Developments in Anaerobic treatment of F&B wastewaters

More biogas at lower investment and operating costs

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Jan Pereboom

Veolia Water
Biothane

Solutions & Technologies
Veolia Environnement

- Veolia Environnement offer a complete range of creative solutions for the environment.

- Supplying water and recycling wastewater; collecting, treating and recovering waste; supplying heat and cooled air; and optimizing industrial processes.

- These solutions are designed to find a balance between the development of human activities and environmental protection.
Veolia Environnement

The reference in environmental solutions

VEOLIA ENVIRONNEMENT
€29.6 billion revenue
More than 330 000 employees in 77 countries

WATER
The global benchmark for water services

WASTE MANAGEMENT
The global benchmark for waste management & resource recovery

ENERGY SERVICES
The global benchmark for energy optimization

TRANSPORTATION
Setting the standard for managing safe and sustainable mobility services
Veolia Water resolve the complexities of guaranteeing water services by:

Managing water and wastewater services for public authorities and industry.

Designing solutions and building the infrastructures.

Construction, rehabilitation and maintenance of networks.
Veolia Water

About us

€ 12.6 billion revenue

96 650 employees in 69 countries
Veolia Water Solutions & Technologies provide the complete range of services required to design, build, maintain and upgrade water and wastewater treatment facilities and systems for public authorities and industrial clients.
Our all-encompassing range of solutions and technologies is dedicated to leverage the value of water and wastewater resources.

Combined with local presence and a worldwide network of experts, we ensure our customers the best possible solutions to treat or reuse wastewater, produce or recovery energy, extract raw materials and capitalize on byproducts.
Veolia Water Solutions & Technologies

in figures

€2.3 billion revenue

10,767 employees
Revenue breakdown

Key figures

North America
- Revenue: 969
- Revenue percentage: 12%

France
- Revenue: 2153
- Revenue percentage: 21%

Europe (excl. France)
- Revenue: 3876
- Revenue percentage: 29%

South America
- Revenue: 1400
- Revenue percentage: 11%

Africa-Middle East
- Revenue: 1292
- Revenue percentage: 16%

Asia-Pacific
- Revenue: 1077
- Revenue percentage: 11%

North America
- Revenue: 10,767
- Revenue: €2.3 billion
HPD; VWS subsidiary

- Evaporators, Dryers, Crystallizers; 675 plants supplied
- HESC™ High Efficiency Stillage Concentration System
Berkefeld; VWS subsidiary

- Process and boiler water make-up
- RO, UF membrane systems
Veolia’s complete service possibilities

- Process water make-up
- Sludge handling
- Wastewater treatment and water recycling
- Bio energy plant
- Cooling water and Boiler
- Boiler water make-up
- Process water make-up
Industrial wastewater treatment

The current State-of-the-Art: combination of

- Anaerobic pre-treatment and
- Aerobic post treatment
Anaerobic versus Aerobic WWT

100 kg COD to Aerobic

Aeration (100 kWh)

45% Carbon Dioxide

50% Biomass

Heat loss

2-10 kg COD

Sludge, 30-60 kg

100 kg COD to Anaerobic

75% Biogas (75% Methane)

CH₄ 26 - 30 Nm³

CO₂ 5 - 12 Nm³

5% Biomass

10-20 kg COD

Sludge, 5 kg

1 kg COD removed ≅ 0.35 Nm³ CH₄ or 3.8 kWh
Biothane Worldwide

- Specialist in anaerobic wastewater treatment
- 35 years of experience
- 530 references
- Part of Veolia since 2008
- 3 offices worldwide
  - BC, BSI, BAP

Biothane Corporation
Camden NJ
USA

Biothane Systems
International
Delft, The Netherlands

Biothane Asia
Pacific (VWS SEA)
Singapore
Biothane’s Granular Technologies

- **Biobed® Advanced UASB or EGSB**
  - Granular Sludge Bed
  - Up to 30 kg COD/m³/d

