**BIOGAS PRODUCTION – A COMPLEX PROCESS**

The term **BIOGAS** is used for every type of fermentation/fouling gases which might emerge in nature where organic compounds gather and are cut off from oxygen supply, making an aerobe decomposition process no longer possible, - like at the bottom of lakes, swamps or even in the digestive system of ruminant animals. Synonyms for **BIOGAS** are such words as sewage gas, marsh gas, methane. Different micro organisms are metabolizing carbon from organic matter in oxygen-free environment (anaerobically). This process is known as decomposition or anoxic fermentation and follows the food chain.

**BIOGAS** is the end product of an aerobic decomposition process. This process can be divided into four distinct phases. During each process step, various micro organisms and a range of enzymes work symbiotically.

**BIOGAS** itself is a gas mixture which mainly consists of Methane CH4, Carbon Dioxide CO2, and minor parts of Hydrogen Sulphide H2S, plus some other volatile Gases.

Raw materials, like the following, can be used for biogas production:
cattle manure, pig manure, chicken dung, slaughterhouse waste (blood, fat, entrails, and rumen content), plants waste, silage, rotten grain, waste water, fats, bio-waste, food industry waste, malt remnants, marc, distillery slop, bio ethanol plant slop, brewer’s grain (crushed malt remnants after filtration), sugar beet and fruit pulp, sugar beet tops, technical glycerine (after bio diesel production), fibre and other starch and treacle production, milk whey, flotation sludge, dewatered flotation sludge from municipal waste water treatment plants, algae.

Most of the raw materials can be mixed with each other.
BIOGAS COMPONENTS

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflammable Methane CH₄</td>
<td>50-70%</td>
</tr>
<tr>
<td>Non-flammable Carbon Dioxide CO₂</td>
<td>30-45%</td>
</tr>
<tr>
<td>Hydrogen Sulphide H₂S</td>
<td>0 - 1%</td>
</tr>
<tr>
<td>Hydrogen H₂</td>
<td>0 - 1%</td>
</tr>
<tr>
<td>Oxygen O₂</td>
<td>0 - 1%</td>
</tr>
<tr>
<td>Nitrogen N₂</td>
<td>0 – 1%</td>
</tr>
</tbody>
</table>

CHARACTERISTICS-BIOGAS

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Density</td>
<td>1.2 kg/m²</td>
</tr>
<tr>
<td>Heating value</td>
<td>4-7.5 kWh/m³</td>
</tr>
<tr>
<td>Ignition temperature</td>
<td>700 degrees C</td>
</tr>
<tr>
<td>Ignition concentration/gas</td>
<td>6-12%</td>
</tr>
<tr>
<td>Scent/smell</td>
<td>rotten eggs/hydrogen sulphide</td>
</tr>
</tbody>
</table>

The higher the share of methane in BIOGAS the more energy-rich the gas will be. Not exploitable is carbon dioxide and water vapour. Problematic in BIOGAS is first of all hydrogen sulphide and ammonia which both have to be removed before the combustion process in order to protect the gas engines against these aggressive compounds.

Good basic material for the technical production of BIOGAS is dung/liquid manure. The average dung production of livestock/cattle is approximately 1.5 m³ per month (depending on type of livestock, age of animal, feeding etc.).

From the amount of liquid manure per day of on cattle we can win approx. 1.5 m³ BIOGAS – the gas volume of 1 m³ equals approx. 0.65 litres if diesel or 0.66 m³ of natural gas. With the calorific value of BIOGAS (average heat rating!) of 6.5 kWh/m³ we are able to produce 2 kWh electrical energy.

With addition of other organic compounds (co-substrates!) the exploitation of BIOGAS can be improved. Co-Substrates are:

- Renewable raw materials (corn, maize, grass, remnants from breweries, vineyards etc.)
- Agriculture waste material
- Waste from food production
Profitability of biogas plants

The profitability of biogas plants is determined by a number of factors: The substrate costs a considerable cost factor, with a share of more than 50% of the variable expenses. Another crucial factor for the profitability of the plant is the utilisation rate of the plant.

Most BIOGAS plants work after a continuous flow process. The fermenter is daily fed with raw materials (silage!), while the same amount is being withdrawn from the fermenting vessel.
Biogas production - a complex process

**BIOGAS** is the end product of an aerobic decomposition process. This process can be divided into four distinct phases. During each process step, various microorganisms and a range of enzymes work symbiotically.

