DRANCO technology for anaerobic digestion of organic waste
TOPICS

OWS

Organic waste

Treatment options

Dry Anaerobic Digestion technology (DRANCO)

The future
COMPANY PROFILE

DRANCO technology – UG, 1983 (pilot in 1984)
Founded in 1988
Consolidated sales (2011-2013): 19 million €/yr
Export: 90%
70 employees

Head office: Gent, Belgium
Affiliates: OWS Inc., Dayton, Ohio, USA
          DRANCO N.V.
          BES GmbH, Germany
Partner: DJK International, Tokyo, Japan
COMPANY PROFILE

- OWS
  - Drancotech: Engineering
  - Lab / Consulting: Various Services
    - BCE: Biodegradation, Composting & Ecotoxicity tests
    - BCS: Biogas Consulting & Support
    - Analyses: Analytical
    - ACS: Auditing, Controlling & Sorting
    - SAS: Sustainability Assessment Services
Expert in anaerobic digestion processes with 25+ years of experience

Covering all possible AD processes available worldwide

Unique combination of both biological and mechanical/technical knowledge

Independent advice and guidance at each level of anaerobic digestion
Feasibility testing of AD processes
  o Over the whole process chain: from pretreatment over AD to post-treatment
  o All necessary information to elaborate a full-scale project

Continuous assistance for full-scale plants
  o Start-up of AD plants
  o Revamping of unstable AD plants
  o Maintaining a stable AD process
  o Increasing performance
ORGANIC WASTE AND TREATMENT OPTIONS
ORGANIC WASTE

Different sources

- Municipal waste (residual, mixed, household organics, garden waste…)
- Waste water treatment (sludge)
- Agriculture (harvest residues, manure…)
- Food industry (left-overs, processing waste, expired products…)
- Biofuel industry (stillage, glycerine, soapstocks…)

How treat this waste?
LANDFILLING

Not sustainable
No recuperation of materials
No recuperation of nutrients
Sometimes recuperation of energy (landfill gas)
  - Low efficiency (suboptimal conditions)
  - Many leakages $\rightarrow$ CH$_4$ emissions to air

$\rightarrow$ Discouraged in many countries (landfill ban / taxes)
INCINERATION

Not sustainable

Limited recuperation of materials (e.g. metals from MSW)

No recuperation of nutrients (ashes are landfilled / low plant availability of ash nutrients)

Recuperation of energy
  - Low efficiency (high moisture content in most organic waste)
Sustainable
Stabilization of organic waste
Recuperation of materials (soil improver)
Recuperation of nutrients as compost
No recovery of energy
Sustainable
Stabilization of organic waste
Recuperation of materials (soil improver)
Recuperation of nutrients as digestate or derived products (compost, effluent, dewatered or dried cake…)
Recovery of energy (biogas)
ANAEROBIC DIGESTION
Organic matter

Microbial population

35 °C - 55 °C

$\text{CH}_4 + \text{CO}_2$

+ humus + heat

BIOGAS = ENERGY
ANAEROBIC DIGESTION

1. Hydrolysis

2. Acidogenesis

3. Acetogenesis

4. Methanogenesis

Organic compounds

- Proteins
- Carbohydrates
- Fats

Monomers/dimers

- Amino acids
- Sugars
- Fatty acids

Acidogenic bacteria

\( \text{pH}_{\text{opt}} = 5.2-7.0 \)

\( \text{pH}_{\text{inhibition}} < 4-5 \)

inhibited by high \([H_2]\)

Acetogens

\( \text{pH}_{\text{opt}} = 6.8-8.2 \)

Methanogens

\( \text{pH}_{\text{opt}} = 6.8-8.2 \)
Several types

- Mesophilic – thermophilic
- Wet – dry digestion
- Single stage – multiple stage
- Monodigestion – co-digestion
- Batch – semi-continuous – continuous
DRANCO
DRANCO

