Food Waste Preprocessing for Anaerobic Digestion

Klaus Ruhmer, BDI-BioEnergy International
BDI Overview

- Waste To Energy – Technology company
- Tailor-made turn-key solutions
- Own technologies
- 35 plants on 4 continents
- Solid reputation, successful customers

- **Key figures 2011:**
  Staff: 140 employees
  Turnover: € 35 mio
  Equity ratio: 64%
  Stock market listed in Frankfurt
Product portfolio

**BDI BioDiesel**
Multi-feedstock technology from the market leader

**BDI BioGas**
The solution for industrial and municipal waste

**BDI RetroFit**
Plant optimisation from the technology leader
Promoting the use of Biogas and Anaerobic Digestion

- 163 Members from the U.S., Germany, Italy, Canada and the UK
- All Industry Sectors Represented

Key Industry Goals:

- Promote biogas markets, technologies and infrastructure
- Achieve policy parity
- Promote as a best practice for environmental stewardship and greenhouse gas reduction

Our mission is to improve the climate for doing business in the biogas industry.

www.americanbiogascouncil.org
Changing the Biogas Industry through:

- Legislative and Regulatory Affairs:
  - Federal: Biogas Tax Credit; Clean Energy Standard; NAT GAS Act; Farm Bill
    - Introduction of Biogas ITC Bill (Rep. Kind)
  - States: California, Iowa, Massachusetts, Indiana, more

- Sharing Expertise:
  - 5 Specialized Working Groups

- Education and Outreach:
  - Briefings, presentations, and webinars for customers, policy makers, and the general public
  - Large Industry Network – 160+ company members
    - Entire supply chain of production, processing and use

Join Today!

Contact Josh Lieberman at jlieberman@ttcorp.com or 202-640-6595 x 322

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from Waste to Value

- Organic fraction of municipal solid waste (OFMSW)
- Source separated organics (SSO)
- Slaughterhouse waste
- Food waste
- Agricultural / animal waste streams
- Spent grain from breweries
- Destillation residue, glycerine phase and gums from biofuel production
- Fruit & vegetable industry residues
- Trap grease
- Used cooking oil
- Animal fat
Process chain

Research & Development → Consulting → Engineering → Project Management → Construction → Quality Management → Start-Up → After-Sales Service
BDI reference plants

Austria, 1991
Austria, 1991
Austria, 1992
Czech Republic, 1994
USA, 1998
Germany, 2001
Spain, 2002
Germany, 2002
Austria, 2003
Scotland, 2005
Austria, 2006
Spain, 2006
Spain, 2006
Germany, 2006
Latvia, 2008
Austria, 2008
Lithuania, 2007
Spain, 2007
Spain, 2007
Spain, 2007
Germany, 2007
Austria, 2007
Portugal, 2007
Denmark, 2008
Spain, 2008
Spain, 2009
Spain, 2008
Ireland, 2008
Norway, 2009
Hongkong, 2011
Netherlands, 2010
Belarus, 2011
Italy, 2006
Turkey, 2011
Germany, 2011
France, 2012
Food Waste Preprocessing for Anaerobic Digestion
Conditioning of Substrates

The famous BioGas / Cow – Analogy:

No – not that one!!
Conditioning of Substrates

The famous BioGas / Cow – Analogy:

Focus on Pre-Processing
Pre Processing of Food Waste

It’s a bit like preparing food:

Depackaging…

Removing Contaminants…

Mixing, stirring, cooking, …
Pre Processing of Food Waste

It’s a bit like preparing food:

- Depackaging…
- Removing Contaminants…
- Mixing, stirring, cooking, …
Pre Processing of Food Waste

It’s a bit like preparing food: You need a “Good Kitchen”!

