



adviesburo voor milieutechniek

grond, water, lucht

Colsen b.v.

Thermophilic sludge digestion

A perfect fit in cradle-to-cradle and
energy neutral sewage treatment

Joop Colsen

Hulst (NL)



Professor Willy Verstraete

Bridge between science & business

It is not the scientific discovery alone:
it is the economic implementation of
the technology that allows its breakthrough!

The Case



WWTP's in NL :

1.500.000 tons sludge per year

costs : 330 € / ton

*Can we turn this challenge into an economic operation?
(via energy production and C2C nutrient recovery)*

The Case contd.



Traditional (mesophilic) sludge digestion:

- Prim. sludge / sec. sludge = 50 : 50
- Hydraulic Retention Time 20 days
- Average yield : 25-35% conversion of odm

Is thermophilic digestion an alternative?

- Tests indicate 60-70% conversion
- But: (technical) need for

- HRT of 18-20 days
- Optimal mixing
- Strict temp. control

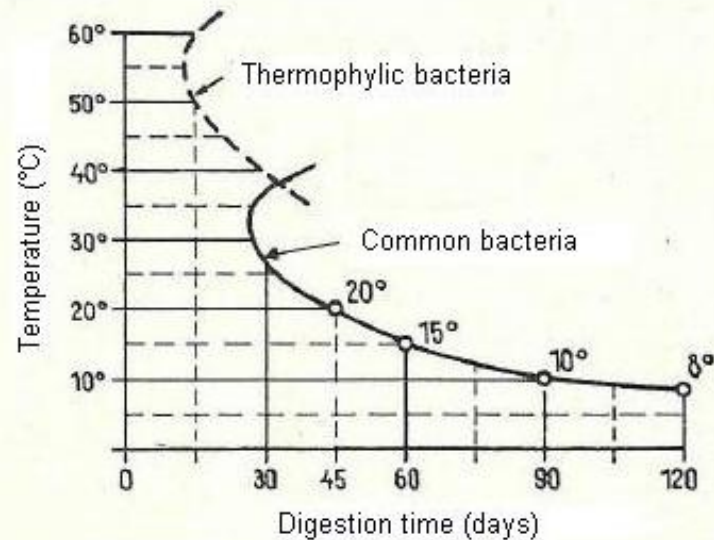
Anticipated results:

- *More biogas produced*
- *Less final sludge to be treated*
- *More nutrients (N/P) in digestate*
- *More H₂S in biogas*

Meso-/thermophilic conditions



More efficiency at higher process temperatures



- > 50% conversion for secondary sludge
- > 90% conversion primary sludge
- Total reduction using prim/sec = 50/50 → 70 % odm
- More nutrients liberated (NH_4^+ > 2.500 & PO_4^{3-} > 600 mg/L)
- More sulphur liberated (H_2S in biogas > 2.000 ppm)
- 50% more energy (e + th) produced

The (economic) challenge



Sludge treatment optimization options:

Mesophilic + thermic (pressure) pre-treatment ↔
Thermophilic digestion

Cost / benefit comparison

Higher investment costs
Higher energy consumption
Higher maintenance costs

Same result as 1-step thermophilic digestion

Can economics match sustainability efforts?

The technological match



Nitrogen fixation (AMFER®)

C2C Nitrogen removal with new airstripping process:

- Air compressor
- Heating to 60-70° C
- Ammonia stripping from 2,500 till 500 mg/L (80% removal)
- Fixation as ammonium sulphate
- 42% $(\text{NH}_4)_2\text{SO}_4$ solution
- liquid fertilizer (marketed at 90 € / ton)

Simple add-on technology in support of C2C

Acknowledgement : Avecom (Ghent, B) collaboration

The technological match



Phosphate removal (ANPHOS®)

C2C Phosphorous removal as Struvite (600 → 25 mg P_{tot}/L)

- Magnesium salt addition
- pH increase by air stripping
- Settling and crystallization
- Overall removal P = 90% (precipitated as struvite)
- Simple dewatering of precipitate to 40% dm
- Struvite marketing as fertilizer (@ 35 €/ton, Germany)
- Effluent quality : < 10 mg/L ortho P

Reaction equation:



Acknowledgement : Professor Olaf Schuiling (Utrecht, NL)

The technological match

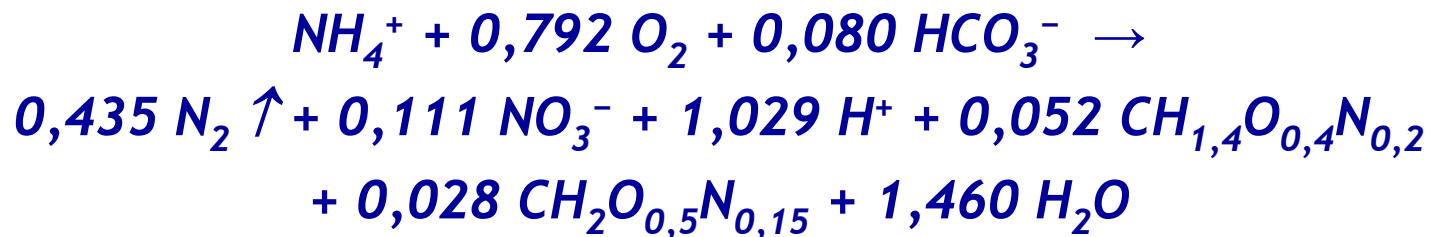


NAS[®] (hybrid activated sludge/*anammox*)

