Improving Efficiency through Recovery

Energy and Nutrients recovery from Biofuel Effluents

Dennis Korthout
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16:20 Improving technological and strategic efficiency
Biorefinery Platform
From wastewater treatment plant to Bio-Refinery...

AWWTP

Wastewater

Residue

Energy in Biogas

Water for reuse

Nutrients for fertilizer
Biothane: competence centre of Veolia Water

- **Veolia Environment**
  - Divisions: Energy Services, Waste Management, Water, Transport
  - Revenues 29.6 bln€; 77 countries; 330,000 employees (2011)

- **Veolia Water**
  - Revenues 12.6 bln€; 69 countries; 97,000 employees
  - Drinking water for 103 mln consumers; sewage of 73 mln inhabitants

- **Veolia Water Solutions and Technologies**
  - Contracting and equipment; 350 proprietary technologies
  - Revenue 2.3 bln€; 135 business units; 10,800 employees

- **Biothane**
  - World market leader for Anaerobic industrial wastewater treatment
  - 35 years; 540 references; since 2008 part of Veolia
Drivers Anaerobic Technology

Aerobic

100 kg COD

Aeration

100 kwh

Carbon Dioxide

Biomass

2-10 kg COD

Heat loss

15 kg COD

Anaerobic

100 kg COD

80% Biogas

(75% Methane)

5% Biomass

Biogas

CH₄ 28 Nm³

CO₂ 9 Nm³

Sludge 5 kg COD

1 kg COD removed ≈ 0.35 Nm³ CH₄ ≈ 3.8 kWh

Sludge, 30-60 kg COD
Case Studies
Borregaard is the global leader in bio-based chemicals. Strong innovation efforts increase the value added to our customers.

Borregaard’s bio-based chemicals are sustainable and environmentally friendly substitutes to petrochemical based alternatives.
Wood based chemicals in an integrated concept

Applications (end products)

- **Cellulose**
  - Construction materials
  - Cosmetics
  - Food
  - Tablets
  - Textiles
  - Filters
  - Paint / varnish

- **Lignin**
  - Concrete additives
  - Animal feed
  - Dyestuff
  - Batteries
  - Briquetting
  - Mining

- **Vanillin**
  - Food
  - Perfumes
  - Pharmaceuticals

- **Ethanol**
  - Car care
  - Paint / varnish
  - Pharmaceutical industry
  - Bio Fuel
Borregaard Norway – Case Study (4)

- **Wastewater Treatment**
  - Flow: 18,240 m³/day; COD load: 100 ton/day
  - High rate anaerobic & Filtration

- **Biogas Production**
  - Biogas Production: 31,200 Nm³/day
  - Gross Calorific Capacity: 10.8 MW

- **Benefits**
  - Water treated to meet effluent limits
  - Biogas produces as renewable energy source
Historical Approach – Ethanol Distillery

- Whole Stillage
- Distillery
- Thin Stillage
- Dewatering
- evaporator
- Condensate
- Other & Cleaning Effluents
- High Rate
- Post treatment
- River Discharge
- Distillers Grain
Vivergo Fuels, United Kingdom

- **Wastewater Treatment**
  - Flow: 2,160 m³/day; COD load: 9.7 ton/day
  - High rate anaerobic
  - Aerobic Post Treatment MBR & UV posttreatment

- **Biogas Production**
  - Biogas Production: 3,600 Nm³/day
  - Gross Calorific Capacity: 1.1 MW

- **Benefits**
  - Water treated to meet effluent limits & Water re-use
  - Biogas produces as renewable energy source
Tereos Lillebonne, France

- **Wastewater Treatment**
  - Flow: 4,800 m³/day; COD load: 30 ton/day
  - Medium rate anaerobic
  - Aerobic Post Treatment

- **Biogas Production**
  - Biogas Production: 11,800 Nm³/day
  - Gross Calorific Capacity: 3.8 MW

- **Benefits**
  - Water treated to meet effluent limits
  - Biogas produces as renewable energy source
Sudzucker Bioethanol GmbH Germany

- Wastewater Treatment
  - COD load: 30 ton/day
  - High rate anaerobic
  - Aerobic Post Treatment

- Biogas Production
  - Biogas Production: 11,800 Nm$^3$/day
  - Gross Calorific Capacity: 3.8 MW

- Benefits
  - Water treated to meet effluent limits
  - Biogas produces as renewable energy source
Lurgi skid mounted plants - USA

- **Wastewater Treatment**
  - COD load: 3 – 7 ton/day
  - High rate anaerobic
  - Package Unit – skid Mounted

- **Biogas Production**
  - Biogas Production: 1,000 – 2,400Nm³/day
  - Gross Calorific Capacity: 0.35 – 0.75 MW