- **Biobed® Modular Plant**
  - Compact off-site construction
  - 50 ~ 200 m³ reactor volume
  - 0.5 ~ 4.0 tCOD/day
Biothane technologies; non-granular

- **Biobulk CSTR**
  - Solid waste digestion
  - With or without sludge recirculation
  - Suitable for high COD / SS / FOG waste(water)

- **Memthane® Anaerobic MBR**
  - New technology for high strength wastewater
  - Using Cross-flow UF membranes
  - High COD / SS removal efficiencies

- **Upthane™**
  - Municipal UASB technology for tropical climates
  - Novel design

- **Pomethane® CSTR**
  - Palm Oil Mill Effluent
Biothane expertise by industry sector

- Food, 39%
- Fermentation, 13%
- Breweries, 23%
- Chemical, 8%
- Pulp & Paper, 8%
- Beverage, 6%
- Pharmaceutical, 1%
- Other, 2%
Selection of Anaerobic References in F&B
1. Biobed® Advanced

Anaerobic granular technology at the next level
Reduced investment and operating costs
Based on fundamental research

- 5 years research by committed team
  - Many with more than 25 years of experience
- Lab scale testing
- Hydraulic model testing at 1:1 scale
- Pilot scale testing at 7 m³
- Full scale testing and data gathering
Novel Biobed® Advanced Settler

- **Patented** new settler and reactor design
- Multi level biogas separation
- **TTS**; Tilted Tube Separator on top of the settler
  - Increasing the settler surface area for
  - Improving the retention of biomass and SS in the reactor
- Robust effluent pipes which replace conventional effluent gutters
Objectives of Biobed® Advanced

- Improving the anaerobic performance
  - Thus reducing investment and operating costs

Improving COD removal rate

Hydraulic buffer tank → Anaerobic reactor (80%) → Aeration tank

Hydraulic buffer tank → Anaerobic reactor (85%) → Aeration tank

10 ~ 25% smaller
Biobed® Advanced in F & B applications

- Distillery; Mexico 38 tCOD/d
- Breweries; South Korea and USA 30 and 19 tCOD/d
- Dairy; Panama 6.0 tCOD/d
- Soya processing; Italy 9.3 tCOD/d
- Soft drinks; Thailand 8.1 tCOD/d
- Sugar; Egypt 32 tCOD/d
- Potato; Indonesia, Belgium 3.0 and 7.2 tCOD/d
Dual Anaerobic; preferred approach for potato

- Sedimentation
- Sludges + peels treated in suspended Biobulk digester
- Wastewaters to Biobed® Advanced
- Aerobic post-treatment

Biobulk digester
2. Biobed® SMART Sludge Management and Reactor control Techniques
Biobed®SMART reactor control system (1)

**Sludge Management and Reactor Control Techniques**

**Objectives:**
- Achieve more stable reactor operation
- Achieve higher COD removal efficiency
- Reduce operating costs

**Dynamic reactor control**
- Measuring online load → load control

**Various online measurements**
- Biogas composition
- Sludge bed level
- In-situ sludge activity

**Result in early warnings**
Objectives of Biobed® Advanced & SMART

- Improving the anaerobic performance
  - Thus reducing investment and operating costs

Improving COD removal rate

80 %

85 %

10 ~ 25% smaller
Dynamic Control: Client Case-study

- Net Biomass growth
- Reduction in N-consumption despite of increased average load
- Stable operation reduced operator and analysis cost

+ 11%  
-40%  
+32%  
-56%  
-43%
Biobed® SMART in situ real-time video imaging
Memthane®

The preferred solution for high-strength wastewaters resulting in crystal clear effluents
Memthane® step-by-step

Conditioning of high-strength wastewaters.

Influent is fed to the anaerobic bioreactor where the organic components are converted into energy-rich biogas.

Cleaning In Place (CIP)

After anaerobic treatment, the UF membrane unit separates the clean permeate from the biomass.