### Biogas is produced in four phases

In a first step, known as the hydrolysis process, carbon hydrates are broken down into simple sugars, proteins into amino acids and fats into fatty acids. The products of the hydrolysis undergo an acidogenic process where organic acids and low alcohols are produced. The subsequent acetogenic process leads to the production of methane. The products of the acidogenic process are converted into acetic acid, carbon dioxide and hydrogen, which are the compounds required for the methanogenic process. If the process is well balanced, these phases are synchronised.

### Optimised nutrient supply ensures smooth processing

In order to ensure that the above processes are completed properly, stable process conditions must be established. The supply of nutrients and essential trace elements to the microorganisms involved in the processes is thereby a key factor.

Trace elements are vital for the production of cellular material, and in particular for the production of enzymes and coenzymes, which in turn act as versatile catalysts for individual reactions in the processes described above. The production of methane from CO$_2$ and H$_2$ for example involves seven different enzymes and three co-enzymes.
Just the right amount

The nutrient balance is of great importance

The fermentation process is governed by the Liebig's "Law of the Minimum". It states that, if there is a deficiency of only one nutrient, it is not possible to achieve potential yield, as this nutrient is the limiting factor. On the other hand, it has been shown that excess availability of minerals can have a toxic effect on micro organisms.

As for some elements, the optimum supply and toxic quantities are however very close to each other, accurate analysis and precision dosing of the trace elements is required to achieve optimised methane production. From the point of view of soil protection, excess concentrations of micro and macro-nutrients should be avoided in order to prevent damage to the environment.

Preservative for pour able and moist organic substrates

CR.ACID are acid mixtures for preserving pour able and moist organic substrates for biogas production. They prevent the development of moulds and bacteria during storage and protect against process inhibiting yeast accumulation. CR.ACID mixtures have a pronounced antimicrobial action. They actively disrupt the carbohydrate metabolism of the micro organisms and specifically inhibit the ability of the microbes to multiply during the storage phase. By lowering the pH of the substrate, CR.ACID creates unfavourable conditions for existing harmful micro organisms to survive.

Schaumann BioEnergy GmbH

1. Silage analysis

State of the art analytical laboratories determine all relevant Parameters for an accurate assessment of silage quality.

- Dry matter content
- pH
- Crude nutrient analysis
- Energy content
- Fermentation acid spectrum
- NH3-N
- Trace and macro element analysis
- Assessment of storage stability
- Assessment of fermentation profiles

2. Fermenter analysis

Sophisticated laboratory facilities analyse micronutrients using leading-edge procedures (iCAP spectrometry) even at the lowest concentrations.

- Dry matter content, organic dry matter content (oDM)
- pH
- Organic acids
- Ammonia nitrogen
- TOA/TAC ratio (total organic acids/total anorganic carbon) acid/alkalinity ratio, best under 4.0
- Macro- and trace elements
- Calculation of the fermenter-specific requirement for essential micronutrients
- Production of tailor-made BC.PRO micronutrient mixtures
What Type of Gases can be measured?

- Methan CH4 (0-100 vol.%)
- Carbon Dioxide CO2 (0-100 vol.%)
- Hydrogen sulphide H2S (0-10, 0-30, 0-200, 0-500, 0-1500, 0-3000 or 0-5000 ppm)
- Oxygen O2 (0-25 vol.%)
- Hydrogen H2 (0-2000 or 0-5000 ppm, 0-20000, 0-50000 ppm)
- More gases and other concentrations on request
- Integration and supply of further sensors possible (e. g. pressure, temperature, flow, humidity, fill level, etc.)

**AWITE Bioenergie GmbH**

**GMC Biogas 08**
Biogasanlysator from Bieler + Lang GmbH

Thermal mass flow-meter in the biogas pipe upstream the block heat and power plant with gas engine. In order to control the fermentation process and allow for balancing, the gas quantity in larger plants is measured at different points: directly downstream the production site and upstream the induct side into the gas engine.

**LINK:**

http://www.abb.com/industries/ap/seitp410/c97a9398ad88a89ac125757b0063bd36.aspx

Practical study:

If the fermentation biology is out of balance - what to do when things go wrong.

Despite all precautions, fermentation processes can go wrong. Serious problems are often due to a number of causes that are interlinked.

Never just wait and hope that the fermenter will regain its balance again. You must identify the cause of the problem and develop a plan to rectify the situation and to prevent it in the future. In order to detect disruptions in the process at the earliest possible stage, we recommend that operators carry out regular fermenter analyses. This applies in particular to plants with high throughput rates or where a number of different substrates are processed. A deficiency of essential nutrients is not the only cause for impaired fermentation. There are other "typical" operating errors such as sudden changes in the fermenter temperature, excess nutrient supply upon substrate change or the fast feed of substrates with high fat or protein content.

