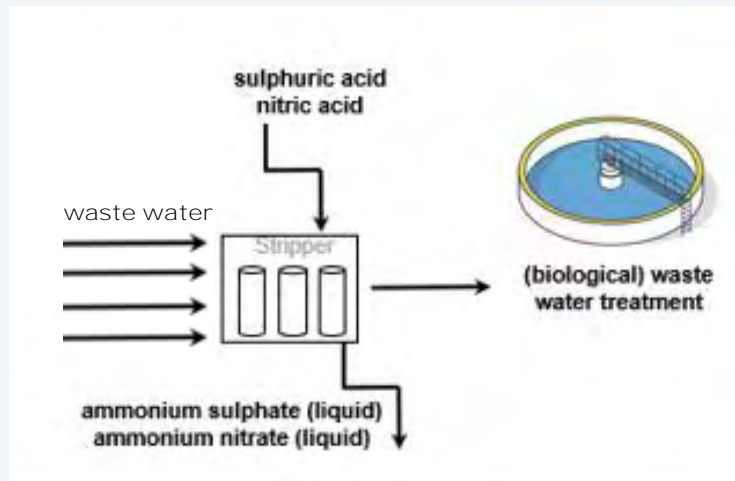
Client: Green Create
Location: Wijster, The Netherlands
Type: ByoFlex 4x20
Substrate: Broiler and Layer manure
Feedstock digester: 200.000 tons/yr
Commissioned: 2022



Project reference Industrial Wastewater

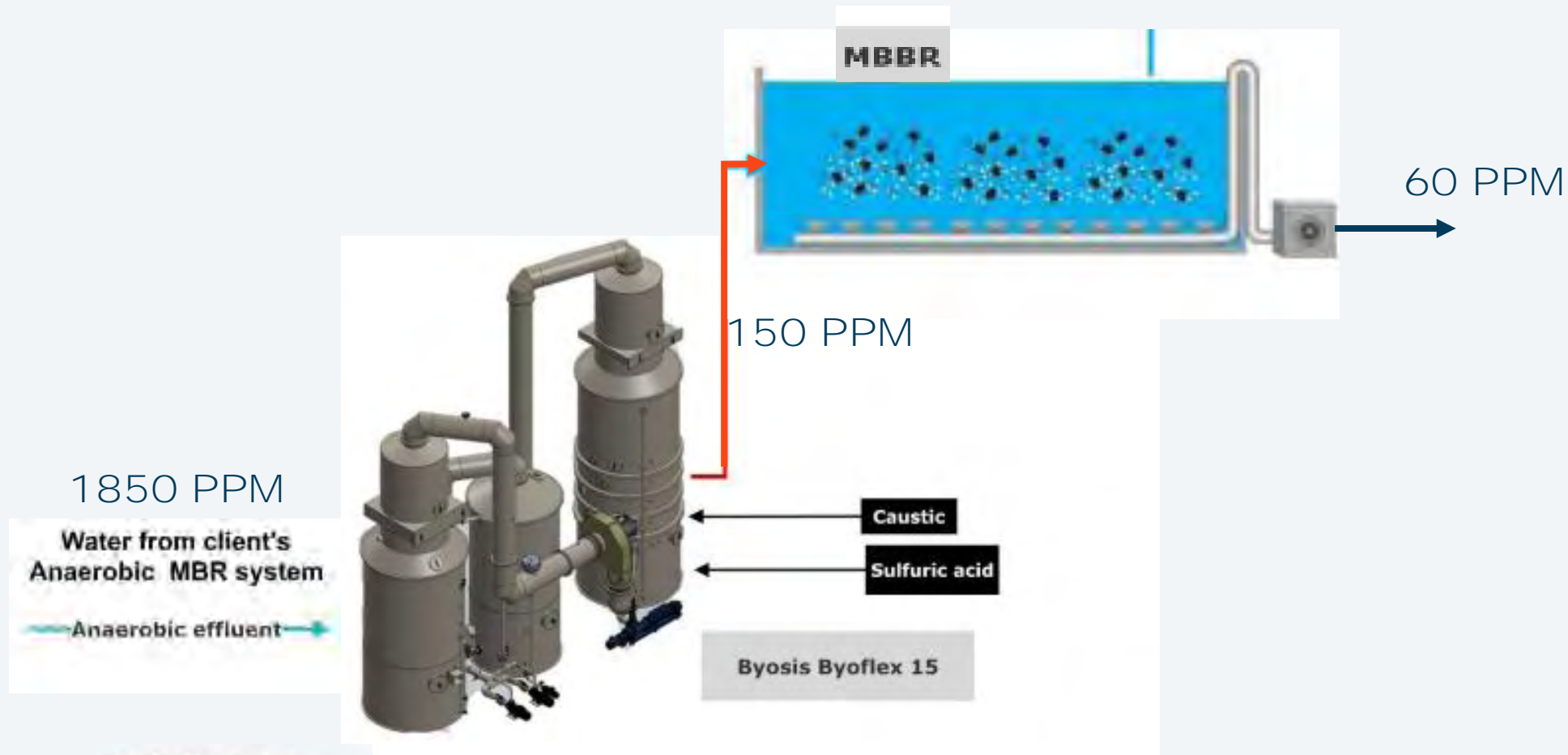
Bergamo (IT)

