BDI BioGas

3rd International Conference on Sustainable Solid Waste Management
2nd - 4th July 2015
Museum of Marble Crafts
From waste to value....

BDI BioGas – The solution for industrial and municipal waste!

BDI develops technologies for producing energy from waste and by-products while ensuring maximum preservation of resources at the same time.

• compact in size
• the system uses a reliable, stable biotechnology process
• outstanding for its high level of profitability

...Your requirement is our challenge because BDI is a leading specialized plant manufacturer with more than 15 years of experience!
**Pre Processing of Waste**

It’s a bit like preparing food:

- Depackaging…
- Removing Contaminants…
- Mixing, stirring, cooking, …
Pre Processing of Waste & BDI Technology

Municipal Solid Waste → Mechanical Treatment (sorting) → Recycling Material

Organic fraction (OFMSW) → Wet pretreatment (Pulper) → Process water tank

Impurities - Heavy fraction (e.g. sand, grit) - Light fraction (e.g. plastics, wood)

Anaerobic digestion (BioGas process) → Liquid digestate

Biogas → Gas storage → Gas cleaning → CHPs

Biological Treatment (e.g. drying, nutrient addition, pelleting, …)

Thermal energy - Hot water - Steam → Electricity to the grid

Solid Digestate → Composting

Clean air

High quality fertilizer

Liquid Digestate

Flare
Substrate Treatment
Organic loading rate **OLR:**

- $5-6 \text{ kg}_{\text{VS}} / \text{ m}^3 \cdot \text{d}$
- $\sim 8 \text{ kg}_{\text{COD}} / \text{ m}^3 \cdot \text{d}$

Hydraulic retention time **HRT:**

- Hydrolysis reactor: **4 d**
- Fermenter: **25 d**
- Post digester: **15 d** (higher if energy crops are substrate)
- Digestate storage tank: **depending on local regulations and customer**
Process temperature:

- **38 – 43°C** (depending on TN and process conditions)

Nitrogen **TKN:**

- TKN Substrate: **max 6 g/kg**

Total Solids **TS:**

- TS Hydrolysis: max 13 %
- TS Fermenter: **max 10 %**
Substrates

- Food industry waste
- Expired food products
- Industrial waste and by-products
- Slaughterhouse waste
Food Waste and OFMSW
Substrate Treatment < 5% impurities

Substrate > Shredder (opt.) > Hygienisation (opt.) > Separator Mill 10-15% TS > Cyclone > Anaerobic Digestion > Fine Particle Removal > Digestate

Cardboard > Aluminum > Plastics → Glass

Sand / Grit > Plastics
Substrate Treatment > 5% impurities

- Substrate
- Shredder
- Pulper 6-10% TS
- Screen
- Anaerobic Digestion
- Digestate

Impurities:
- Cardboard
- Aluminum
- Glass
- Sand / Grit
- Oversize
- Plastics

Hygienisation (opt.)

NH3 (opt.)
Crushing & Separation

Perfect solution for individual needs:
- Food waste with low amount of inerts
- Food waste with higher amount of inerts
- Biowaste and Organic Waste - OFMSW
- Slaughterhouse waste
Treatment of packaged food waste by means of Centrifugal Separation

> 97% of the organics goes into the slurry.

< 3% organics in the fluffy inert stream.
Removal of inerts
by means of
Pulper System

- Dissolving organic material into process liquid (liquid digestate)
- Separation of inert material (glass, sand, stones...) and washing
- Separation of light (non digestable) fraction like plastics and wood
- Storage of suspension in adjacent hydrolysis tank (first step of AD)
Substrate Treatment

- Impurities like glass, sand, metals, stones, e.g. cause problems in several sections of a BioGas plant
  - higher pump wear
  - sediments in heat exchangers
  - sediments in digesters

- Legal requirements to pre-treat organic substrates (EC 1069/2009) hygienization
  - Processed food waste
  - Slaughterhouse waste

- Tailor made solutions for any application
  - Screening
  - Sieving
  - Crushing
Hygienisation

**Pasteurization:**
+ 1 hour at 70°C / 1 bar
+ Particle size < 12 mm

**Sterilization:**
+ 20 min at 133°C / 3 bar
+ Particle size < 50 mm

Required for meat based waste depending on local regulations (Europe: EU 1069/2009)
Anaerobic Digestion
Fundamentals Anaerobic Digestion (Biogas process)

The famous BioGas / Cow – Example:

Focus on Pre-Processing
Inside an anaerobic digester there are specific consortia of microorganisms.

4 major groups of microorganisms have been identified with different functions in the overall degradation process:

1. The hydrolyzing and fermenting microorganisms
2. The obligate hydrogen-producing acetogenic bacteria
3. & 4 Two groups of methanogenic Archaea
BDI BioGas-Technology

3 Stage System

1. Hydrolysis / mixing tank
   - First degradation step of organic polymers
   - Homogenisation of fluctuating feedstock composition

2. Digestion tank
   - Main organic matter degradation
   - Main biogas production

3. Post digester
   - final degradation processes
   - Increasing digestate quality (better mineralisation, less odour potential)
Main characteristics of BDI technology

- CSTR technology (continuous stirred tank reactor)
- Digester Geometry: Height to diameter ratio ~ 1
- Central slow rotating paddle agitator
- External heat exchanger
- Tank material: bolted steel or reinforced concrete
Reactor mixing

