The One and Only Waste Treatment and Processing Technique

There is no Plan „B“ because we do not have a „Planet B“!

Profile

The companies in the voran® holding stand for quality, dynamics and professionalism, and have done for more than eight decades.

Always at the leading edge, we continue to develop proven systems as well as pioneer new ways, where experience and expertise count.

With customer orientation, openness and innovative spirit, voran® Maschinen GmbH offers cost-effective overall solutions through our plant construction, facade, machinery and manufacturing companies. An integral part of the wide field of operations offered by voran® holding is for example Voran Immobilien und Beteiligungen GmbH with its subsidiary voran Projektinvest GmbH.

The successful Austrian construction firm Steiner Bau GmbH with its headquarters in Heiligeneich also contributes to the overall success of voran® holding with its large-scale building projects (hospitals, schools, housing projects, etc.).

The Viennese Projektinvest Bauträger GmbH on the other hand, is committed to perfection in furnishing the highest quality living spaces.

On the subject of sustainable, realistic energy technology and recycling of biogenic waste, voran® holding has a visionary and future-oriented partner in EBK Reiter GmbH.

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Establishment of Biogenic Waste Plant: 3435 Zwentendorf an der Donau, Austria
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Hygiene gets more and more important

Only if the connections between sanitary conditions and diseases have been recognized for the first time, humans will begin with the creation of proper waste disposal systems.

Until about 30 years ago, most waste was dumped in landfills anywhere in the area without a plan - many of them are now hazardous waste sites which cause serious environmental damage. At the same time contaminated groundwater is an almost insoluble problem in many places. People proceeded to burn the garbage - but most incinerators proved to be a cost trap.

On the one hand because the energy that is required for combustion is usually much higher than the energy that can be recovered from the combustion.

On the other hand, because all recyclables are simply destroyed.

The exhaust gas cleaning has up to date been a very expensive process

Take the best – from the waste

A complete system schematically consists of 3 parts:
The Sorting, the Biogas Plant, and the Pyrolysis.

1. Sorting

Separation of directly reuseable and non-reuseable materials

The greatest part of reuseable materials from the waste is selected and separately collected according to the individual material for further sale to recycling companies. By means of recovery of recyclable material (eg glass, metal, paper, PVC, ..) salable products are created.

1.1

Substances that interfere with the fermentation process, are again selected and routed directly to step 3.

2. Fermentation at the Biogas Plant

Reuse of organic components by means of fermentation and reuse of the final residues as fertilizer.

Firstly the packaging is removed mechanically. These packaging residues are routed to step 3. Through biochemical processes (anaerobic fermentation by archaea - primitive bacteria), energy (electricity and biogas that likewise can be upgraded to natural gas quality), heat, organic fertilizer and „technical“ water may be obtained from the mass that remains after the sorting process.

2.1 Biogas Plant ⇨ Organic Fertilizer

The organic fertilizer has been approved in accordance with the Austrian Fertilizer Regulation (DMV), and also complies with EU regulations

WITH FERTILIZER

WITHOUT FERTILIZER

Austrian
Federal Office for
Food Safety
BAES

Spargelfeldstraße 191
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STEINER BAU GmbH
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Reference code: BAES-DMT-2017-0187

Certificate of registration for the product "Active Land"

Dear Ladies and Gentlemen!

The Austrian Federal Office for Food Safety confirms that the product **"Active Land"** is registered in Austria as a organic fertilizer according to the fertilizer law 1994 (BGBl. Nr. 513/1994 i.d.g.F.) and the fertilizer regulation 2004 (BGBl. II Nr. 100/2004 i.d.g.F.). Therefore, **"Active Land"** can be sold and used as organic fertilizer in Austria.

On behalf of the Director
of the Austrian Federal Office for Food Safety:

Dr. Wolfgang Bärnthaler

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DVR: 0014541 I Bank Name: BAWAG P.S.K. AG I Account Number: 96051513 | Bank Code: 60000
IBAN: AT85 6000 0000 9605 1513 I UID: ATU 54088605
Dokument-Nr. 7979_3

1 of 1

CERTIFICATE OF REGISTRATION

2.2 Treatment of category 3 material

With proper planning, even category 3 materials (slaughter blood, offal, animal sections, etc.) can be treated. Those requisite hygiene measures that are required are elementary and already provided in the technical structure of the system (keyword: Sanitation).

3. Pyrolysis

Utilization of the remaining parts by the chemical process of pyrolysis

Thanks to special chemical processes, pyrolysis again transforms the residual material remaining from the biogas plant to energy eg heat or electricity. There only remains a very small part of ash, which for example may be added to the asphalt for road construction work.

Detailed Explanation and Illustration:

1. Separation

The separation of reusable materials from the non-usable materials of the communal waste is the first step. Also parts of waste with large volume or foreign materials have to be sorted i.e. removed manually. This has to be done by people working on slow transporting conveyor bands (see pictures 3.1 and 3.2).

Fig.3.1.: Sorting cabins with containers for extraneous materials below

Fig.3.2.: Inside the sorting cabins

Materials which can be recycled (like glass, metals, carton, PET-bottles, and so on) are collected and brought back for recycling purposes. This saves natural resources.

The organic parts (i.e. from food industry or household) move further along to step 2, the fermentation.

Other materials with hygienic purposes (like cleaning substances), antibacterials (i.e. medications) or of mineralic consistence (like motor-oil) are also separated here. These materials will go directly to step 3, the pyrolysis.

Some samples of materials which can be collected for recycling:

- All kinds of glass (bottles, window-glass, etc.)
- PET (PolyEthylenterephthalat), mostly used for drinking bottles (water, softdrinks)
- Metal parts like they are used in motors, cables, construction parts, tools, etc.
- Electric and electronic parts
- Carton packages, paper
- Wood
- and so on

2. Fermentation

The organic parts including packaging materials will be treated at the biogas-plant.
The biologically recyclable waste coming from the separation unit is the raw material. The treatment of the waste happens in one or more processing stages on the basis of fermentation. The fermentation produces biogas with high methane content, and this biogas serves as a starting material for many uses.

EBK-Reiter in Austria

Kinds of biodegradable waste – consecutively named as raw materials – can be:

- Bakery waste
- Brewery waste
- Fats (also contents of fat-separators)
- Fish waste
- Municipal organic waste (household waste)
- Manure from chicken, from pigs, and from cattle
- Kitchen waste, and waste from canteens
- Molasses from sugar beet pulp (10% dry substance)
- Dairy waste
- Slaughterhouse waste (only category 3)
- Slaughterhouse blood (only category 3)
- Food condemned to be unfit for consumption (also mixed up with glass and/or metal)
- Food in cans

For an easier explanation, the processes at the biogas plant are distinguished by the following criteria:

1. Treatment of raw materials
2. Processing of the produced biogas
3. Production of one (ore more) kinds of energy
4. Recovery and reuse of the thermal energy
5. Avoidance of smell nuisance
6. Treatment of final substrate (digestate)

Treatment of raw materials

The treatment is, in principle, always identical:

1. Delivery to the plant (for example, with a garbage truck)
2. Mechanical treatment where necessary
3. Intermediate Storage in different tanks
4. Mixing up and preparation for fermentation
5. Fermentation (in 2 steps and within app. 30 days)
6. Treatment and storage of the final substrate (the digestate)

Figure 4.1.:
Delivery of kitchen waste and waste from canteens

Delivery to the plant

The raw materials are delivered from the producing factory to the biogas plant. By weighing the truck on a scale, the delivered amounts are determined. Unloading the truck takes place in the closed main-building. On leaving of the truck, the delivered amounts are controlled by reweighing them on a truck scale.

