



Innovations in Biogas production

in Industrial and Municipal Sludge Digesters

Workshop Biogas April 6th 2017

Colsen



water, energy & environment

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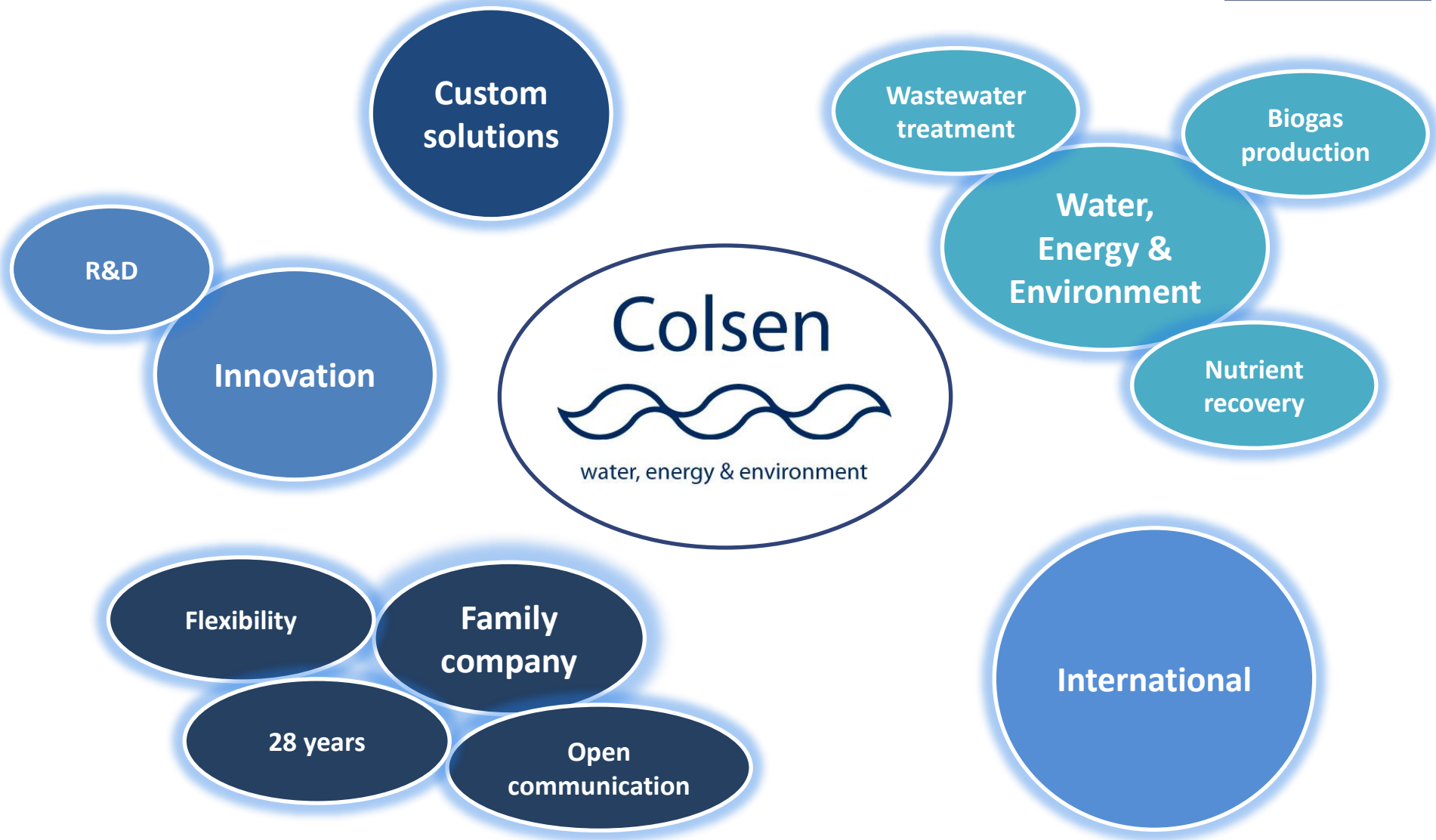
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1.1. About Colsen