Feeding tubes

Dosing screw

Gas storage

Feeding pump

Extraction pump
Advantages of the DRANCO-design

- No floating or sedimentation in the reactor
- Minimal heat requirements
- Intensive and reliable digestion
- Less intensive pretreatment (robust technology)
- High flexibility to input (TS content in reactor: 15-40%)
- No mixing equipment inside the digester
- Simple reactor design (conical outlet)
- Avoids or minimizes wastewater production
- Combination of plug flow (guaranteed residence time of 2 days) and CSTR (intensive recirculation and external mixing)
<table>
<thead>
<tr>
<th></th>
<th>Location</th>
<th>Year</th>
<th>Capacity (sh tpy)</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>BRECHT I (Belgium)</td>
<td>1992</td>
<td>22,000</td>
<td>biowaste</td>
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<td>2.</td>
<td>SALZBURG (Austria)</td>
<td>1993</td>
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<td>BASSUM (Germany)</td>
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<td>4.</td>
<td>AARBERG (Switzerland)</td>
<td>1998</td>
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<td>KAIERSLAUTERN (Germany)</td>
<td>1999</td>
<td>27,600</td>
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<td>6.</td>
<td>VILLENEUVE (Switzerland)</td>
<td>1999</td>
<td>11,000</td>
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<td>7.</td>
<td>BRECHT II (Belgium)</td>
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<td>8.</td>
<td>ROME (Italy)</td>
<td>2003</td>
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<td>9.</td>
<td>LEONBERG (Germany)</td>
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<td>PUSAN (South Korea)</td>
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<td>77,200</td>
<td>Biowaste</td>
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<td>11.</td>
<td>HILLE (Germany)</td>
<td>2005</td>
<td>110,200</td>
<td>Organic fraction of MSW + sludge</td>
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<td>12.</td>
<td>MÜNSTER (Germany)</td>
<td>2005</td>
<td>88,200</td>
<td>Organic fraction of MSW</td>
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<td>13.</td>
<td>TERRASSA (Spain)</td>
<td>2006</td>
<td>27,600</td>
<td>Biowaste</td>
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<td>14.</td>
<td>VITORIA (Spain)</td>
<td>2007</td>
<td>132,300</td>
<td>Organic fraction of MSW</td>
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<td>HOTAKA (Japan)</td>
<td>2008</td>
<td>3,300</td>
<td>Biowaste</td>
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<td>16.</td>
<td>ALICANTE (Spain)</td>
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<td>198,400</td>
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<td>TENNEVILLE (Belgium)</td>
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<td>SEOUL (South Korea)</td>
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<td>33,000</td>
<td>Biowaste</td>
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<td>19.</td>
<td>KEMPTEN (Germany)</td>
<td>2009</td>
<td>19,500</td>
<td>Biowaste</td>
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<td>20.</td>
<td>LESZNO (Poland)</td>
<td>2010</td>
<td>55,000</td>
<td>Organic fraction of MSW</td>
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<td>21.</td>
<td>HENGELO (The Netherlands)</td>
<td>2011</td>
<td>55,000</td>
<td>Biowaste</td>
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<td>MIRANDELA (Portugal)</td>
<td>2012</td>
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<td>WIJSTER (The Netherlands)</td>
<td>2012</td>
<td>62,800</td>
<td>Organic fraction of MSW</td>
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<td>24.</td>
<td>WIJSTER (The Netherlands)</td>
<td>2013</td>
<td>44,000</td>
<td>Biowaste</td>
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<td>25.</td>
<td>BOURG-EN-BRESSE (France)</td>
<td>2015</td>
<td>81,000</td>
<td>Organic fraction of MSW + Green waste</td>
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<tr>
<td>26.</td>
<td>CHAGNY (France)</td>
<td>2015</td>
<td>89,300</td>
<td>Organic fraction of MSW + Green waste</td>
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<td>27.</td>
<td>NORTH YORKSHIRE (UK)</td>
<td>2017</td>
<td>44,000</td>
<td>Organic fraction of MSW</td>
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<td>28.</td>
<td>NÜSTEDT (Germany)</td>
<td>2006</td>
<td>22,000</td>
<td>Energy crops (1 Mwel)</td>
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<tr>
<td>29.</td>
<td>LANGENDORF (Germany)</td>
<td>2010</td>
<td></td>
<td>Wet post-digester</td>
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</tbody>
</table>
REFERENCE
PLANT BRECHT
(Belgium)
BRECHT: DIGESTION OF BIOWASTE
BRECHT II: DIGESTION OF BIOWASTE

Capacity:
  - 50,000 tpy

Digester volume: 3,150 m³

Start-up: 2000

Biogas production: 125 Nm³/t
  - 100% gas engines
  - Biogas to 3 gas engines of 700 kW_{el} each