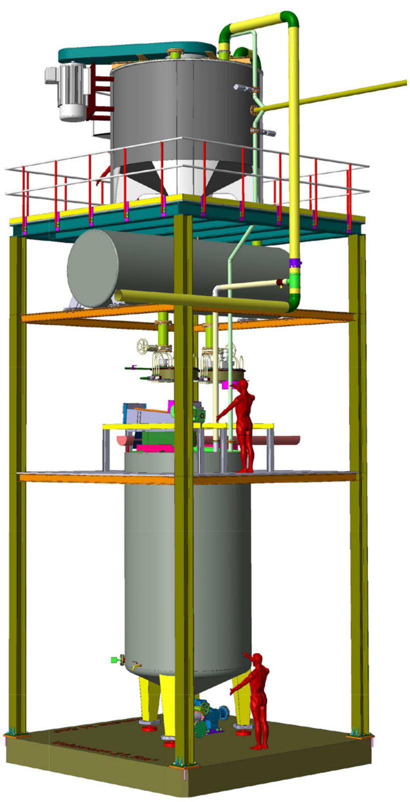
Based on the kind of waste, which is delivered (fig. 4.1), different methods for treatment are required. For example, a treatment of waste or blood from the slaughterhouse generally has its own governmental regulation on waste.

Mechanical treatment

All solid wastes are going to the treatment tower for crushing to sort out bigger parts of foreign materials. At a second stage smaller parts (for example metal pieces, plastic pieces, pieces of wood and so on) are getting extracted.

A substrate with papescent consistence appears at this second stage which is easily pumpable without any problems. At the end of the treatment the substrate has a particle size of max. 5 millimeters (demand by EU-Laws for sanitation is a particle size of 12 millimeters). Now the substrate goes for intermediate storage into different tanks. All tanks are equipped with an agitator to avoid sedimentation. Also, based on the design of the piping-system, a recirculation is possible. (see also fig. 4.2)

Liquid wastes are directly pumped through the system of pipes into the storage tanks. At this point in time all raw materials are inside a closed system of pipes and tanks.



Treatment Tower

Figure 4.2.: Central pump station; in the back one of the mash tanks is visible

Recipes and putting into fermentation

The central pump station feeds the mash with specified amounts from the storage tanks. The agitation of the mash tanks mixes up a recipe for an optimised fermentation. The ready mixed substrate is inserted from the mash tanks into the tube fermenter.

Fermentation in 2 stages

The basic fermentation happens inside the tube fermenters and in an anaerobic environment. Bacteria are doing the fermentation process, and at the end of the process biogas arises. The biogas is extracted from the tube fermenters.

In general, the time while the substrate stays in the tube fermenters, is not enough for a complete fermentation. The substrate flows into a tank-like fermenter, where fermentation continues.

The substrate from the tank-like fermenter runs into the sanitation, where it stays for 1 hour at a temperature of 72 degrees Celsius (EU-Law for sanitation). Due to the design of the plant, it is not possible to avoid the sanitation.

At the end of the process the finalized substrate – the digestate – stays at the repository.

Storage and treatment of the finalized substrate

The finalized substrate can be used as digestate in agricultural areas. Alternatively it can be recycled and transformed to organic fertilizer.

Fig 4.5 Sanitization

Fig. 4.6 Tube Fermenter

Workflow of the produced biogas

During the fermentation in the tube fermenters and towards the 2nd stage fermenter biogas develops. It is similar to the processes inside the bowel of animals or humans.

Development of biogas

A very simplified description, how biogas is created (Fig. 4.7):

The methanogenic condition (methanogenesis) is the last stage of degradation of the substrate (table 4.1). The degradation, based on bacteria, is taking place in 4 steps:

Hydrolysis, Acidogenesis, Acetogenesis und Methanogenesis. The products coming from acido-and acetogenesis are transformed from methanogenesis into methan. (CH_4). Depending on the contained substances in the substrate, different processes are possible:

- an acetic acid-degrading (acetoclastic) methanogenesis: $CH_3COOH \Rightarrow CH_2 + CH_4$

- methane formation from hydrogen and carbon dioxide: $4\ H_2 + CO_2 \Rightarrow CH_4 + 2\ H_2O$

- with respect to carbohydrates (as components of biomass) , the result is the degradation of glucose or fructose: $C_6H_{12}O_6 \Rightarrow 3\ CH_4 + 3\ CO_2$

Furthermore coenzymes with characteristic enzymes also play a role in the reduction of carboxyl groups (−COOH) to methane and carbon dioxide to methane. In particular, these are the tetrahydromethanopterin coenzymes, coenzyme M, an enzyme-corrin, and specific electron or hydrogen carriers.

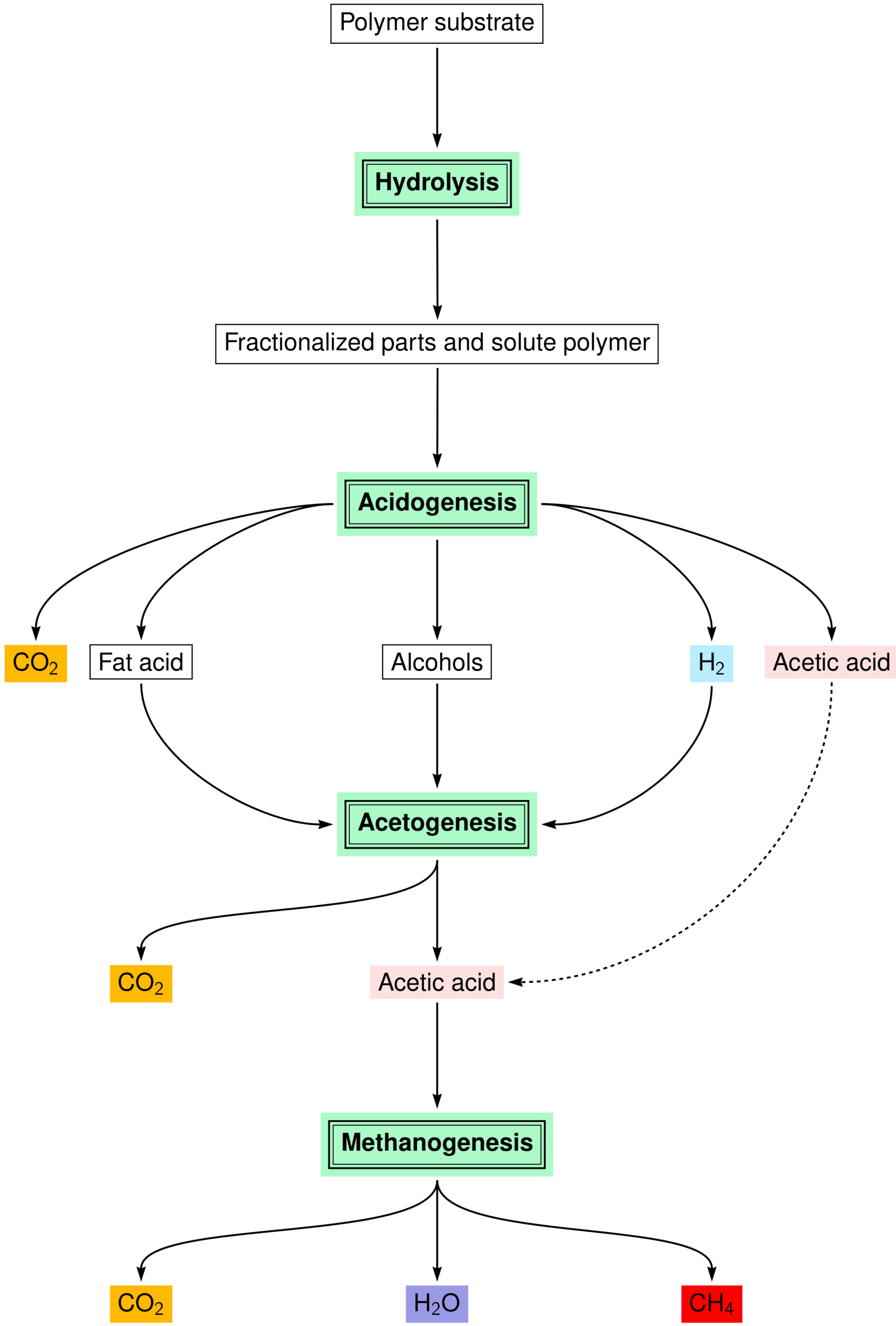


Table 4.7.: Simplified diagram about the development of biogas

Dissipate the biogas from the fermenters

Based on the high methan content of the biogas, it can be dissipated from the top of the fermenters. Before the biogas reaches the intermediate storage, it goes through the gas coulometer, the foam interceptor, and through valves, which are protected against back coupling.