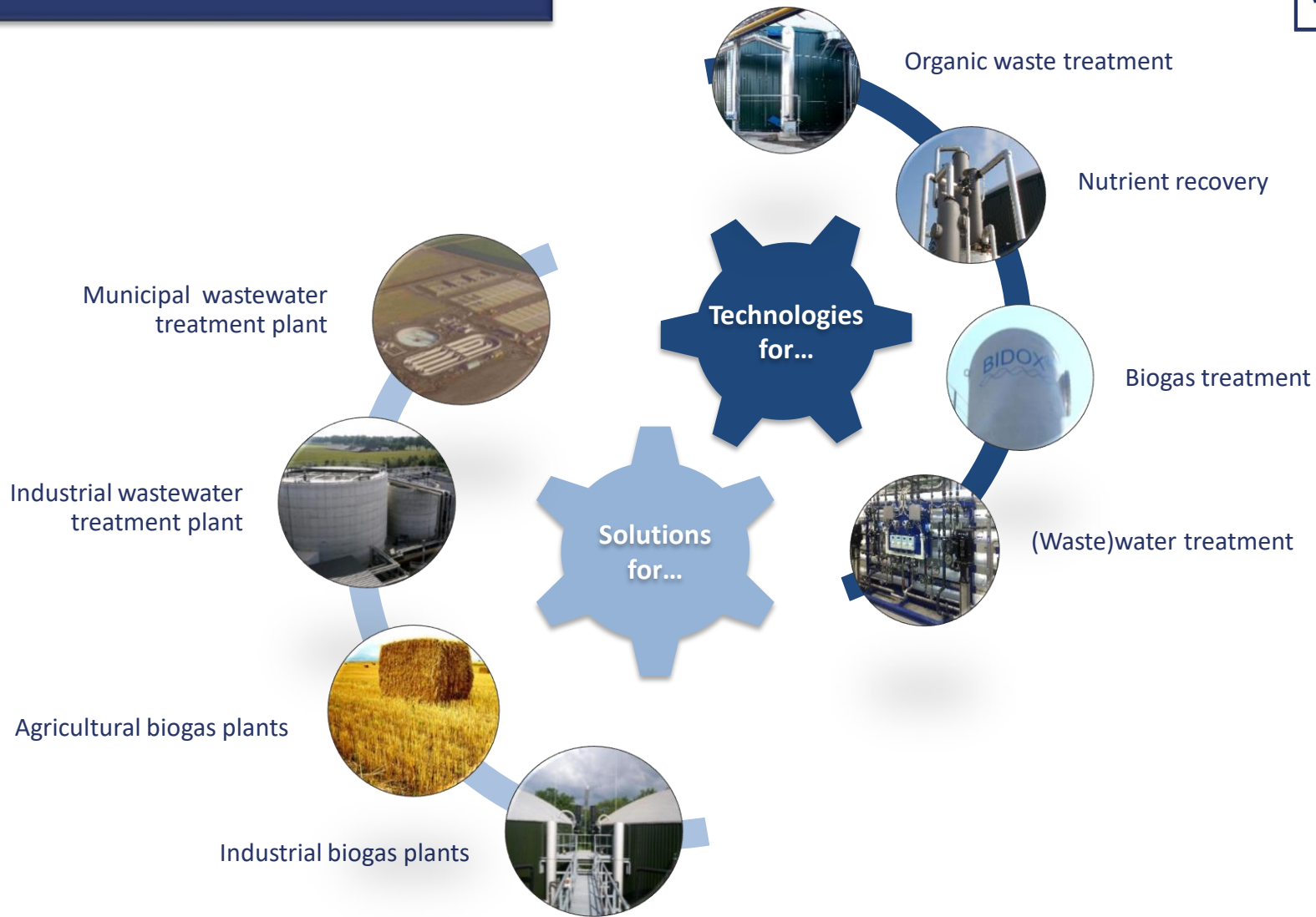


I.2. Colsen partners

Partner	Country
Colsen Group (Headquarters)	Nederland
Colsen b.v.b.a.	Belgium
Ahidra Colsen Technologies	Spain
Aquest Colsen	South Africa
HydroItalia Colsen SRL	Italia
Clear Industry Co. Ltd.	China
IBS	Argentina
Aqualimpia	El Salvador
Bioril	Chili
AQIP SAS	Colombia
Grupo GPHN	Mexico
Grupo MEGASAGERSA	Peru
Hidrotec	Republica Dominicana
LATCONGROUP CIA LTDA	Ecuador
PROCKNOR ENGENHARIA LTDA	Brazil
Grupo GRATT	Brazil