Client: 3V-Green Eagle
Location: Bergamo, Italy
Type: ByoFlex®-10 stripping unit
Substrate: Industrial wastewater
Quantity: 80.000 tons/yr
To be commissioned: 2023



Project reference industrial wastewater

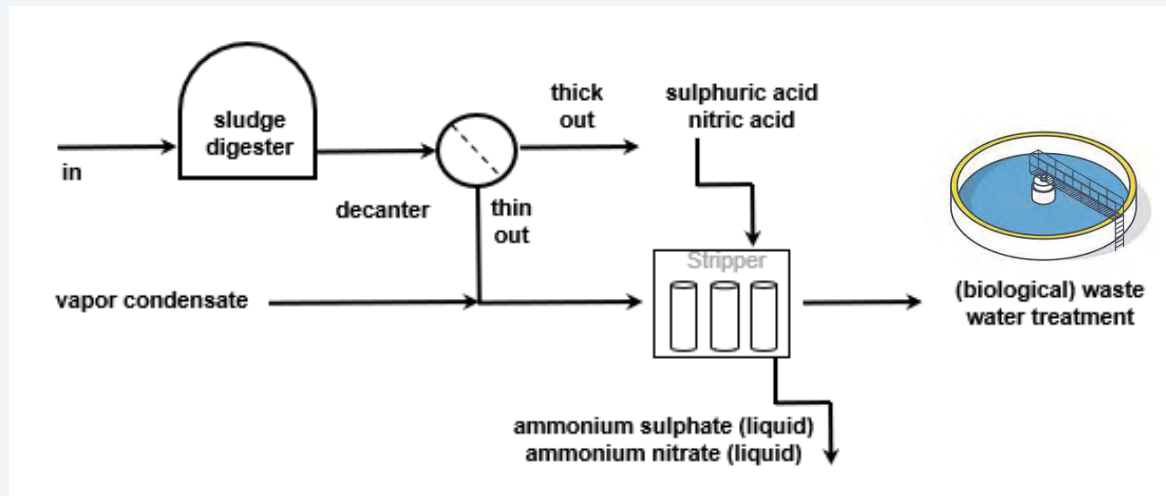
Polishing step; 2 locations (USA), under construction



Project reference Municipal Wastewater

Bergen auf Rügen (DE)

Client: WKS, ZWAR
Location: Bergen auf Rügen, Germany
Type: ByoFlex®-5 stripping unit
Substrate: Sludge digestate/Condensate
Quantity: 38.000 tons/yr
Commissioned: 2021



Byosis and wastewater treatment

Why ammonia stripping and recovery should be something to consider

03

ByoFlex[®] is a competitive and proven technology for N-stripping and recovery from municipal and/or industrial wastewater