All parts, where gas passes through, are made of acid resistant sustained steel.
If the biogas goes into a co-generation unit, it can optionally be desulfurized. Afterwards it is burned at the co-generation unit with a generator and transformed to electric power.

Safety precaution of biogas containing parts

In principle, the entire gas bearing area is designed in a way that it works nearly without pressure. As a first security measure a gas flare is installed at the end of the gas-bearing parts.
Before excess pressure is even generated, this ignites and burns the excess gas.

The foam interceptor acts at second stage. It works only by atmospheric pressure and allows the gas to blow out directly into the atmosphere.

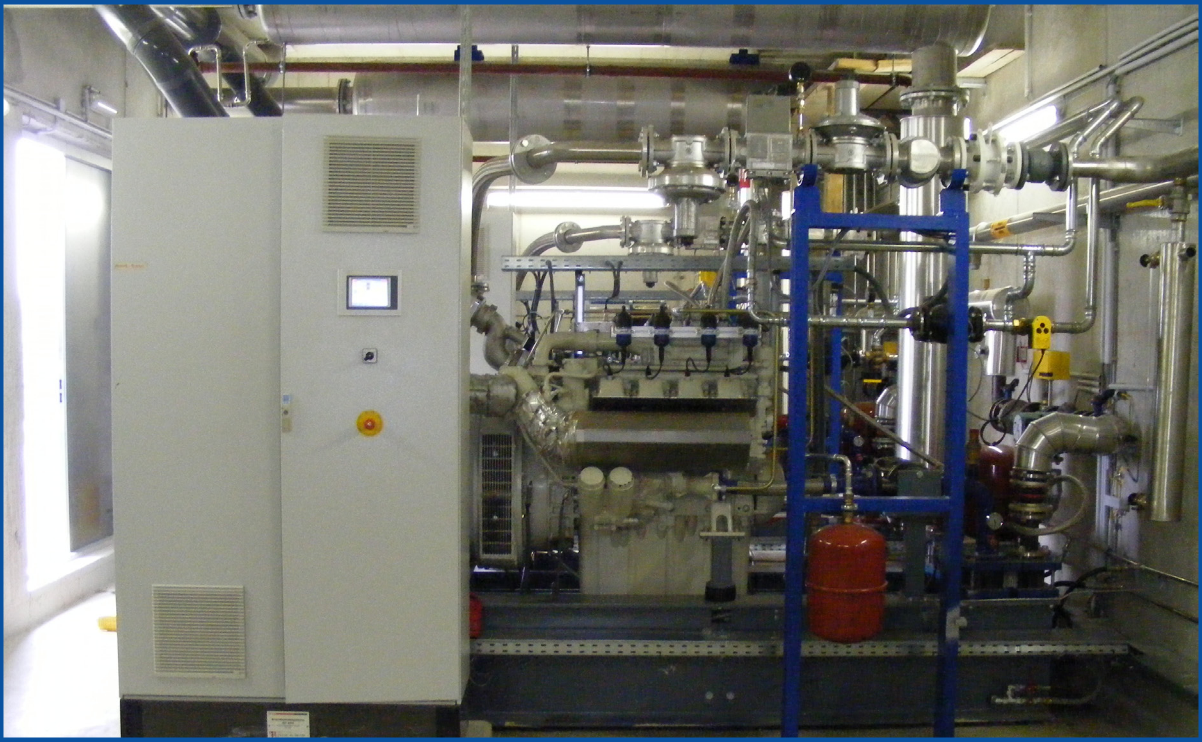


Fig. 4.8.: Gas motor (manufacturer: MAN) and connected generator. In front the switchboard is visible that contains the control device for the engine

Production of one (ore more) forms of energy

The most common usage of biogas is the combustion via generator in a co-generation unit to produce electricity. But there are also other possibilities:

1. The electric power is inserted into the public electric grid

2. The electric power is applied as green electricity

3. Instead of transformation to electricity, it can be

   a) transformed to heat (for example with a gas-burner) or steam (also hot-steam)
   b) refined to natural gas and applied to a public gas grid
   c) refined for usage for gas-driven vehicles

Formation of other products

Usage of the byproducts in a reasonable way:

1. The digestate can be recycled and transformed to organic fertilizer.

Recovery of other forms of energy

The singular processes for the creation of biogas require heat in order to work properly. For that reason, the complete design of the plant is done in a way to get a closed heat-circulation. To avoid loosing heat, the piping system is kept as short as possible. Pipes at exposed places are heat-insulated.

This measure has a major influence on the arrangement of the individual parts of the building on the area where the plant is located.

Heat during the creation of biogas

The tube fermenters and also the 2nd stage fermenters are equipped with heating, which is self regulatory and directly dependent on the ambient temperatures.

The heat energy itself is created by the heat of the co-generation units. Only while booting the plant, the heat energy has to come from outside. Once the chemical reactions are processing and the co-generation units are running, the needed thermal energy is produced by the plant itself.

Heat from the co-generation units

Like every combustion engine, the co-generation units as well are producing heat during operation. All the heat, which is needed inside the plant, is taken from the heat of the co-generation units. With an adequate heat exchanging device, the heating circulations are taken to a temperature up to 95 Degrees Celsius.

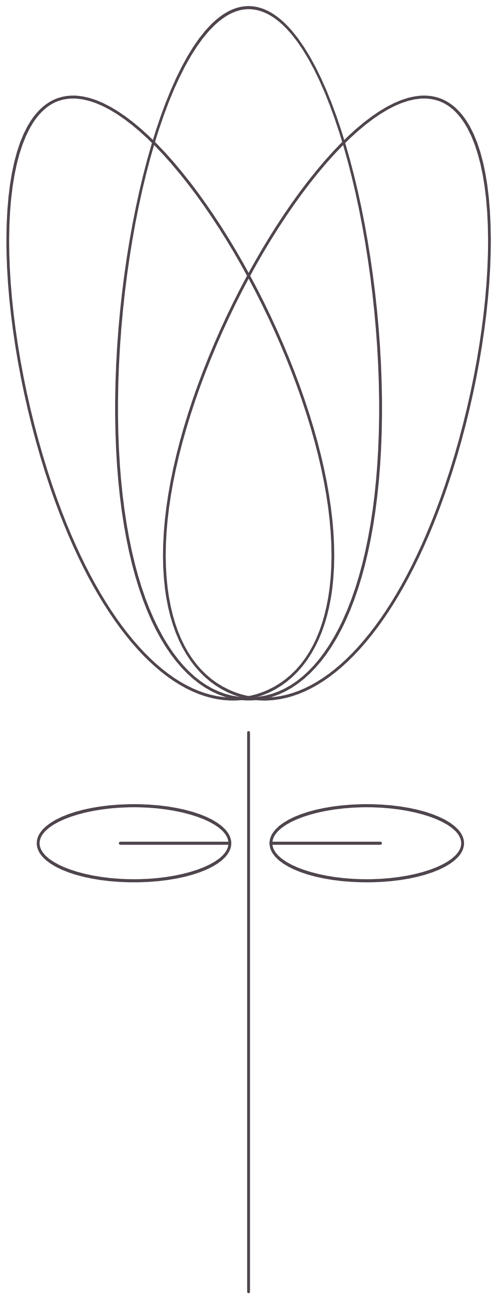
Avoidance of smell nuisance

In general, it is not possible to guarantee the avoidance of smell nuisance at a level of 100%-simply based on logistics: The content of a garbage truck smells.