If required, several polishing techniques are available to further treat the suspended solids free effluent for reuse or recovery of nutrients, while the low COD permeate is often clean enough for direct discharge to sewer.

Biomass is returned to the bioreactor, while a small amount of biomass is removed from the system and discharged after dewatering.
Memthane®; Features

- Treat high-strength effluent previously considered untreatable
  - High concentrated streams: COD 15,000 – 250,000 ppm
  - Superb effluent quality
  - Create product for nutrient recovery (N+P)

- Maximize renewable green energy production
  - Generates biogas from wastewater
  - Minimizes carbon footprint and water footprint

- Remove COD efficiency: > 98%
  - Avoids costly aerobic post treatment
  - Generates more biogas

- Reduced OPEX
  - Reduces disposal costs while generating biogas
Impact of membranes on anaerobic process

Biogas
CH$_4$ 28 Nm$^3$ ≈ 280 kWh
CO$_2$ 9 Nm$^3$

Biogas
CH$_4$ 33 Nm$^3$ ≈ 330 kWh
CO$_2$ 11 Nm$^3$

*Based on 95% biogas production

Anaerobic
100 kg COD

80% Biogas
(75% Methane)

15 kg COD

Sludge 5 kg COD

1 kg COD removed ≈ 0.35 Nm$^3$ CH$_4$ ≈ 3.8 kWh

An-MBR
100 kg COD

95-99% Biogas
(75% Methane)

1-5 kg COD

Sludge 5-7 kg COD
Case study 1; ARLA – Aylesbury, UK

- Contract signed 2012
- Memthane® for treatment middle-high strength wastewater from milk processing dairy
- ELGA – RO for direct treatment of low strength wastewater
- Scope: Turn Key Supply
- Value: approx. GBP 2,5 M
- Start Up: Medio 2013
Case study 2; Carriage House Inc.; USA

- Bottling of foods
  - jams, jellies, salsa, BBQ sauce, etc

- Influent Parameters:
  - Flow: 500 m3/d
  - Total COD: 20,000 mg/l
  - Total SS: 2,000 mg/l
  - Sewer requirements 250/250 BOD & TSS
  - Strong fluctuations

- Design and Build contract
- Operations 10 year by VWNA
Case study 3; Dutch food company

- Pilot plant: May – September 2012
- Competition: DAF + conventional anaerobic
- Memthane (> 99% COD)
  - Turn Key 2.5 mln €
  - Veolia Operations 3 year
- Decision early 2013
Case study 3; Dutch food company

- **Sustainable**
  - Positive Carbon Foot Print
  - Future Option Water Re-Use
  - Nutrient Recovery

- **Process Security**
  - 100% Biomass Retention
  - 0% Solids in Effluent
  - Max. COD conversion
  - Simplest Process Outline and Operation

- **Lowest Opex**
  - Minimal PE discharge
  - Maximal Biogas Production
  - 0 to absolute minimal Sludge Production

![GHG emissions for the two options](image)

![Comparison Operational Expenses Memthane versus Granular Sludge Technology](image)
Memthane®; Track record

- **Proven Innovation**
  - 10 full-scale Memthane® plants
    - 4 years of full-scale industrial operation
    - 14 pilot plant tests

- **Implemented in:**
  - Dairy industries
  - Bio-ethanol plant; thin stillage
  - Cellulosic Bio-ethanol; condensate
  - Biodiesel plant
  - Food processing
Observations and Conclusions

- **Biobed® Advanced** reactor
  - Reduced investment and operating costs

- **Biobed® SMART** control system
  - Substantial reduction in operating costs
  - More stable operation
  - Especially as retrofit to existing plants

- **Memthane® AnMBR**
  - Cost effective solution for concentrated wastewaters
  - Crystal clear effluents
Biothane: Establishing growth through innovation

Thanks for your attention

For further information or questions
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