Many advantages compared to existing biological alternatives

Mobile DEMO units are available to demonstrate the ByoFlex[®]-technology

N-recovery from municipal wastewater

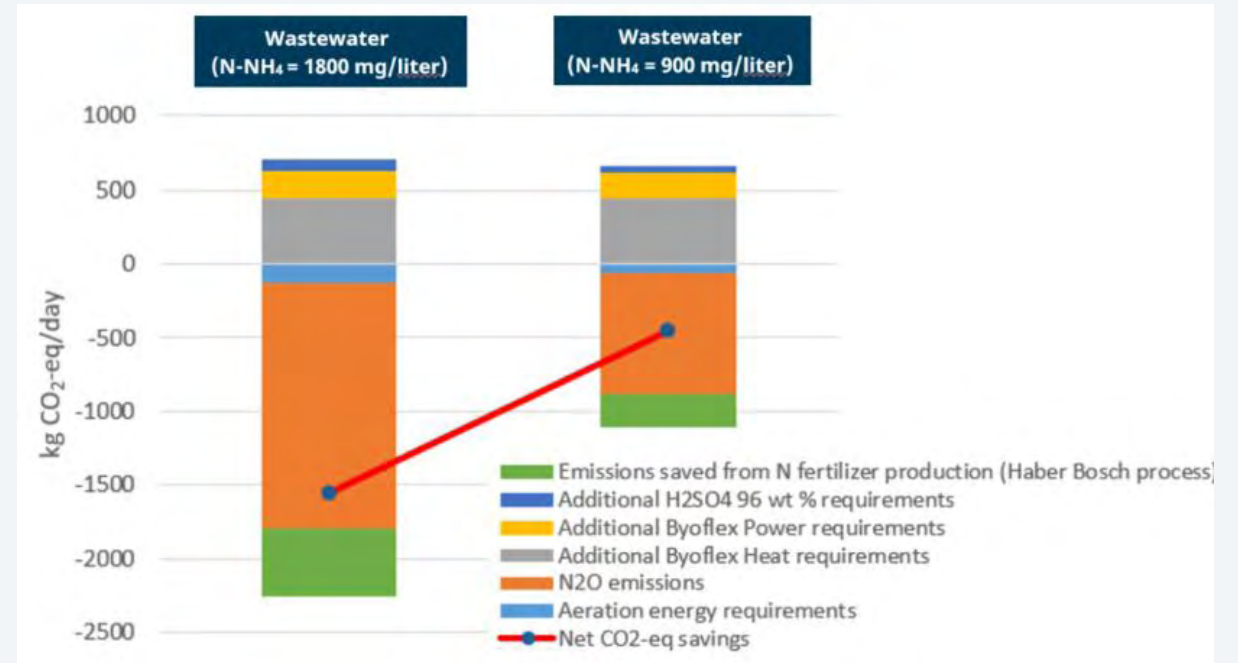
ByoFlex[®] stripping compared to anammox and/or biological treatment

Benefits of stripping:

- ❑ Improvement of carbon footprint (CO₂-eq)
 - N-recovery instead of N-removal
 - Production renewable N-fertilizer
 - No N₂O emissions
- ❑ Reduction of OPEX & CAPEX
 - Compact and modular
 - No expensive carbon source necessary
 - No extra sludge production
- ❑ Operability and safety
 - Easy to control and flexible
 - No risk of formation legionella

Points of attention:

- Fertilizer certification according to FPR, via NoBo
- Acid consumption



**Significant improvement of carbon footprint +
Competitive in terms of CAPEX and OPEX**

Byosis and practical results

With ByoFlex[®]