Based on this circumstance, all unloadings are taking place only in the closed main building. Inside the main building there is always a marginally low pressure. No air leaves the building during normal operations.

Entering the main building with a truck is only possible, if the doors of the waste collectors are closed. These doors cannot be opened before the truck is inside the building, and the entry door has been closed. Leaving of the truck works the same way, but with inverse direction. Parallel to the door-system, during unloading a truck an additional air inlet system is booted.

Also all the intermediate storage tanks and the mash tanks are connected to the air inlet system. Overpressure goes immediately into a multiple staged system of different washers, and lastly into the biofilter. The biofilter itself cleans the air by metabolism of microorganism. To get optimised climatic conditions for the microorganism, the system of different washers is necessary. After leaving the biofilter, the air is free of smell.



3. Pyrolysis

The residual waste arising from fermentation will be pyrolysed into gas and slag.

Basic Conception

- Patented pressure lock delivery system
- Pressure gasification with steam
- Autothermal operation with integrated heat recovery
- High temperatures up to 1.400°C
- Reformation of all organic compounds
- Highest possible efficiency
- Simple design, only few plant components
- Use of robust truck engines in the low-load range
- Full automation and internet monitoring

Description of technology

Thanks to the innovative concept no typical problems connected with other wood gasification, such as forming of tar and pyrolysis and oil formation etc.

This is accomplished since the utilized cooling water is „converted“ to synthesis gas which in an overheated state is directly used for the pyrolysis (watersteam reforming) of the newly entering fuel. Due to the high reactivity of its overheated steam it is quickly and completely gasified.

The newly developed gasifier operates at pressure and therefore has a very compact design. The pressure speeds up chemical reactions.

An essential feature of the system is the use of pure oxygen for the compensation of the losses (partial burning of low amounts of the gases compensate the inevitable losses of the heat exchanger) to a temperature of about 1.400°C.

This results in the splitting of all produced organic compounds during the gasification process, like long-chained tar compounds, aromatics, and so on.

Also these high temperatures degrade all hazardous materials into CO and H2.

The degree of efficiency increases significantly, since no energy is removed from the system by warming up the useless atmospheric nitrogen.

A special system-integrated heat recovery (countercurrent water tube steam boiler system) ensures that no energy is lost and recovered energy introduces a highly efficient gasification. The recovery rate is > 93 %, because the water which is used to cool, completely passes into the synthesis gas.

The pyrolysis gas leaves the high pressure gasifier at an already very cold temperature (about 300 ° C) and is now dusted off in a pressure-resistant filter (eg JET filter) dustand therefore exempt from ash particles etc. Subsequent the gas passes through a cold trap and is cooled below condensation point.
The condensate that forms here, warms up the incoming cooling water in a heat exchanger thanks to the heat of condensation. This condensate is now being readded to the cooling water.

The gas now has about 50°C, the required purity and is suitable for motor usage. Before it is converted to electricity in a co-generation unit, it is expanded via a generator set for an initial production of electricity.

The introduction fuel is done with a simple pressure lock delivery system, which is inexpensive and guarantees a safe pressure lock.

The ash outlet (1% to 2% of the fuel quantity) takes place in liquid state. The ash discharge has an electrical high temperature heating of up to 1.800°C. This guarantees the liquefaction of ashes with a high melting point (depends on the used material) and avoids sintering.

Ashes with high melting point are, for example, from straw, also from eg fossil amendments like peat, and so on, up to the biomaterial. The ash from biomass contains valuable minerals and can be reapplied as fertilizer to agricultural land.

Since the produced pyrolysis gas is without any nitrogen content (so it is a rich gas), it acts like a turbo charger to reach a high degree of filling in the cylinder motor. The low inlet temperature in the engine also ensures high efficiency .
The waste heat from the engine, as usual in a CHP plant, can be used for thermical application.

The oxygen production to maintain the gasification and overheating of the gas stream is done by a PSA. By means of overheating the oxygen is also heated at 1,400 ° C .

The control of the process is ensured by the frequency of the hydraulic fuel injection through the stuffing tube and the amount of oxygen dosage.

Another effective control loop is given by the feed water pump which is pumping the water for cooling respectively heat recovery purposes. This pump is fed by a water osmosis system. The system is controlled and monitored by a standard industrial PC with ethernet profibus technology. This low cost system is designed with redundancy and comes standard with an internet platform. Remote monitoring, data logging and analysis are given accordingly.