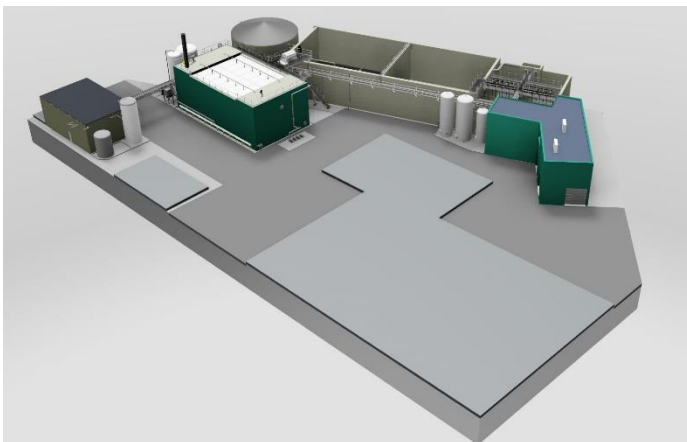


1.3. Services & technologies



I.4. Key sectors

Colsen builds TAILOR-MADE & TURN-KEY plants in following key sectors



Vion, Boxtel (NL)

- **Food & beverages**
 - **Potato**
 - **Slaughterhouses**
 - **Dairy**
 - **etc.**
- **Municipalities**
- **Agricultural sector**
- **Pulp & paper**
- **Pharmaceuticals**
- **Petrochemical**

I.5. Key products

Wastewater



NAS[®]
anammox



UASB



RO-recycle[®]

Digestion



DIGESTER



DIGESTMIX[®]



POUL-AR[®]

Biogas line



BIDOX[®]

Products with a
direct link to biogas

Nutrient recovery



AMFER[®]



ANPHOS[®]

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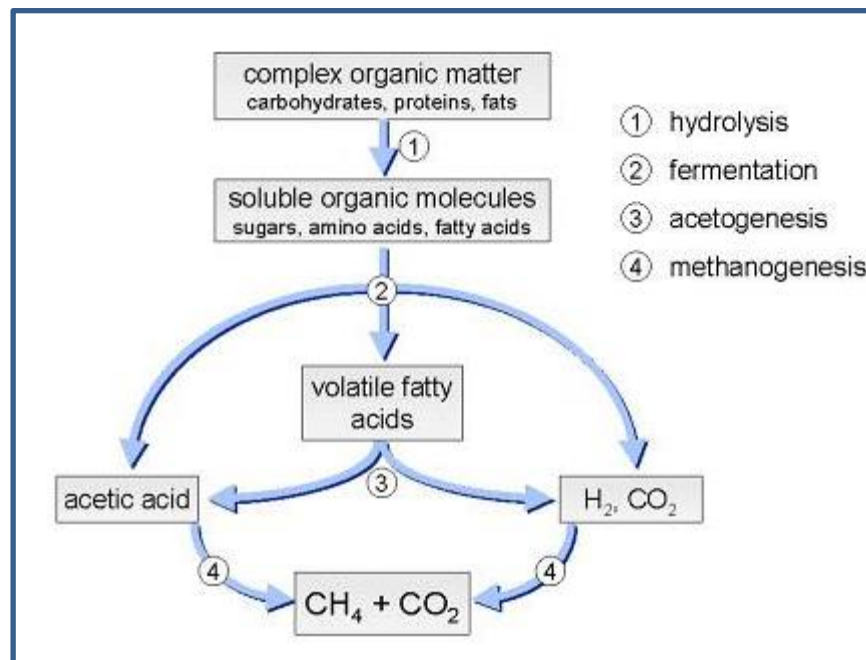
II.1. Digestion