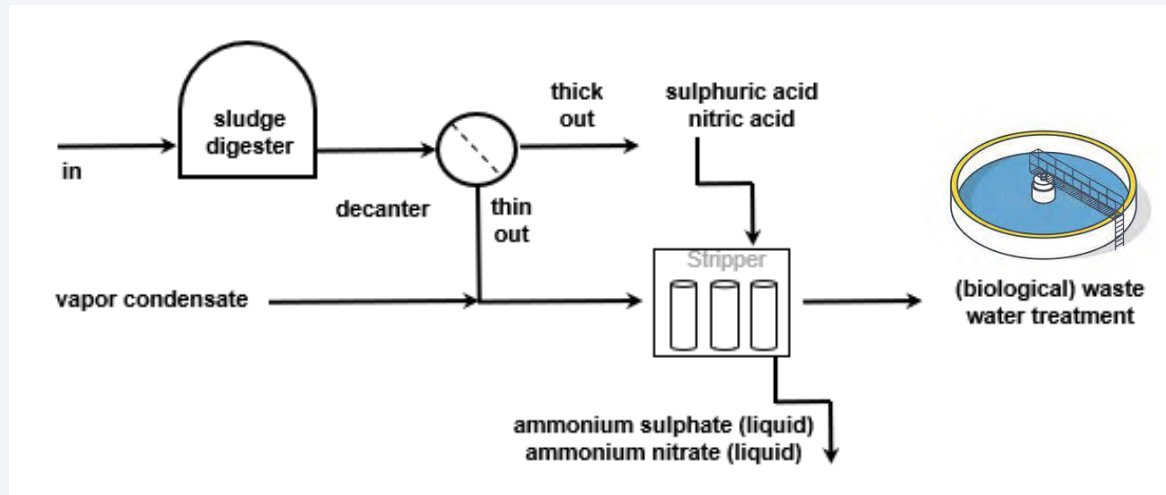
04

**Practical results of ByoFlex[®] at 3
municipal sites**

Project reference Municipal Wastewater

Bergen auf Rügen (DE)

Client: WKS, ZWAR
Location: Bergen auf Rügen, Germany
Type: ByoFlex®-5 stripping unit
Substrate: Sludge digestate/Condensate
Quantity: 38.000 tons/yr
Commissioned: 2021



Practical results

ByoFlex[®]-5 Rügen (DE)

At Flow = 4,7 m³/hr

- N-NH_{4,in} = 820-920 mg/l
- pH_{in} = 8,1
- N-NH_{4,in} = 106-130 mg/l
- Stripping Temp._{in} = 78 °C
- E-consumption = 4,7 kWh_e/m³

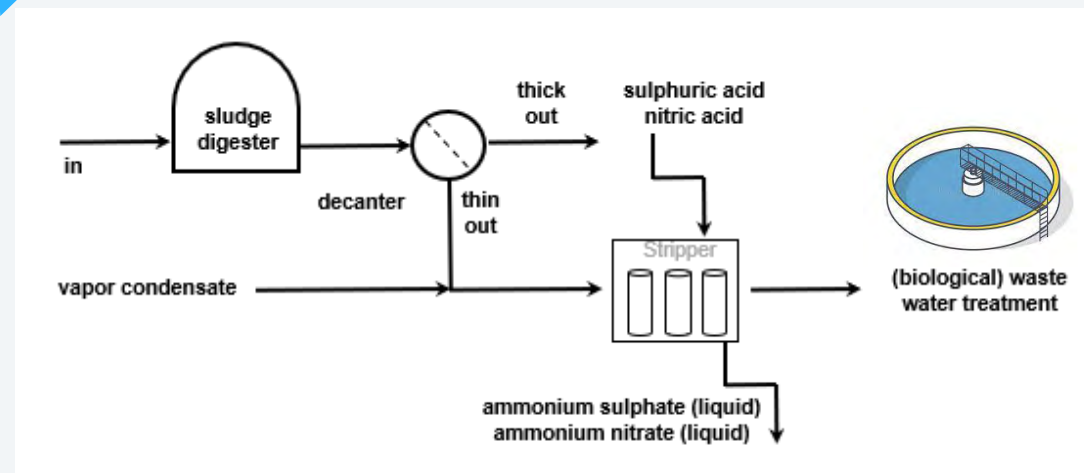
Result: 85-88 % stripping

**No alkaline dosing!
> 80% heat recovery!**

At Flow = 7,0 m³/hr

- N-NH_{4,in} = 920 mg/l
- pH_{in} = 8,1
- N-NH_{4,out} = 247 mg/l
- Stripping Temp._{in} = 78 °C
- E-consumption = 3,2 kWh_e/m³

Result: 73 % stripping



Byosis Demo stripping units

2x ByoFlex[®] demo-unit 5m³/hr (UK & EU)