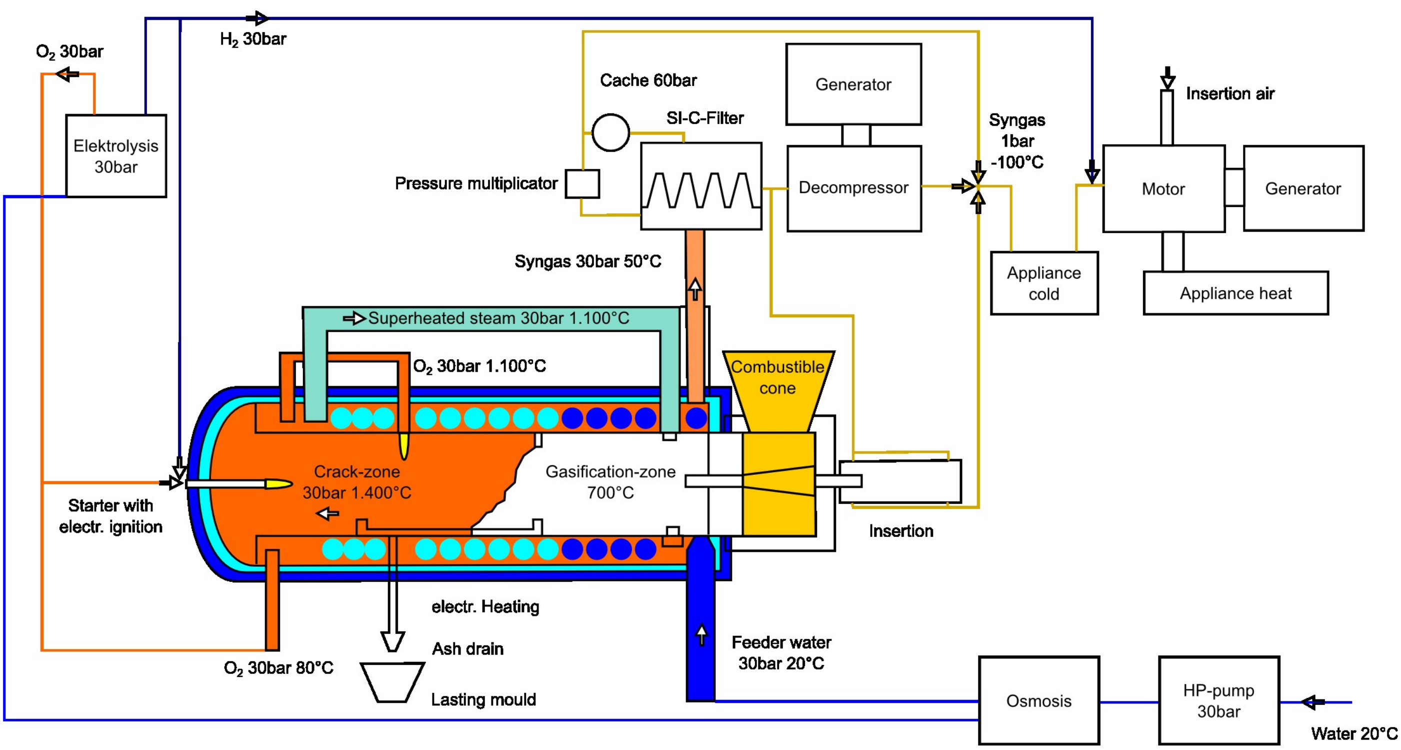


Figure 5.1.: Flow diagram

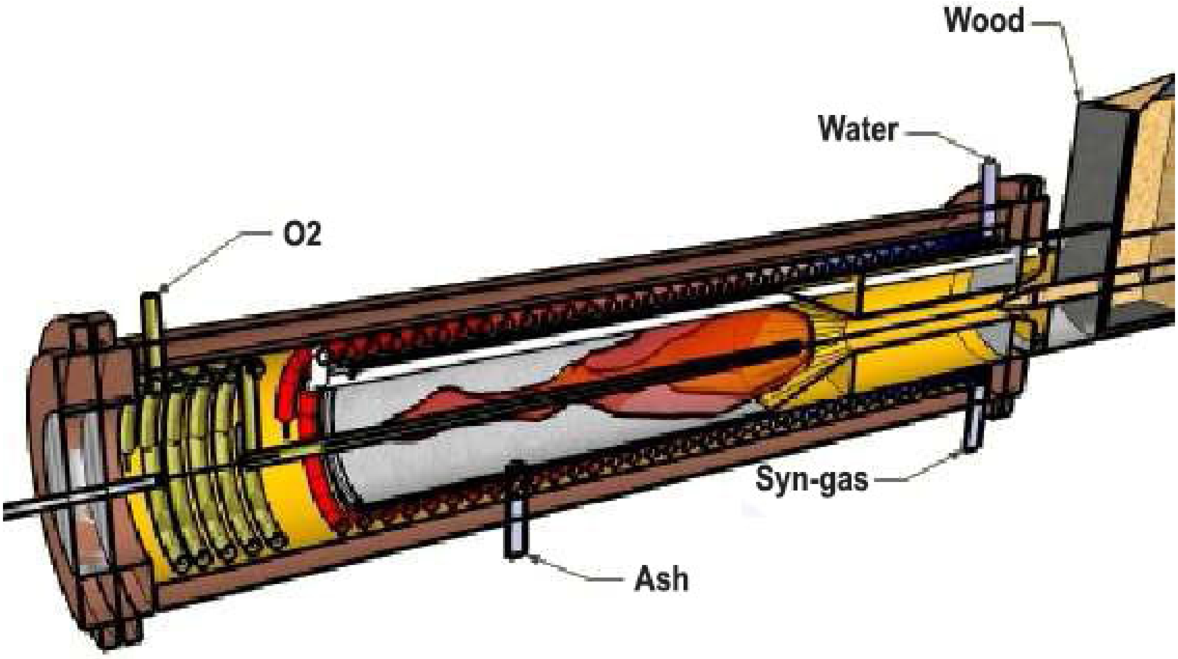


Figure 5.2.: Pyrolysis reactor (scheme drawing)

Description of the chemical process

A pyrolysis process can be understood as a process which transforms biomass or organic waste materials into fuel gas. The biomass is gasified by a pyrolysis reactor. Pure pyrolysis gas is a mixture of carbon monoxide (CO), hydrogen (H2) and some methane (CH4).

For gasification mainly raw materials consisting of carbon compounds are used.

A special form is wood gasification, in which wood is used as raw material. Previously biomass gasification plants were designed for the gasification of wood in forest wood and wood residues, which were supplied as wood chips to the pyrolysis. However, generally organic wastes of all kinds are able to get gasified, with or without biomass admixture in the pyrolyzer.

Often energy from biomass is paid at a higher rate, making pyrolysis of these raw materials generally be more economical.

For biomass gasification different technical gasification processes may be used, which differ primarily by the nature of the contact between biomass and gasification medium (air, oxygen or water vapor), and allothermic (foreign heated) or autothermal (intrinsically heated) pyrolysis.

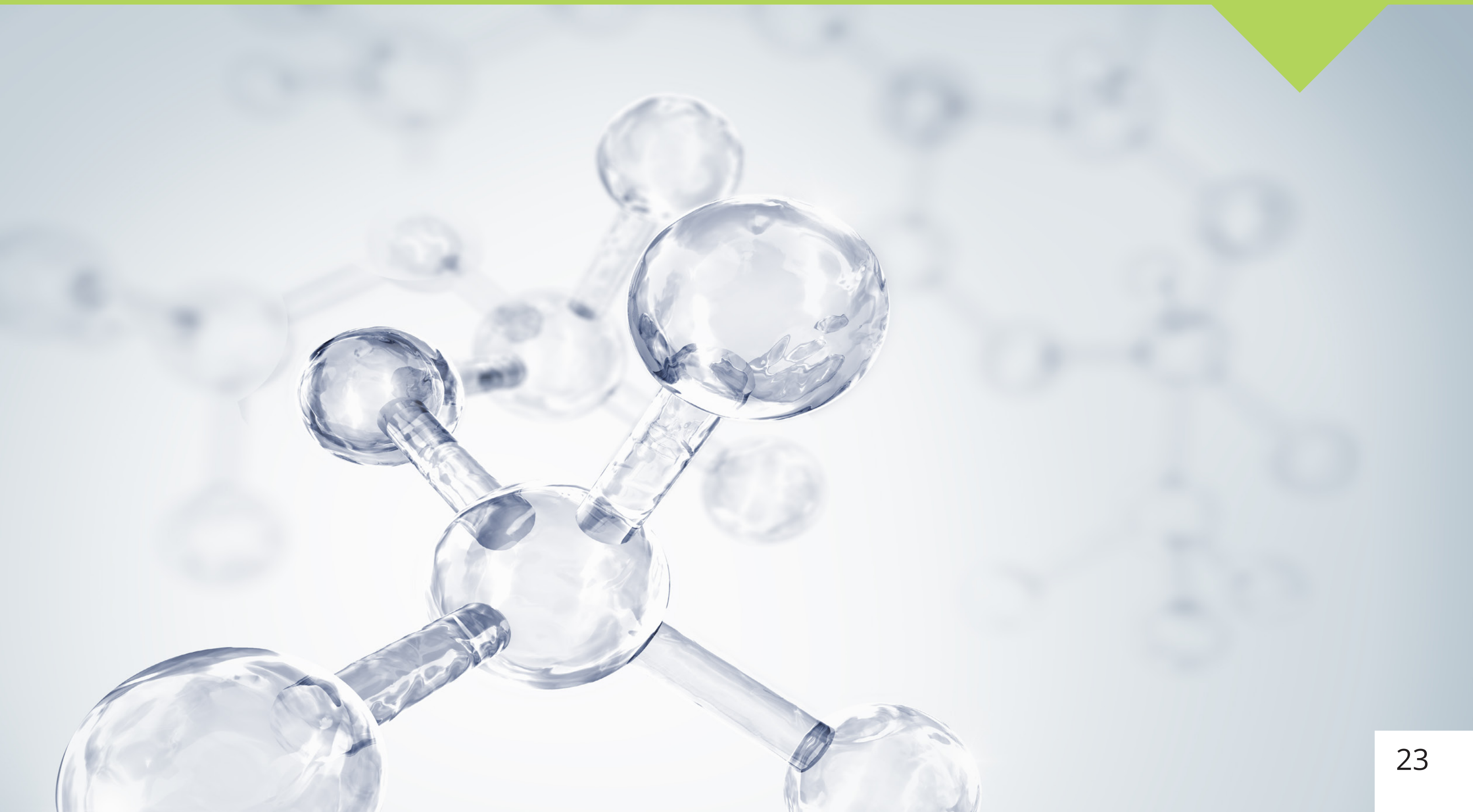
Representational process:

No air is used as a gasifying agent for this method but the heat of the high temperature pyrolysis process only. This is done according to the type and moisture content of the raw material by means of the production of hot steam and indirect heating of the raw material in countercurrent with the hot pyrolysis gas.