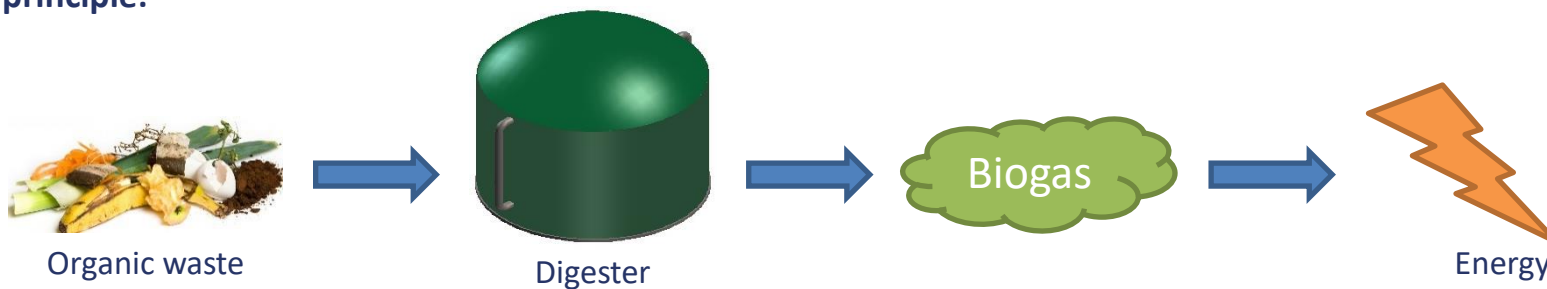
II.1.1. Digester

Process applications:

- ▶ Industrial organic waste products
- ▶ Agricultural energy products: manure; maize, etc.
- ▶ WWTP sludge: primary sludge; activated sludge, etc.
- ▶ Combined various waste streams



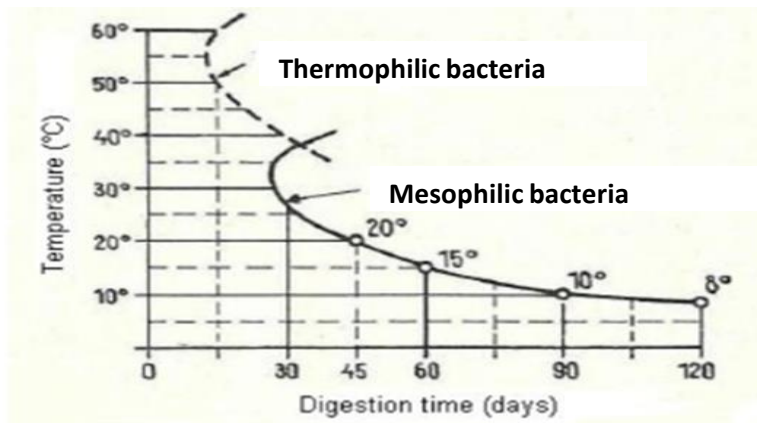
Process principle:



II.1.1.a. Digester: thermophilic

Thermophilic vs. mesophilic

- ▶ Faster biomass metabolism
- ▶ Smaller digester
- ▶ More residue converted
- ▶ Enhanced conversion of fibrous material
- ▶ Lower degree of carbon residuals



Pilot research WWTP Bath 2012-2017:



Practical experience with thermophilic digestion

(Full-scale) pilot research at WWTP Bath 2012-2017:

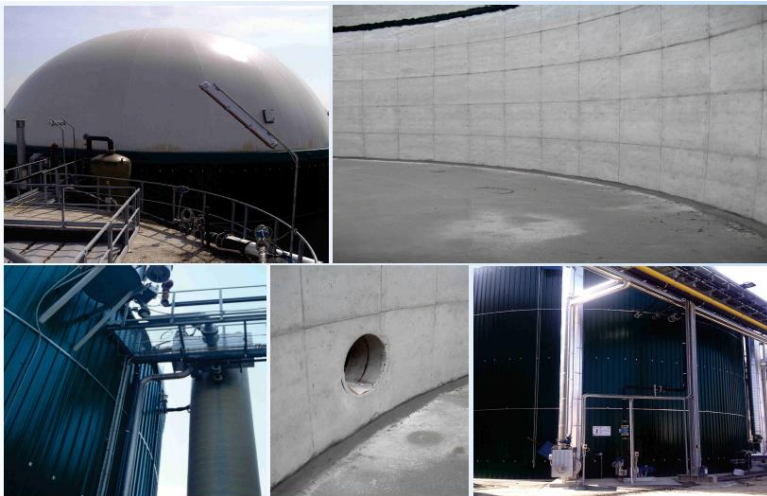
- ✓ Pilot research at small scale and large scale pilot (18 m³) ;
- ✓ Adjusting one full-scale (mesophilic) digester for thermophilic operation;

Parameter	Compared with mesophilic digestion
ODM conversion	+ 12,7 %
Methane production	+ 17,9 %

Source: De Vrieze, J., et al. (2016)

Full scale projects

- ✓ EcoFuels (2007): 3 x 3400 m³,
- ✓ Pizzolli (2015): 1 x 1800 m³,
- ✓ RWZI Den Bosch (2017): 2 x 4000 m³,

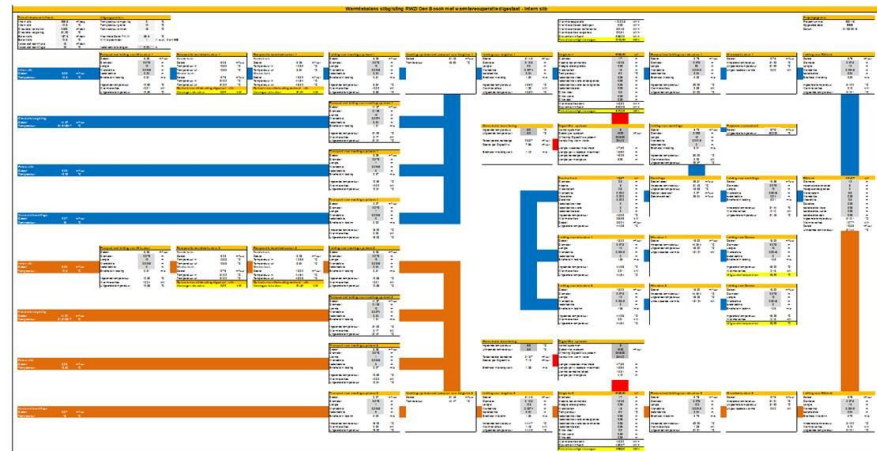


Our approach to thermophilic digestion in practice

Thermophilic digestion process is stable when certain conditions are taken into account:

- ✓ Temperature fluctuations influence efficiency
 - ✓ (+/- 0,5 ° C per day)

- ✓ Analysis of heat balance



Our approach to thermophilic digestion in practice

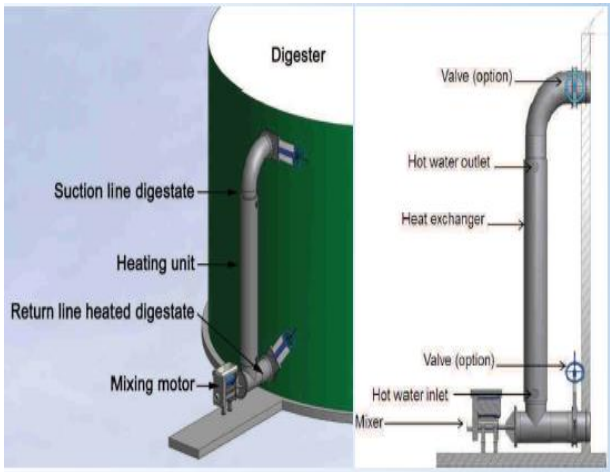
Isolation and heat exchange:

- ✓ Den Bosch: before and after
- ✓ Heat loss reduced from 450 kW to 45 kW per tank



Our approach to thermophilic digestion in practice

DigestMix:



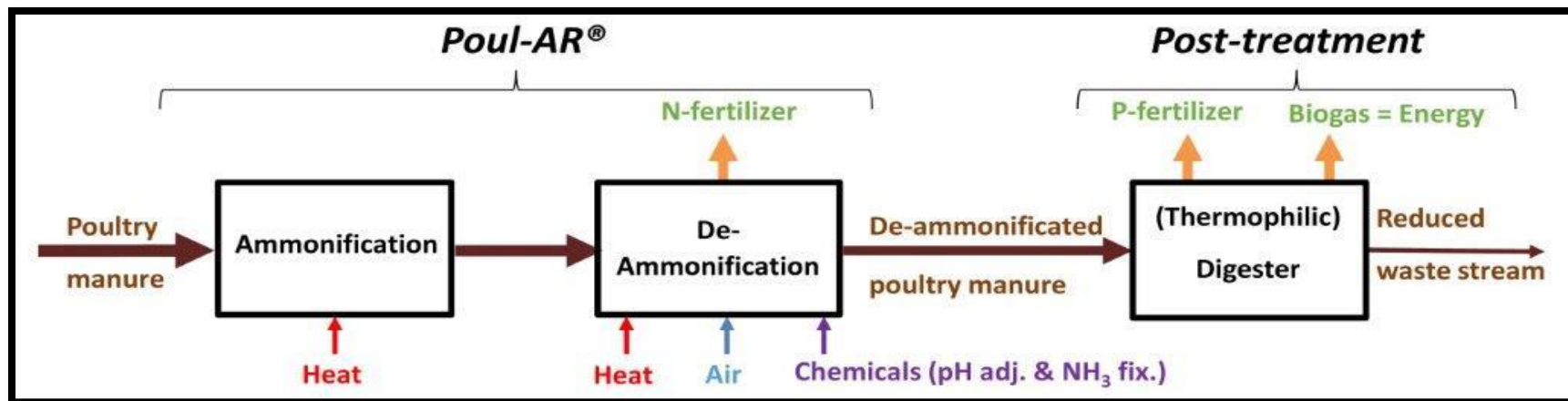
II.1.3. Poul-AR®

Poul-AR®: General system

- Step 1: Ammonification with enzymes
- Step 2: De-ammonification with addition lime
- Up to 90% NH₄-N removal over the complete system
- Minimal COD loss
- Formation of N-fertilizer: e.g. 52% NH₄NO₃
- NPK for 52% NH₄NO₃ is 18-0-0

Poul-AR®: Effluent potential

- High temperature effluent accessible for high temperature digestion processes
- No-toxic N concentration for mesophilic and thermophilic digestion processes
- High biogas/energy potential
- 100 Nm³ CH₄ per ton manure

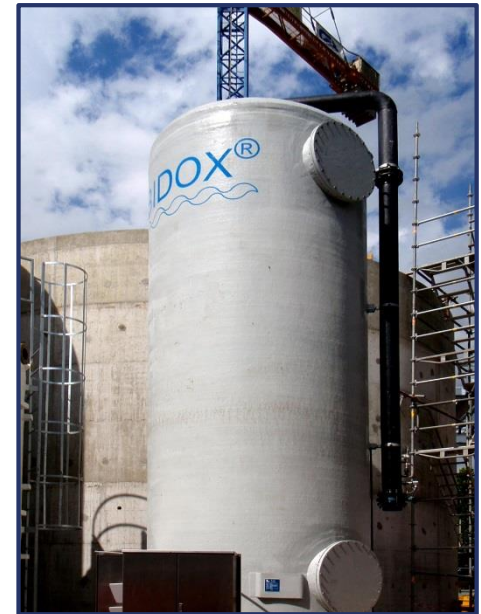


II.1.3.b. Poul-AR[®] innovation route

- 2012: Project idea and literature research
- 2013: Preliminary labscale test of individual processes
- 2014: Succesfull European H2020 subsidy:
 - Labscale testing
 - Market research
- 2015: Labscale optimization
- 2016: Pilot scale verification
- 2017: Demonstration of Poul-AR[®] at full scale TKI hernieuwbare energie
- 2018: Exploitation full scale demonstration plant