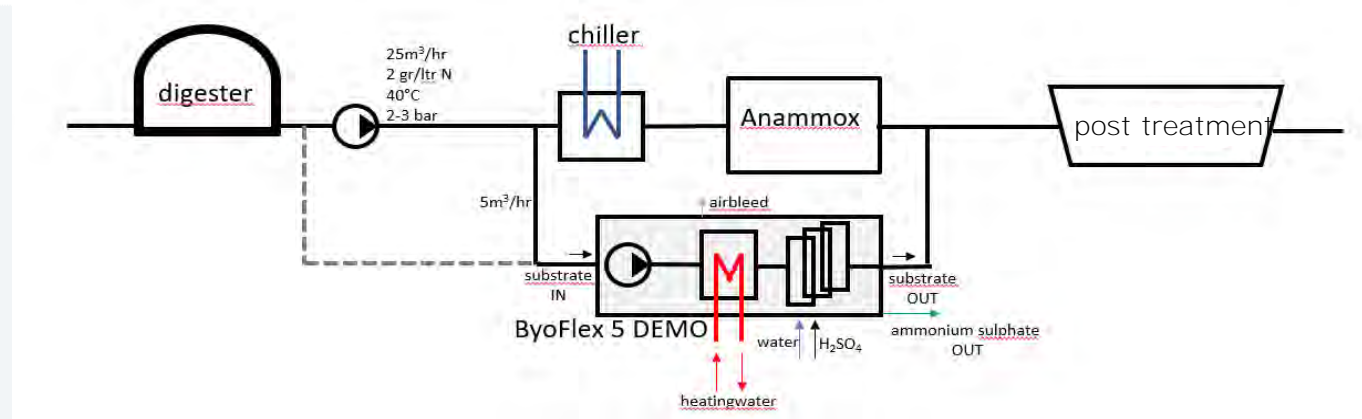
ByoFlex[®] Demo-unit

Transport & Lifting



Test Programs (municipal waste water)

ByoFlex-5 demo stripping unit (WWTP, NL)



Test program ByoFlex®-5 demo (April-June 2023):

- Centrate from decanter after thermophilic digester ($\text{NH}_4=2,5$ g/l)
- Determination of performance matrix
 - temperature variation: 55-70 °C
 - flow variation: 3-7 m³/hr
- Duration test at 5 m³/hr (longer term effects)

Full scale perspective:

- 35 m³/hr ByoFlex® operated at 70 °C
- Goal: increase of N-reducing capacity, N-recovery before biological treatment or replacement of anammox system

Test Programs (municipal waste water)

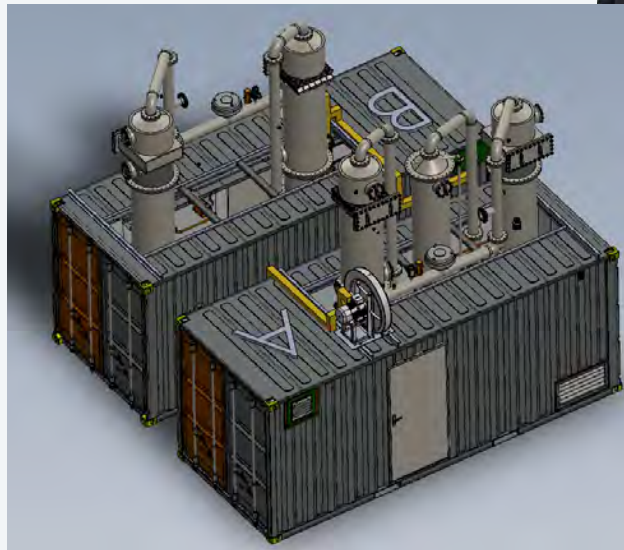
N-recovery pilot double unit

ByoFlex[®] pilot stripping unit (Duiven, NL)

- Designed for high N-recovery at lower stripping temperatures
- Double line interconnected ByoFlex[®] system in series
- Capacity: 0,75 m³/hr
- Several types of municipal wastewater tested
- Several municipal wastewater treatment companies involved
- Initiatives for certification of ammonium sulfate liquid fertilizer

Results:

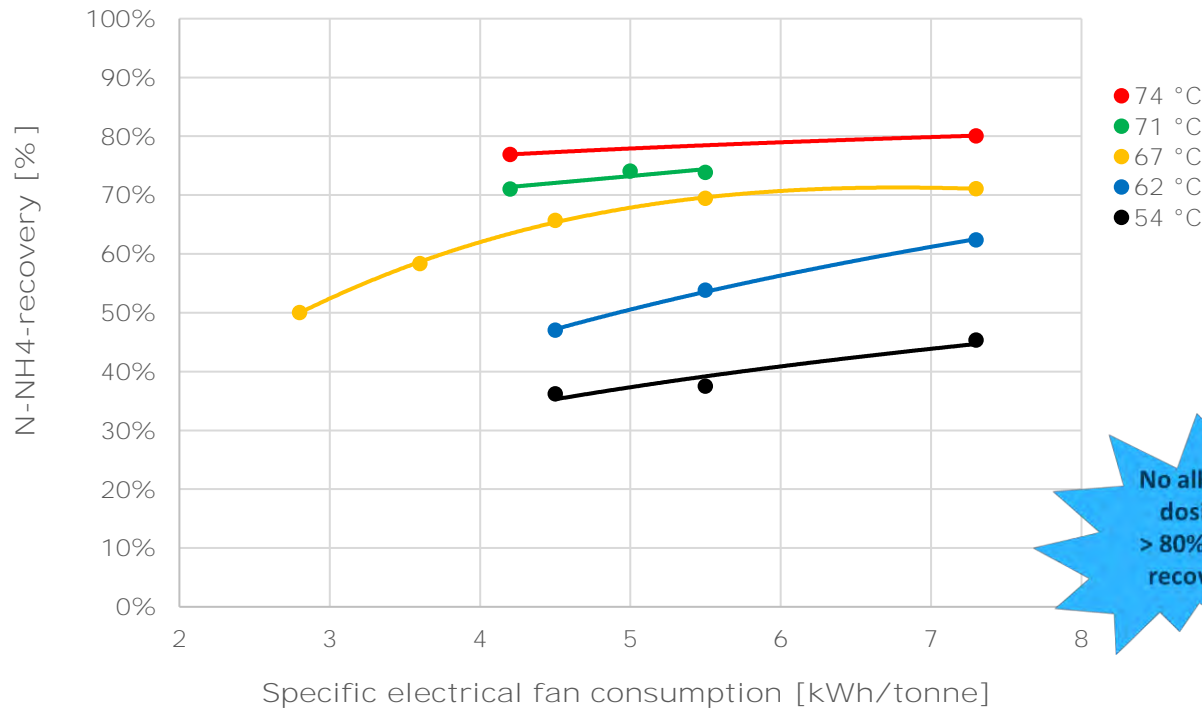
- 77-85 % N-recovery at 62 °C
- 82-94 % N-recovery at 70 °C



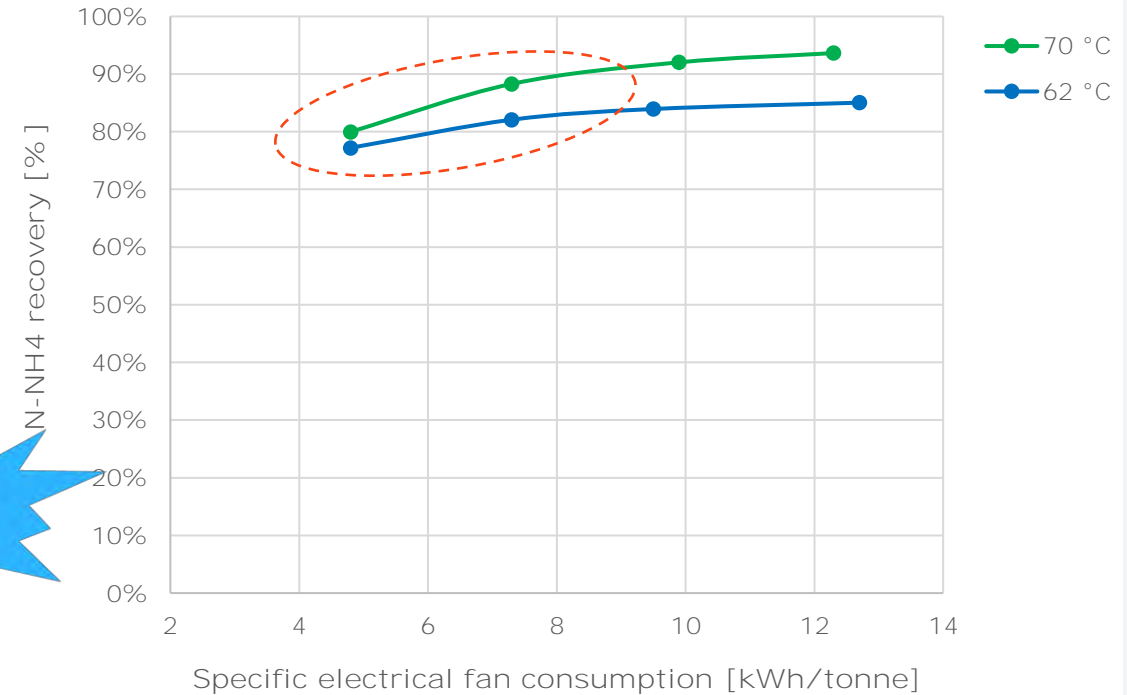
Practical results

ByoFlex[®] municipal waste water (single line vs. double line)