- **Benefits**
  - Water treated to meet effluent limits
  - Biogas produces as renewable energy source
Nowadays Approach – full recovery & valorization

Distillery

Draff → Dewatering → Centrifuge → High-rate anaerobic plant → Membrane bio-reactor → Reuse and/or Discharge

Pot Ale

Wash Waters

Spent Lees → Copper removal

Biomass Boiler

Biogas Boiler

Biogas
Energy Potential Distilling slob

**Distillery alcohol production**
- **100,000 hl/a**

- **Draff**
  - **35,000 t/a**

- **Pot Ale**
  - **100,000 t/a**

- **Spent Lees**
  - **120,000 t/a**

**Waste to Energy**

- **Heat**
  - **18,400 MWh/a**

- **CH$_4$**
  - **35,300 MWh/a**

- **Electr.1**
  - **2,300 MWh/a**
Diageo – St. Croix USVI

- **Wastewater Treatment**
  - Flow: 1,893 m$^3$/day; COD load: 170 ton/day
  - Low rate anaerobic & Evaporation

- **Biogas Production**
  - Biogas Production: 66,000 Nm$^3$/day
  - Gross Calorific Capacity: 17.7 MW

- **Benefits**
  - Water treated to meet effluent limits
  - Biogas produces as renewable energy source
Development of Memthane Technology

Biogas
CH₄ 28 Nm³ ≈ 280 kWh
CO₂ 9 Nm³

Biogas
CH₄ 33 Nm³ ≈ 330 kWh
CO₂ 11 Nm³

*Based on 95% biogas production

Anaerobic
100 kg COD

80% Biogas
(75% Methane)

An-MBR
100 kg COD

95-99% Biogas
(75% Methane)

1-5 kg COD

1 kg COD removed ≈ 0.35 Nm³ CH₄ ≈ 3.8 kWh

Sludge 5 kg COD

Sludge 5 - 7 kg COD

15 kg COD
Memthane®; Track record

- **Proven Innovation**
  - 9 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
Ethanol distillery- Poland

Introduction

- Production Capacity: 10,000 m$^3$ Ethanol per year
- Bases: Corn
- Flow: 700 m$^3$/day / COD: 48 ton/day
- TKN: 720 ppm / t-P: 820 ppm
Ethanol distillery - Poland

Design Considerations

BIOBED

Stillage → Centrate → DAF → BT → Dilution Effluent → Post Treatment

DAF Float

MEMTHANE

Stillage → BT → AnMBR sludge stream → Post Treatment
Ethanol distillery - Poland

Design Considerations

- BIOBED
- Stillage → Centrate
- DAF
- BT
- Dilution Effluent
- DAF Float
- Post Treatment
- AnMBR sludge stream

- MEMTHANE
- BT
- Biogas
- Post Treatment
- AnMBR sludge stream
Ethanol distillery - Poland

Process Outline Memthane® Process

- Biogas: 5.3 MW
- 2 x CHP Unit 1.2 MW
- 1.2 MWe

Biogas scrubber

Waste water

Memthane Process 6,000 m³

Centrifuge

Back Set water For re-use

Sludge disposal
Development Works...

Biogas → Electricity CHP

Memthane® → Water Re-Use Evaporator

Decanter → Water Re-Use RO Treatment

N-removal Ammonia Stripping

P-removal Struvite & Anitamox

Thin Stillage

Boiler Feed Water

Cooling Water & Other

Back set water

Ammonia for Re-use

Fertilizer
Development Works...

- **Design & Pilot Study:**
- *Development of Process Route Map for maximizing Energy recovery from Stillage treatment*

5 Mwe + 7 MW heat

- Precentrifuged spent wash from Evapo-1
- WAnS SBR required for 5.0 MWe, optional for 2.5 MWe
- Anaerobic digester
- Biogas scrubber + dryer
- Biogas holder
- CHP unit
- UF system
- UF permeate
- Struvite + H₂S oxidation
- Struvite + H₂S oxidation
- Treated UF permeate
- UF permeate SBR or ammonia stripper
- Treated WAnS
- Other wastewater (10 – 15,000 m³/d)
- Effluent to river discharge
- Dewatered sludge to disposal
- Existing aerobic WWTP

River

Struvite

Sludge

Thin Stillage
Development Works...

- Development Water Technology Roadmap for Leading 2nd Generation Ethanol producer
Conclusions

- Water and nutrient recovery is considered more and more as a strategic aim of BioFuels producing industry

- Latest technology developments allow to realize water re-use and nutrient schemes even more effectively

- Valorization of Nutrients for direct use (NH4) or indirect re-use is becoming more valuable in mid-long term due to scarcity of nutrients world wide
Questions

To which extent do you consider energy and water recovery part of your company's strategic mission?

And how is this effected in practice?