Digestate:
  - Total solids-content: 30%
  - Dewatering & two weeks post-composting
BRECHT: DIGESTION OF BIOWASTE
REFERENCE PLANT
HENGELO
(The Netherlands)
Capacity:
  o 50,000 tpy
    • 40,000 tpy biowaste
    • 5,000 tpy overdue products
    • 5,000 tpy liquid products

Digester volume: 3,450 m³

Start-up: 2011

Digestate is mixed with fraction 60-160 mm
  → dewatering is avoided

Biogas production
  o 100% gas engines (2 x 1.2 MW)
  o Heat is used in district heating network
HENGELO: DIGESTION OF BIOWASTE

Existing aerobic composting: 1,5 ha

Anaerobic digestion: 0,17 ha
Partial stream digestion concept (applied in Hengelo and other DRANCO plants)
FULL STREAM DIGESTION CONCEPT

Full stream digestion applied in many other AD facilities:

MSW

Metals

RDF

Dry sorting

Biogas

Anaerobic digestion

Effluent

Digestate dewatering

Water

CO$_2$

Aerobic composting / drying

Compost, incineration or landfill
Advantages of partial stream
- Avoids costly dewatering step: investment - operation
- Avoids treatment of excess wastewater/effluent
- Economics

Disadvantages of partial stream
- Less energy recovery
- Longer aerobic treatment required
DRANCO FARM
Comparison of 3 energy crop digesters in Germany (after Braun et al., 2009)

<table>
<thead>
<tr>
<th>Installation 1</th>
<th>Installation 2</th>
<th>DRANCO-FARM Nüstedt</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>500 kW\textsubscript{el}</td>
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<tr>
<td>Energy crops</td>
<td>t/year</td>
<td>9 500</td>
</tr>
<tr>
<td>Manure</td>
<td>t/year</td>
<td>-</td>
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<tr>
<td>Total input</td>
<td>t/year</td>
<td>9 500</td>
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<tr>
<td>Installed electrical power</td>
<td>kWe</td>
<td>500</td>
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<tr>
<td>Reactor volume</td>
<td>m\textsuperscript{3}</td>
<td>3000</td>
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<tr>
<td>Temperature</td>
<td>°C</td>
<td>49.5</td>
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<tr>
<td>Retention time</td>
<td>days</td>
<td>-</td>
</tr>
<tr>
<td>Loading rate</td>
<td>kg VS/m\textsuperscript{3}/d</td>
<td>-</td>
</tr>
<tr>
<td>Biogas productivity</td>
<td>Nm\textsuperscript{3}/m\textsuperscript{3}\textsubscript{R}/d</td>
<td>1.72</td>
</tr>
<tr>
<td>TS-content reactor</td>
<td>%</td>
<td>&lt; 10</td>
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</tbody>
</table>

The data for 1 Mwe are not part of the study but were collected by OWS
SORDISEP
Making full-stream digestion of MSW competitive with Mechanical-Biological Treatment by:

- Recovery of clean products
- Increasing recycle rate of material
- Minimisation of treatment or landfill costs of end fractions
- Production of compost according to standards

AN INNOVATIVE POST-TREATMENT TECHNOLOGY AFTER ANAEROBIC DIGESTION OF MUNICIPAL SOLID WASTE
MUNICIPAL SOLID WASTE

100%

DRY SORTING

RDF (28%)
METALS (5%)
REFUSE (3%)

64%

DIGESTION

BIOGAS (12%)

52%

WET SEPARATION

SAND (4%)
INERTS (8%)
LIGHT FRACTION (10%)

30%

ORGANIC FRACTION

AEROBIC STABILIZATION

EVAPORATION (5%)
DRY MATTER LOSS (1%)

COMPOST (24%)
FUTURE EVOLUTIONS
Integration with production of biomaterials/biotechnologies

- More efficient use of available biomass
- Combination of high-value materials and energy recovery
  - 1\textsuperscript{st} step: pretreatment of organic waste
  - 2\textsuperscript{nd} step: extraction of valuable bioproducts
  - 3\textsuperscript{rd} step: anaerobic digestion of remaining (spent) biomass to produce energy and recover plant nutrients
FUTURE EVOLUTIONS

- organic waste
- pretreatment
- biorefinery
- anaerobic digestion
- spent biomass
- compost
- bioproducts