Measured stripping performance
ByoFlex[®] single line



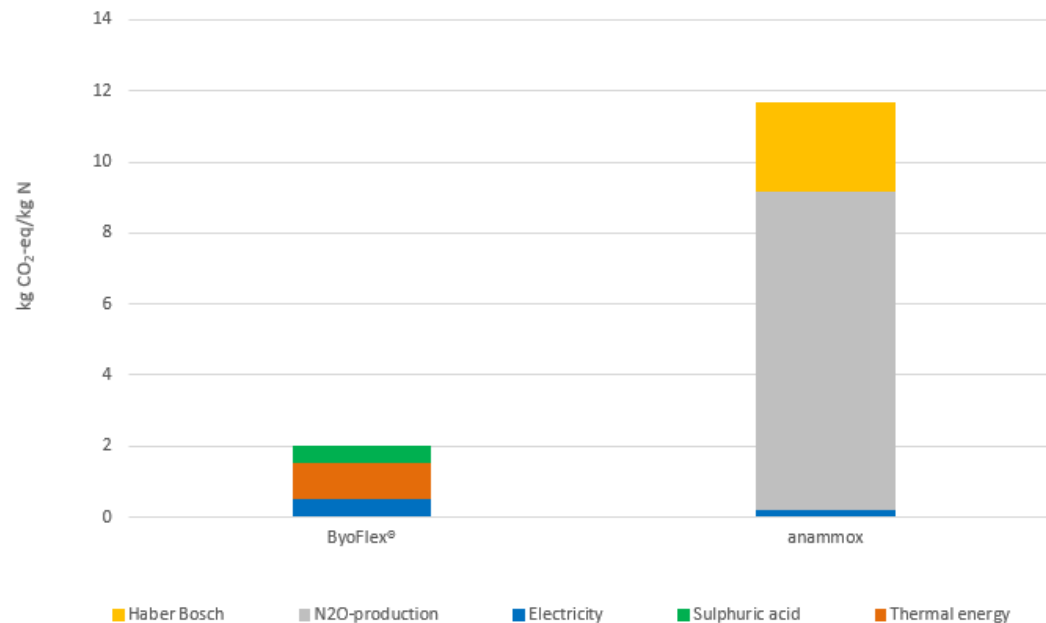
Measured stripping performance
ByoFlex[®] double line (in series)



ByoFlex[®] N-stripping improves carbon footprint vs anammox

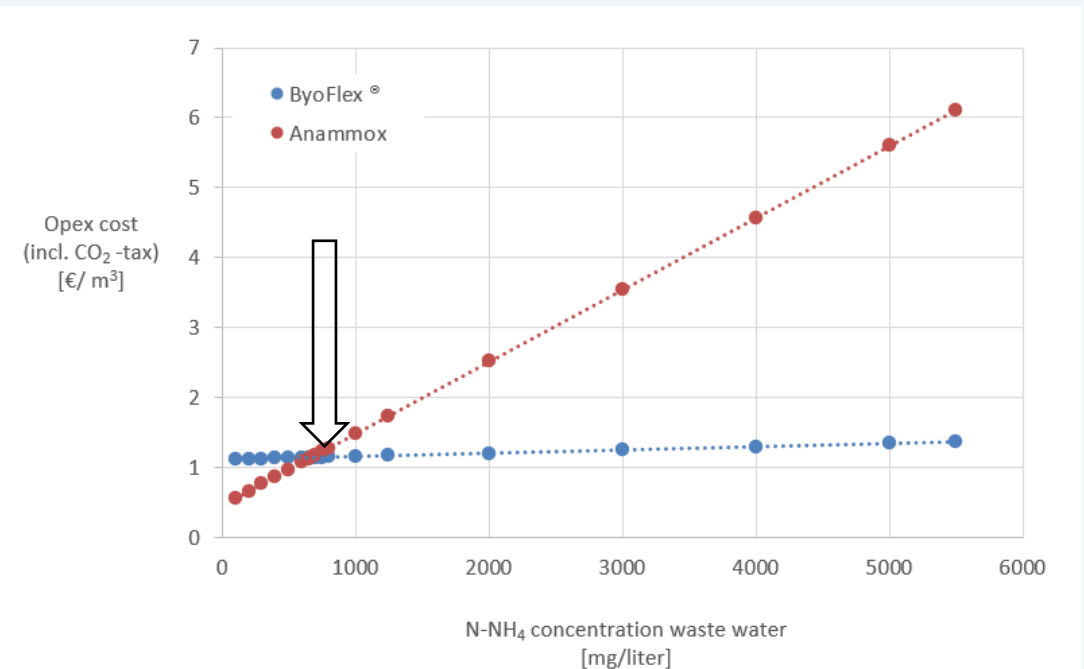
Example carbon footprint (influent: 35 m³/hr with 2500 mg/l N-NH₄)