II.2. Biogas



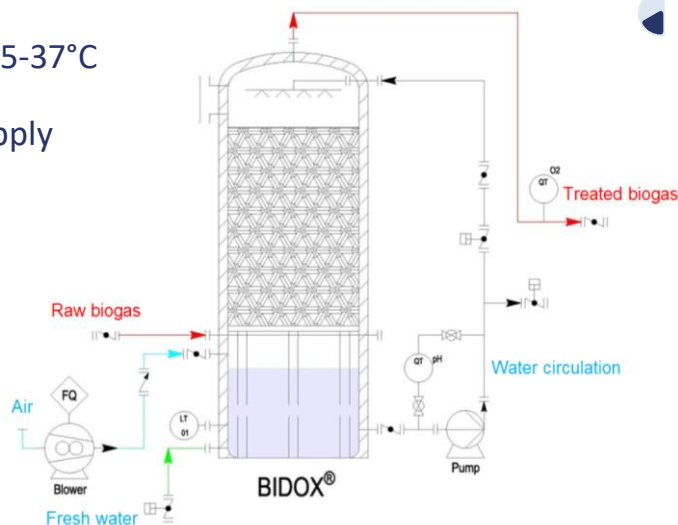
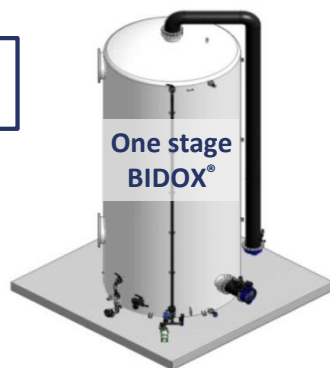
II.2.1.a. BIDOX®

BIDOX® = Biological biogas Desulphurization by Oxidation



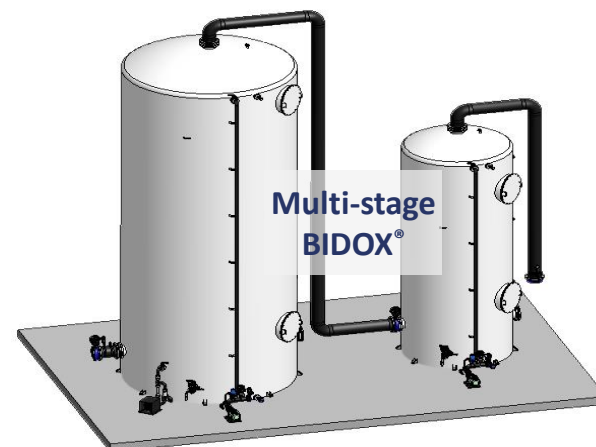
Process conditions

- ▶ Air supply: oxygen
- ▶ Nutrients supply
- ▶ Temperature: 35-37°C
- ▶ Fresh water supply
- ▶ Packed media



Process figures

- ▶ H₂S loading capacity: ~ 0.5 – 50.0 kg h⁻¹
- ▶ Biogas flow range: ~ 25 – 3,000 Nm³ h⁻¹
- ▶ H₂S outlet conc.: < 20 – 200 ppm
- ▶ Power consumption: ~ 0.2 kWh kg⁻¹ H₂S removal
- ▶ Operational cost: ~ €0.2 kg⁻¹ H₂S removal



II.2.1.b. BIDOX® advantages

Process advantages

- ▶ Robust system quality
- ▶ High efficiency
- ▶ No chemical requirements
- ▶ Low running costs
- ▶ No cleaning intervals and process downtime
- ▶ No solid disposal
- ▶ No clogging → **Unique BIDOX® advantage !**

At low PH $\leq 1.5 - 2$

- ▶ Almost all sulphur is converted into SO_4^{2-}
- ▶ Only a minor part formed as elemental sulphur

→ **Removed as suspended solid with the effluent !**




BIDOX® - 2004


After 7 years of non-stop operation, BIDOX® was opened for inspection.


The filling material contained some sulphur at the outside borders and no sulphur inside.



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