Thanks to the high temperatures, up to 1.400°C, all of the organic material is gasified, since organic compounds are not stable at this temperature. As a result, heat exchangers can be used, which with appropriate design, recover up to 93% of the heat energy. For unavoidable losses a small proportion of the raw materials must be burned. This can be done in several ways:

- Using pure oxygen, which is extracted from the air with membranes or alternating pressure adsorption - energy consumption about 25kWh / 1.000kg dry mass (energy content of ~5 kWh / kg)
- Using electric heater about 50 kWh / 1.000 kg dry mass
- By microwave - energy consumption about 80kWh / 1.000kg dry mass

This type of pyrolysis increases the energy content of the combustion gases considerably, because no CO_2 is formed. The yield of electrical energy increases by approximately twice, at the expense of waste heat.



Since not too many requirements are linked to the fuel, great resources in previously usable raw materials are also available (green cuttings, leaves, underbrush, peat). Many waste materials can be recycled, such as grass clippings, pressboard, contaminated waste wood, biogenic or mineral oils, plastics, sewage sludge, etc., as are all organic compounds in the pyrolysis gas converted by splitting and then burned by the engine.

The exhaust gas values (based on 5% residual oxygen in the exhaust) obtained are therefore excellent:

CO	< 650mg / Nm³
NO_x	< 400mg / Nm³
NMHC	< 150mg / Nm³
Formaldehyde	< 150mg / Nm³
SO_x as SO_2	< 310mg / Nm³

The waste heat from the engines is well suited for integration into heating and district heating networks.

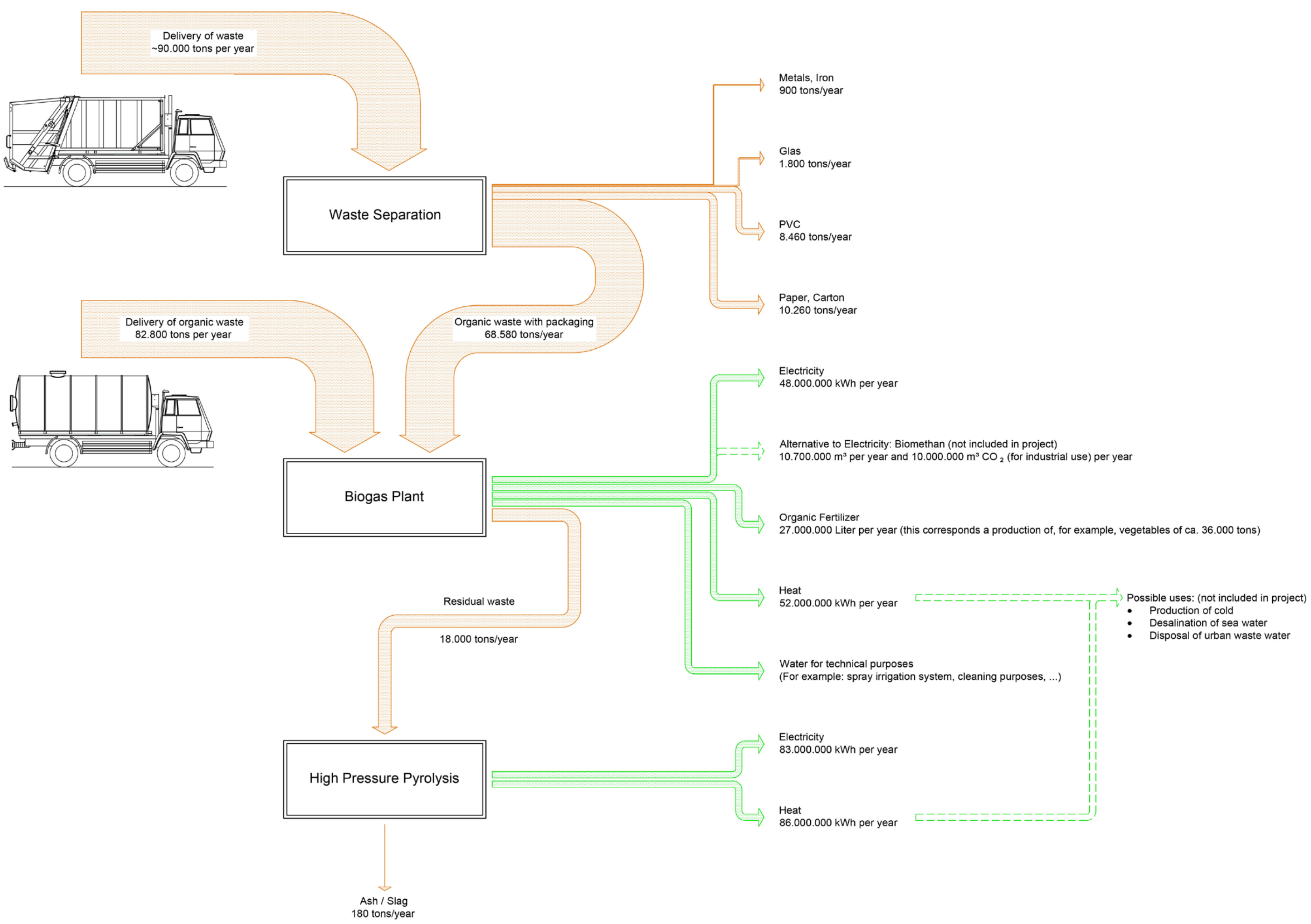


Figure 2.1 shows a graphical scheme reflecting the entire process.

SOME GENERAL FACTS

1. Plant Area
The design of a plant is carried out in such dimensions that even with a multi-day standstill (maintenance is required from time to time and technical deficiencies can not be avoided 100%) waste acceptance remains fully operative and waste can be delivered without any interruption (very important for waste-collectors for example who can precisely plan their logistics). From an economical point of view minimum capacity for any plant is 15000 MT per annum.

2. Avoidance of Smell Nuisance
It is generally a part of the system that waste is never stored outdoors to avoid odor nuisance. The entire system is under negative pressure to avoid that smell (waste smells, and not just a little) escapes to the outside. In general, the exhaust treatment is an important part of the technical infrastructure, and the air escaping from the biofilters at the very end, smells like a fresh forest floor after a downpour.

3. Energy Consumption
Once the entire system has booted (cold start), it supplies itself with all appropriate energy. Only the initial boot requires energy from outside. Our own plant in Zwentendorf/Austria has been running since its commissioning in Dec. 2007 to date without a single „shutdown“.

4. Water Consumption
Since the biogas plant water is extracted from the organic content in the Biogas Plant, it can be used again in the plant, for example, to dilute, for cleaning purposes, etc. The actual potable and fresh water consumption is limited to the use by employees (shower, toilets, ...)

5. Toxic Substances
Toxic substances (batteries, chemical waste, asbestos, ...) according to legal regulations have to be treated particularly. An insertion into the plant is undesirable but not always avoidable. Hence they are rejected during the sorting process and passed on to the appropriate locations for proper disposal. Waste collectors should be advised that this waste category should by all means be avoided to be delivered to the plant.

6. Treatment of Radioactive Substances
(eg waste from hospitals), drugs, etc. theoretically should be possible with the pyrolysis . However due to the sensitive handling procedure based on their classification as hazard class I and the strict law noone has dared to treat these substances so far to our knowledge. Waste collectors should be advised that this waste category should by all means be avoided to be delivered to the plant.

USP

We are no planners, just sitting at the desk. We developed, built and even operate our own plant- not with selected waste, but the waste that actually occurs in wholesale, food industry, slaughterhouses, etc. And thanks to this fact, we can continuously develop the machines and test them in practice and long term. Therefore, we have 2 decades of experience including the realization that accidents usually occur at night or on weekends and public holidays.

With us there are no leaks or excuses, but only solutions and professionalism!