• **Substrate takeover facility**
  • Closed building w/ truck take-over & washing
  • Negative pressure & bio-filters (NO odors)
  • Substrate stream management (blending, mixing, storage, etc.)
  • Trained personnel

• **Proven Equipment**
  • Solid references
  • Performance data & guarantees
  • Automated / integrated with PCS
  • Service & Spare part support
DEFINITION:

Removal or conditioning of substrate components which would otherwise negatively impact the interaction with technical equipment and/or the microbiology as well as the quality of the digestate

What needs to be done:

- Contaminants must be removed
- Particle size must be adjusted
- Solid content and substrate consistency must be adjusted
- Nitrogen / ammonia levels must be controlled
- System must be flexible to changing substrates & volumes
- As automated as possible
Conditioning of Substrates

Removal of impurities at the first point of physical differentiation:
Mainly: Plastics, Glass & Metals

- Transports
- Dosing Bunker
- Crushing
- Centrifugal Separation
- Sand removal
- Mazeration
- Pasteurization and/or N Removal
Food Waste and more
Pre-Treatment technology selection

Technology selection driven by:

- **Level of contamination <5%:**
  Grocery store, catering, market waste
  Use of mill / screening technology

- **Level of contamination >5%**
  OFMSW
  Use of pulping technology

- **Digestate quality requirements**
  Drives the specification for incoming substrates
  May require secondary contaminant removal
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

- NH3 (opt.)
- Sand / Grit
- Plastics
Substrate Treatment < 5% impurities
Substrate Treatment < 5% impurities

**Supply**
- Food (packed, unpacked) unverpackt
- Food waste
- Leftovers
- Organic wastes

**Grinding and Separating**
- Conveying
- Unpacking
- Grinding
- Separating

**Results**
- Contraries
- Substrate
## Organics extraction efficiency

<table>
<thead>
<tr>
<th></th>
<th>Organics in Packaging [ % ]</th>
<th>Impurities Plastic/Alu &gt; 12 mm</th>
<th>humid [ % ]</th>
<th>dry [ % ]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yoghurt</td>
<td>2,06</td>
<td></td>
<td>0,08</td>
<td>0,20</td>
</tr>
<tr>
<td>Petfood, Paper, Alu</td>
<td>0,82</td>
<td></td>
<td>0,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Pudding small</td>
<td>1,49</td>
<td></td>
<td>0,05</td>
<td>0,20</td>
</tr>
<tr>
<td>Jeast hydrolysate</td>
<td>4,61</td>
<td></td>
<td>0,00</td>
<td>0,00</td>
</tr>
<tr>
<td>Salmon in plastic bags 200g</td>
<td>13,57</td>
<td></td>
<td>0,03</td>
<td>0,03</td>
</tr>
<tr>
<td>Chicken breast in big plastic bags (20-50kg)</td>
<td>0,00</td>
<td></td>
<td>0,07</td>
<td>0,19</td>
</tr>
<tr>
<td>Appletarte in Alu-trays, in big cardboard trays</td>
<td>10,10</td>
<td></td>
<td>0,11</td>
<td>0,19</td>
</tr>
<tr>
<td>Milk in plastic bottles</td>
<td>2,02</td>
<td></td>
<td>0,09</td>
<td>0,14</td>
</tr>
<tr>
<td>Median</td>
<td>2,04</td>
<td></td>
<td>0,07</td>
<td>0,19</td>
</tr>
<tr>
<td>Main</td>
<td>4,33</td>
<td></td>
<td>0,07</td>
<td>0,16</td>
</tr>
<tr>
<td>Expected/Guarantee</td>
<td>&lt; 5%</td>
<td></td>
<td>&lt; 1%</td>
<td>&lt; 1%</td>
</tr>
</tbody>
</table>
Various equipment

RotaCut  

Hydrocyclone  

Removed material (Hydrocyclone)
Hygeniesation / Pasteurization

Semicontinuous 3-vessel system (loading, pasteurizing, unloading) with heat recovery or true continuous and enclosed system
Substrate Treatment > 5% impurities

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

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

Hygienisation (opt.)
NH3 (opt.)
Substrate Treatment > 5% impurities
Substrate Treatment > 5% impurities

Screw conveyor

Wet Screen
Nitrogen removal – BDI Flash

Protein or other nitrogen containing substrates such as slaughterhouse wastes or poultry litter contain too much nitrogen, which is transformed to ammonia. Ammonia may inhibit the microbiological performance.