C2C Nitrogen removal with 10 % *anammox* bacteria

- Removes > 70% of all N in the *anammox* stage
- Overall removal N = 95% (liberated as N₂)
- Effluent quality : < 20 mg/L N_{tot}

Overall reaction equation:



Ref.: Colsen, J. et al. (2011) A retrofitted activated-sludge plant with sequential nitrification and anammox obtains dischargeable effluent. Water Research (in press)

Acknowledgement : LabMET (Ghent, B) collaboration

The technological match

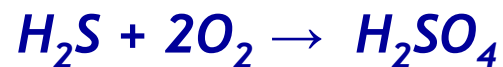


Sulphur (H₂S) removal (BIDOX®)

C2C Sulphur removal as bio-sulphuric acid

- Prevent adding Fe-sludge for S precipitation
- Removal by biological desulphurization instead
- Bio-sulphuric acid application:
 - In air washers (ammonia scrubbers)
 - As acidification step (for membranes or sludge decanters)
- Improved biogas quality for CHP or green gas
- Reduction to < 50 ppm H₂S

Reaction equation:



Overall result



Integrated scientific & technical approach

Results in:

- Clean (C2C) technology
- Low energy consumption and/or
- Low chemical demand
- Recovery of N, P & S
- WWTP operation margin = positive
the benefits from energy production and cost reduction surpass the investment and operational costs
- Easy to implement in existing WWTP's

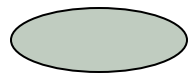
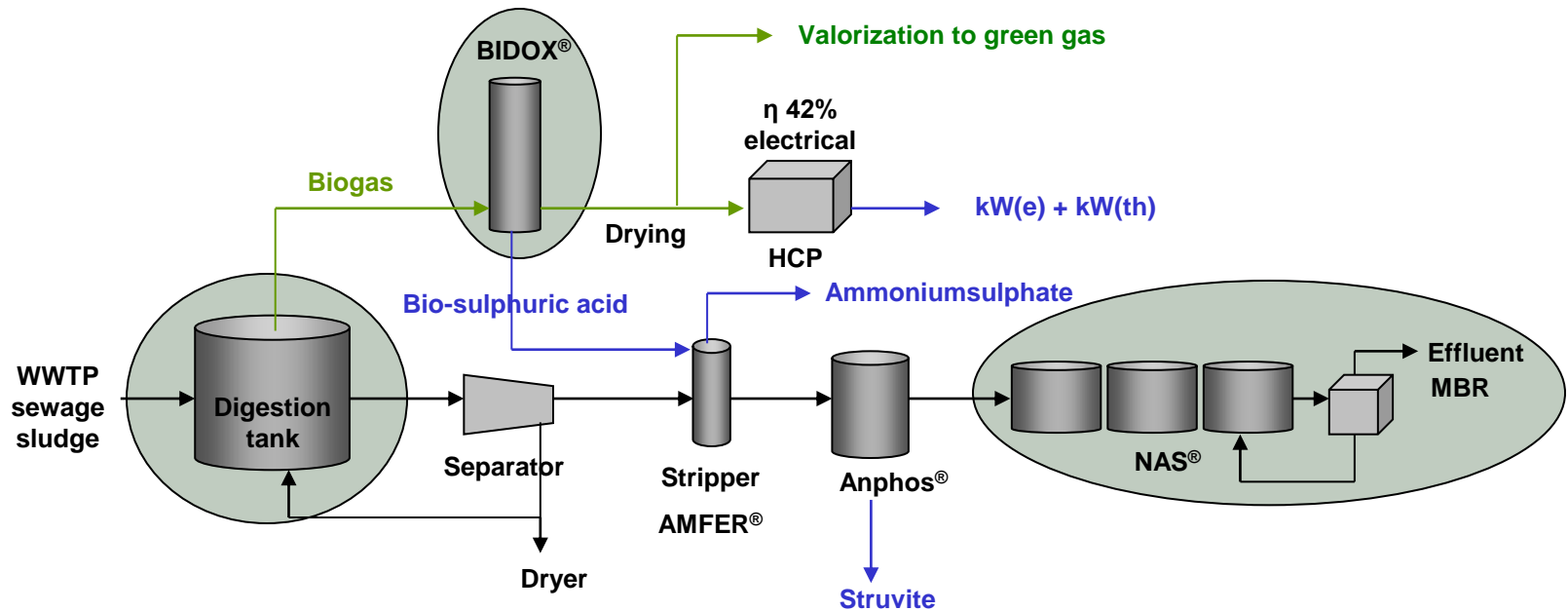
Energy neutral WWTP is not a dream, but reality

Paradigm shift



Concept of the “Energy Factory”

(valorization of waste by intelligent technology application)



areas for microbial resource management

Acknowledgement : WWTP's in Haps & Tilburg (Noord Brabant, NL)

Thank you !



Thank you professor Verstraete
for your friendship and support!

Thank you all for your attention!