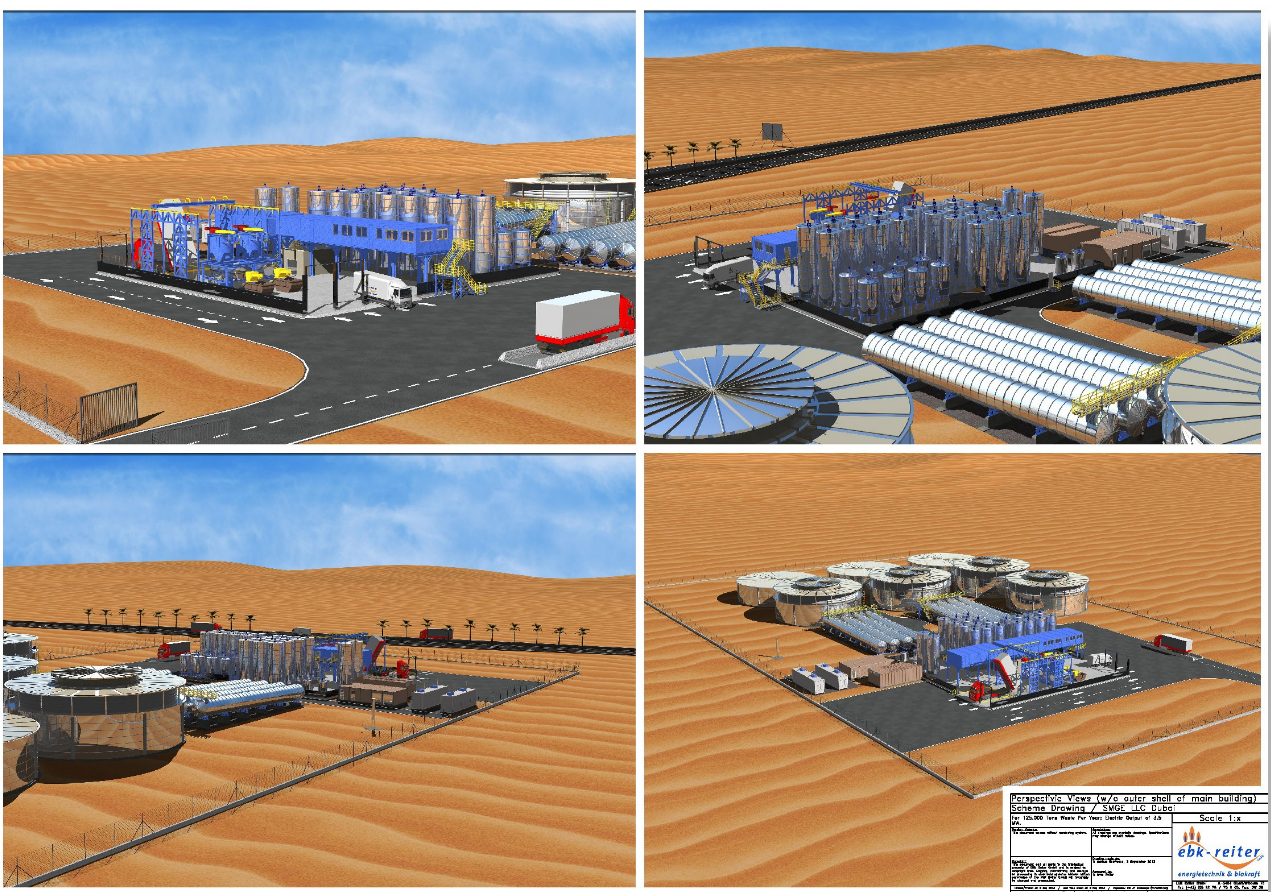
Our Plant in Zwentendorf, Austria, Front View/Offices