Carbon footprint ByoFlex[®] vs anammox



ByoFlex[®] OPEX benefits at N-H₄ ≥ 800 mg/liter
@ 110-120 €/ton CO₂eq (Dutch market)

ByoFlex[®] CAPEX comparable to anammox



N-recovery wastewater



ByoFlex[®] Summary

ByoFlex[®] is a competitive and proven technology for N-removal and recovery from municipal and industrial wastewater.

ByoFlex[®] has operational and environmental advantages over biological alternatives

ByoFlex[®]- DEMO units are available. Convince yourself! It is not a pilot! We deliver performance



Byosis and innovations

Example ByoNix[®]

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**Brief overview of some
innovations**

Some innovations

Chemical free stripper – ByoNix[®] ; EDBM after ByoFlex[®]

ByoNix[®] NH₃-Stripper

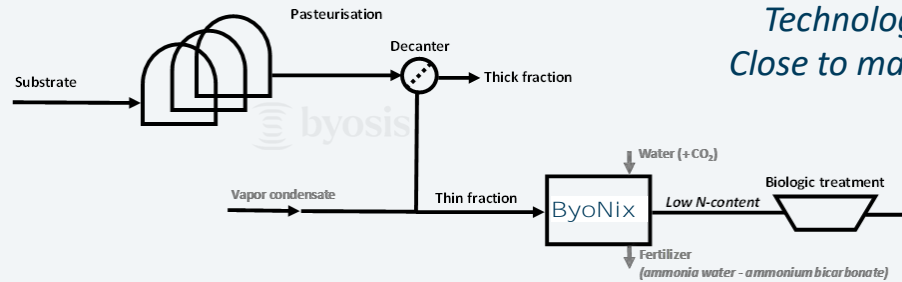
As ByoFlex for production of ammonia water / ammonia bicarbonate using CO₂

No chemicals needed to capture ammonia.

N-NH₄- strip-efficiency
 < 85% No alkaline agent
 > 85% With alkaline agent

Upgrade to

- Crystalline products
- Ammonium bicarbonate solutions
- Ammonia water (>20%)
- Advanced fertilizer with eg Greenswitch[®] process
-



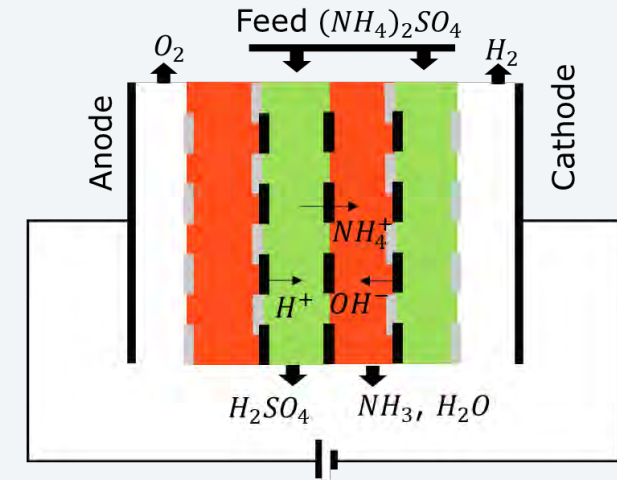
*Technology is in demonstration phase.
Close to market roll-out. Patent pending.*

No chemicals

ByoFlex[®] + EDBM NH₃-Stripper

ByoFlex with EDPM to separate base and acid

Recovery of chemicals and production of ammonia water (pilot phase)





[#missionwater](#)