The patented BDI-FLASH process is designed to reduce the ammonia-level in the fermentation liquid or the digestate of biogas plants providing an aqueous ammonia-solution.

Winner of Wastewater-Award Phönix 2010
Nitrogen / protein rich substrates lead to ammonia in the digester!

**BDI-FLASH** to reduce ammonia concentration in substrate to TKN <8g/kg.

**BDI-FLASH** to recover ammonia from digestate to generate valuable product.

**BDI-FLASH** prior to digestate treatment via MBR (Membrane Bio Reactor)
Requirements and advantages

- No removal of particles < 5mm necessary
- Temperature supply: Hot water ≤ 100°C (CHP-Cooling Water, no steam required). Energy recovery is integrated.
- The process is optimized for a minimum chemical consumption
- No packed columns which can block
- No gas-scrubber
- Production of a valuable aqueous ammonia solution.
- Integration of a rectification step to provide high-quality ammonia water as option
- Fully automated
- Full process integration into existing biogas plants
<table>
<thead>
<tr>
<th>Process</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas stripping</td>
<td>Recycling of stripping gas, only treatment of excess gas necessary, continuous or batch, usable at various pressure levels, tolerant to solids.</td>
<td>Inert gas has to be cleaned via chemical washing step, ammonia is available in the form of ammonia sulfate or ammonia nitrate, higher gas flow compared to steam, potential for foaming.</td>
</tr>
<tr>
<td>Steam stripping</td>
<td>Efficient ammonia removal, continuous process, Final product ammonia water, can be rectified to technical grade NH3 or sold as ammonia sulfate.</td>
<td>Steam requirement (boiler, etc.) Packed column: Liquid must be &lt;0.1% TSS. May require centrifuge or belt filter press.</td>
</tr>
<tr>
<td>Flash Vacuum spray evaporation</td>
<td>Continuous process, tolerant to solids, energy supply by CHP possible (typically &lt;100°C, sometimes &lt;105°C), final product ammonia water, can be rectified to technical grade NH3 or sold as ammonia sulfate, no foaming issue</td>
<td>Vacuum system requires elevated position of flash vessel (5-7m)</td>
</tr>
</tbody>
</table>
Removal of Ammonia vs. Addition of NaOH

Laborversuche:
400 mBar (abs.) verschiedene pH-Werte

NaOH Dosierung g/kg Substrate
Industry examples

Example – SARIA ReFood, Marl, Germany

Substrate: expired food from food retailers, catering waste (87,000 tons per year)

Capacity: 6.3 mio Nm³ of BioGas (approx. 3 MW_{el})

Side products: Heat, Fertilizer

Multi-Feedstock BioGas plant
Customer: SARIA ReFood

- Located within industrial food waste processing complex
- Next to rendering processing company (user of thermal energy)
- Owner/Operator is major player in food residue industry (experience)
- Favorable environment for renewable electricity
Industry examples

Example Este (Italy) – Largest Plant in Europe

Feedstock: OFMSW, food industry waste, slaughter house waste, biofuel residues
Input: 105,000 tons/year
Fermenter: 2 x 2900m³, loading rate > 10 kg COD/m³
Output: Biogas: 1,450 Nm³/h (59% CH₄)
         Electricity: 3.4 MWₑₑ (27 GWh/y)
         Purified Water & Fertilizer
Start-up: 2006 (original plant), 2011 (expansion)

- Co-Located with composting facility
- Located next to former landfill
- Heat is fed into district heating network, concentrated fertilizer for land appl.
- Owner/Operator is major player in waste industry (experience)
- Favorable environment for renewable electricity
## Industry examples

**Example Pamukova, Turkey – Biosun / Hexagon**

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>50 000 t/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSO; OFMSW; Agricultural Residues</td>
</tr>
<tr>
<td>Energy production</td>
<td>~ 1.4 MW_el</td>
</tr>
<tr>
<td>Start-up</td>
<td>2011</td>
</tr>
</tbody>
</table>

- Co-Located with composting facility
- Integrated with MRF and RDF facility
- Heat used for local heating applications
- Favorable environment for renewable electricity
- Owner/Operator has large waste collection business
See us at our booth!

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