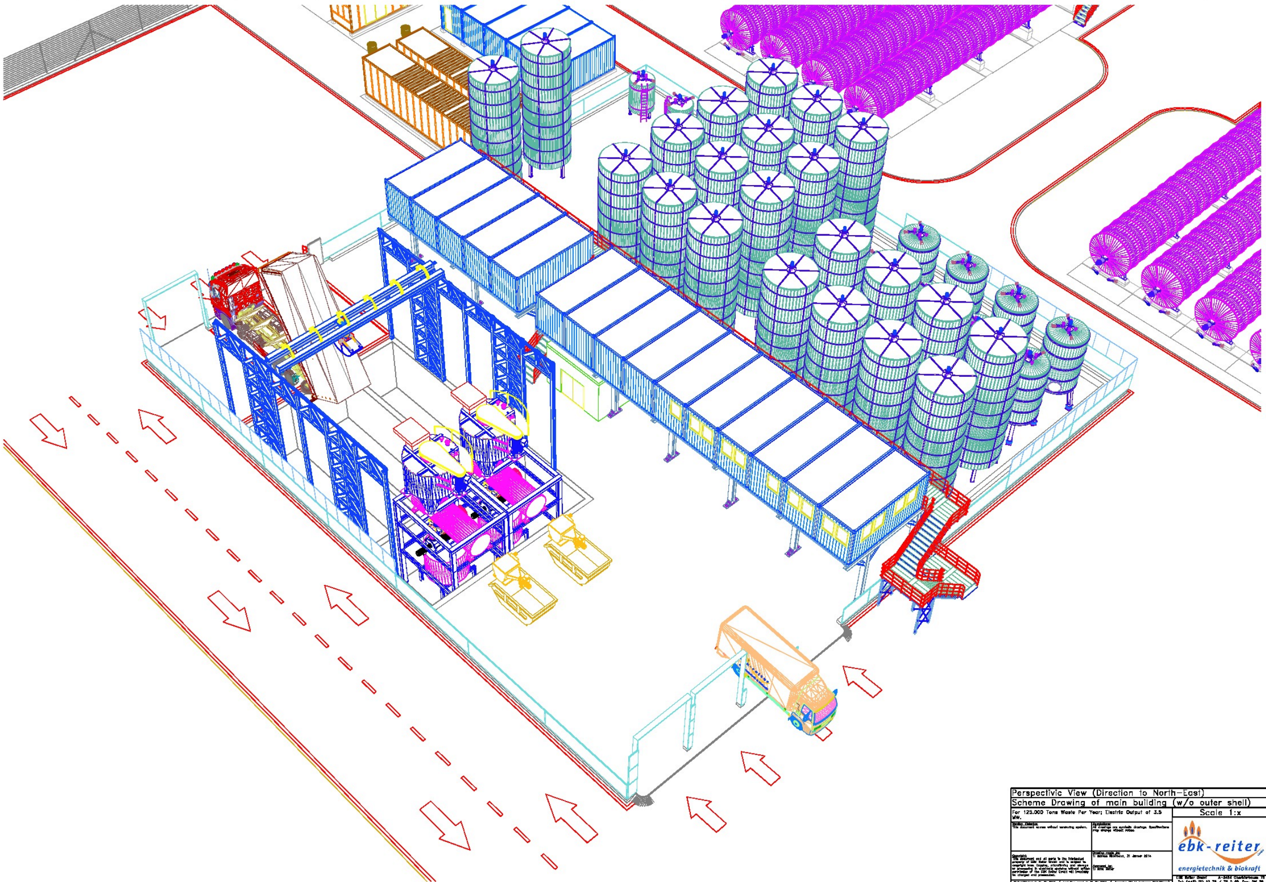
REFERENCES

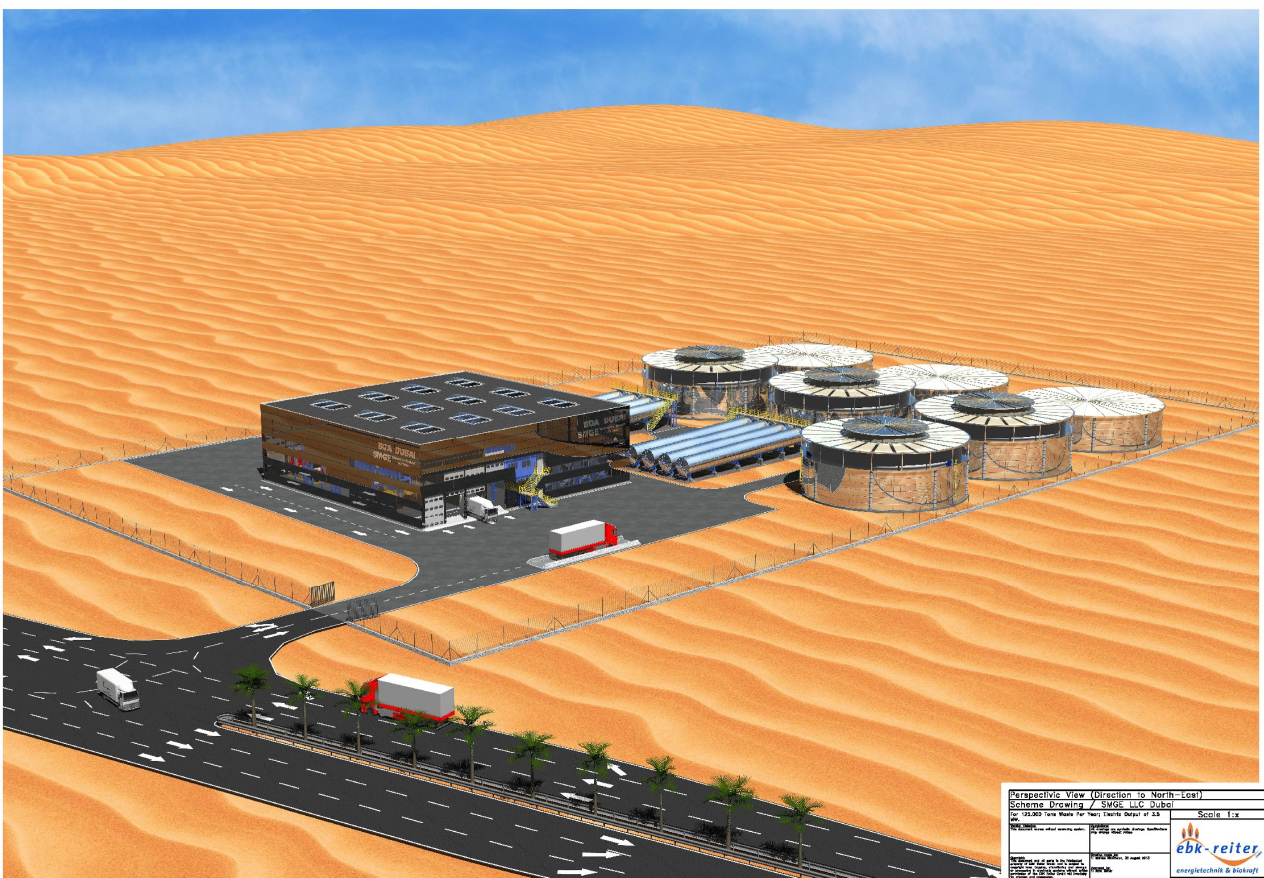
Argentinia / Buenos Aires
Australia / Sydney (NSW)
Czech Republic / BGA Pilsen
Czech Republic / BGA Horni Sucha
Czech Republic / BGA Moravsky Zizkov Sucha
Mexico / Pupla
Poland / Schweiger
Slovakia / BGA Blatne
Slovakia / BGA Petrovany
Slovakia / BGA Rastislavice

Projects pending or under process:
India
UAE

You can watch our video „About the Biogas Plant“ here
https://www.youtube.com/watch?v=3B7t3060liw




Perspectivic View (Direction to North-East)
Scheme Drawing of main building (w/o outer shell)
For 125.000 Tons Waste Per Year; Electric Output of 3.5 MW.
Scale 1:x
ebk-reiter
energietechnik & biokraft


Perspectivic View (Direction to North-East)
Scheme Drawing / SMGE LLC Dubai
For 125.000 Tons Waste Per Year; Electric Output of 3.5 MW.
Scale 1:x
ebk-reiter
energietechnik & biokraft


Perspectivic View From South-West Direction
Scheme Drawing / Biogas Plant
For 125.000 Tons Waste Per Year; Electric Output of 3.5 MW.
Scale 1:x
ebk-reiter
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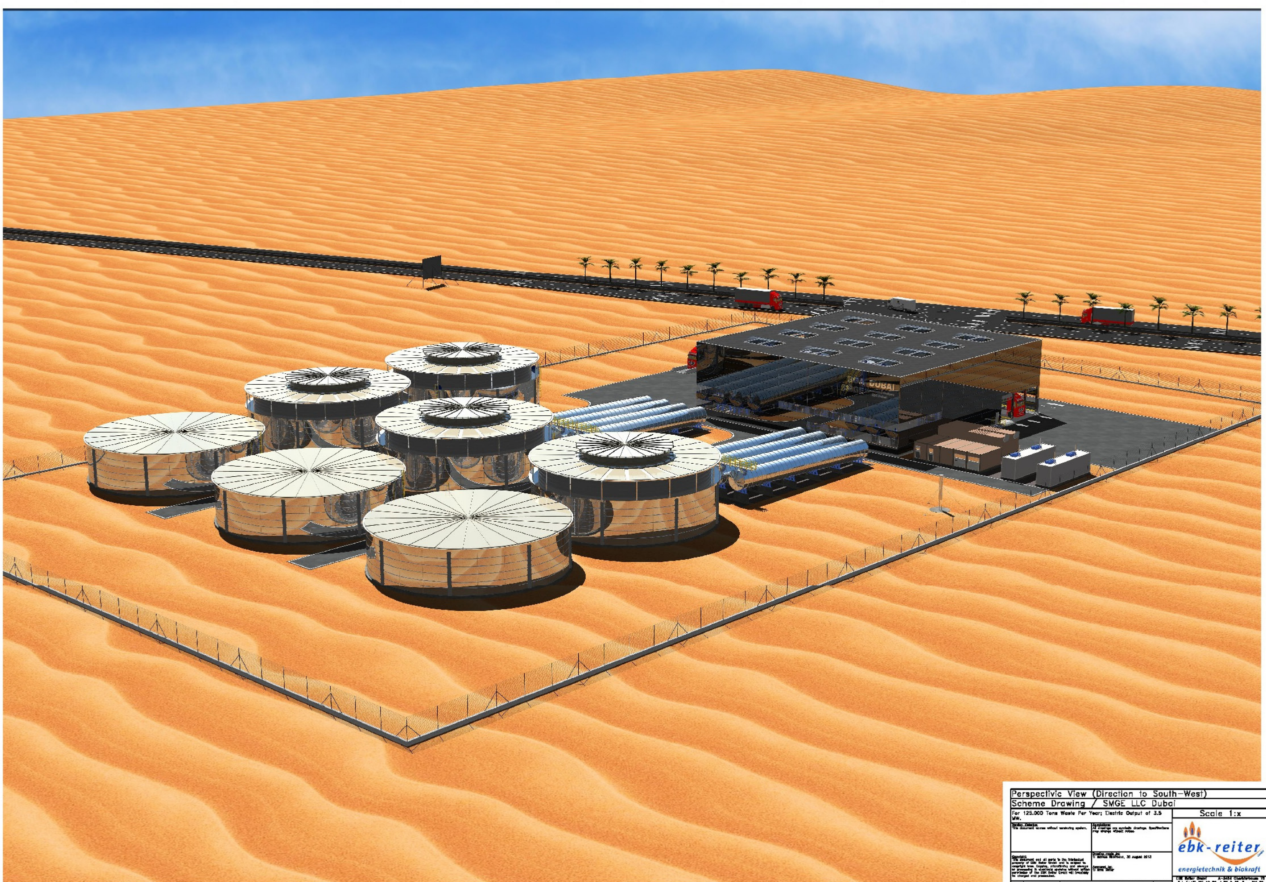
Perspectivic View (Direction to South-West)
Scheme Drawing / SMGE LLC Dubai
For 125.000 Tons Waste Per Year; Electric Output of 3.5 MW.
Scale 1:x
ebk-reiter
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