- Mixing of fresh substrate with digester sludge
- Even distribution of heat in the fermenter
- Distribution of nutrients
- Homogenisation; prevention of sedimentation and scum layer formation
- Good degassing of biogas from the fermentation sludge

This has to be fulfilled by a mixing technology with minimum energy demand !!!
Reactor Design

- Diameter to height ratio of 1:1
- Maximum volume of 4800 m³
- Material resistant to corrosion

Steel

Concrete
Heating

**External Heat Exchanger:**
- Optimum & equal heat transfer
- Easy cleaning & maintenance
- Good temperature control
Advantages of the BDI technology

- Optimized digester mixing by customized central paddle agitator and digester geometry
- Reliable and easy to maintain digester heating system (external heat exchanger)
- Prevention of sediment and scum formation inside the digester
- Highest quality requirements for mechanical and electrical equipment
- High grade of plant automation
- Sophisticated security measures
  - Gas warning devices in critical areas (CH₄ and H₂S)
  - Security devices for Vessels (overpressure protection, busting disks, level indicators, overfill protection sensors)
- Automatic shut off measures
Energy Conversion
Energy Conversion

After the utilization of the BioGas (removal of sulfur and water) the BioGas can be used for:

- Production of electricity and heat energy in a gas engine (CHP)
- Production of hot water or steam in a gas boiler
- Injection to the gas grid (purification units)
- Vehicle fuel (CBG)
Compressed Biogas (CBG) as vehicle fuel
Natural gas & Biogas as alternative vehicle fuel

- Fleets are converting to CNG for cost savings and environmental sustainability.
- Compressed Biogas (Biomethane) can be used in vehicles operated with natural gas without any engine modification

### Distance with fuel for 10€*

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Distance (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>128</td>
</tr>
<tr>
<td>Diesel</td>
<td>184</td>
</tr>
<tr>
<td>Liquefied Petroleum Gas</td>
<td>201</td>
</tr>
<tr>
<td>Biogas via grid injection</td>
<td>275</td>
</tr>
<tr>
<td>Biogas direct fuel station</td>
<td></td>
</tr>
</tbody>
</table>

*depending on driving style. Information based on the Audi A3. Average prices of 2013. Publication of the Federal Ministry of Economics and Technology (Germany) from 30.6.2014.
Digestate Treatment
- Most common utilization of digestate is land application as fertilizer
- As a result of large area demand due to maximum nutrient dosage the transport costs get significant.

- Main goals of digestate treatment
  - Separating nutrients and providing a transportable, storable and marketable fertilizer
  - Reduction of the mass to be applied on agricultural land
  - Reducing costs for storing and land application
  - Reducing the impact on the environment

**BDI solution → Membrane Bio Reactor (MBR-Process)**
Membrane Bio Reactor

Process steps and main components
- Solid liquid separation (decanter and/or belt filter)
- Aeration basin
- Filtration (Ultrafiltration)
- Concentration (Reverseosmosis)

Diagram:
- Solid liquid separation
  - Polymer
  - CO₂ & N₂
- Aeration
  - Digestate
  - Pellet
  - Sludge
- Filtration
  - Retentate
- Concentration
  - Sulfuric Acid
  - Water
Membrane Bio Reactor

**MBR Process:**

- **Goal**
  - Reach direct discharge quality
  - Concentrated nutrient for fertilizer

- **Advantages**
  - simple modular setup
  - closed system (odours)
  - physical separation method
BioGas | Etampes
North France

**Capacity:** 2,1 MW_{el} / **Substrate:** 65,000 tons/year

**Scope of delivery:** sanitation, fermentation, power generation, distribution of heat

**Scope of services:** planning, plant engineering, biological commissioning, assembling

**Substrates:** Food waste from households and restaurants, expired food products from supermarkets

**Project start:** December 2011

**Construction start:** February 2012

**Handover:** September 2013
BioGas | Pamukova

Turkey

**Capacity:** 1.4 MW<sub>el</sub> / **Substrate:** 56,000 tons/year

**Scope of delivery:** construction, planning of overall plant

**Scope of services:** planning, plant engineering, biological performance commissioning

**Substrates:** cleaned household organics, kitchen waste, manure, straw

**Project start:** March 2010

**Construction start:** September 2010

**Handover:** February 2012
**BioGas | Marl**

**Germany**

**Capacity:** 3,1 MW<sub>el</sub> / **Substrate:** 60,000 tons/year

**Scope of delivery:** planning, delivery, installation, commissioning and assembly

**Scope of services:** design & construction

**Substrates:** expired food waste, catering waste

**Project start:** May 2011

**Construction start:** September 2011

**Handover:** December 2011
Why BDI BioGas?

- BDI is a stock market listed company with many years of experience in international plant design

- BDI plants are suitable to handle various substrates

- BDI plants provides a continuous, stable and robust operation

- BDI plants ensure a high level of plant automation and the usage of high quality material and equipment

- BDI provides an extensive After Sale Service to ensure a maximum plant availability
After Sale Service

**BASIC CONCEPT TO BE AWARE OF .......**

When biogas yields of the AD reactor are not so satisfactory

Take care of who is working together to produce it and try to understand what is the inhibition factor that make them
Hrvoje Milosevic
hrvoje.milosevic@bdi-bioenergy.com

BDI – BioEnergy International AG
Parkring 18
A-8074 Grambach/Graz
www.bdi-bioenergy.com