Regular analysis for the early detection of problems

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Risks associated with renewable raw material silage

If untreated silage becomes hot, it is being digested by yeast. Silage containing high concentrations of acetic acid prevents yeast from growing.

Critical phase: contact with ambient air when silo is opened

Considerable loss often occurs after the silo is opened, as the silage then is exposed to the oxygen of the ambient air. This causes microorganisms such as mould, which are to be found in every substrate silo, to grow intensively and thus preventing a proper fermentation. A generation of heat in the silage material is a clear indicator for spoilage and associated loss of energy. Energy that has been lost during storage or preparation in the form of heat is of course not available in the subsequent fermentation process for the production of biogas.

One of the vital facts is the right mixture of and storage of the silage. Wrong storage leads to an enrichment of wrong type of micro-organism - to much oxygen during the storage could be such a reason. There are wanted and unwanted types of bacteria, yeast and mildew that will influence the productivity of the fermentation process which again will lead to poor effectiveness in gas production. Actually the only micro organism wanted are the lactic acid bacteria.

Here again you have to divide between homofermentative lab and heterofermentative lab (lab - lactic acid bacteria). The heterofermentative lab are the unwanted ones, as they also produce acetic acid and carbon dioxide. Extremely important it is to immobilize the enterobacteria. They will reproduce rapidly and are the reason for the production of acetic acid and carbon dioxide. If this is the case in the stored silage you will know it by a sour smell. A process of butyric fermentation will start which reduces the ability of the silage to start a productive fermentation process.

The absence of clostridia – a butyric acid bacteria is a quality sign for good and productive silage. But if they are present in great numbers and active, they will even turn proteins, sugar and lactic acid into butyric acid. Again this reduces the production of biogas and cause a methane insufficiency.

The silage should not produce yeasts! This can be followed if the silage is starting to get warm and this is influenced by inadequate storage - to much oxygen gets into the stored silage. The silage has to be covered and the cover material should sit tight so that neither wind, nor air will get under the cover.

The last unwanted species are the mildews. They also destroy proteins, sugar and lactic acids and they will also form mycotoxin - like aspergillus’ s - which are very dangerous for humans too. Their spores are easily transported by air and can create respiratory disturbances - up to illness and infections. Silage that is infested by mildews should not be used and be burned instead.

Fast drop of pH keeps ensiling loss to a minimum

During the ensiling process, freely available carbohydrates are digested by lactic acid bacteria in an anaerobic climate. This process results in various short-chain organic acids and invariably leads to a loss of substrate. To keep this loss to a minimum, it is necessary to lower the pH as quickly as possible. This ensures that enzymatic reactions and further energy loss caused by micro organisms that impair fermentation are effectively prevented.
BIOGAS FROM SLAUGHTERHOUSEWASTE

A CASE STUDY

- Waste from slaughterhouse and other animal wastes are often mishandled and underutilized
- Leading to many serious environmental and economic problems:
- Efficient, economical and sustainable solution is needed, preferably one which converts waste into valuable products and
- Biogas production is one:
  - Significantly reduce impact on greenhouse gas emissions
  - Preventing the accumulation of organic and animal waste
  - Used for heat, electricity and liquid fuel production

A combined slaughterhouse/biogas-plant is located at St.Martin/Innkreis in the North-West of Austria. This biogas plant is processing all animal by-products which may not be further utilized such as blood, hind gut, stomach content and fat scrubber content.

CASE STUDY Link:  http://www.iea-biogas.net/_download/st_martin.pdf

Animal By-products

The inefficient treatment of slaughterhouse waste or improper use of products produced from it led to the pandemic occurrence of animal diseases throughout Europe.
The EU has therefore introduced rigorous regulations on the collection, transport, methods and procedures of treatment, and further disposal of animal by-products, as well as the use of or trade in the products (Regulation (EC) No. 1774/2002).
The Swiss Government also released a comparable regulation.
The waste material is classified in three categories: Category 1 products bear increased risk for human and animal health (BSE, foot and mouth disease, etc.) and have to be incinerated. The Categories 2 (perished animals or animals slaughtered, but not intended for human consumption, milk and colostrums, manure as well as digestive tract content) and 3 materials (meat-containing wastes from the foodstuff industry, slaughterhouse waste of animals fit for human consumption, catering waste) are strongly recommended for biogas production after sanitising. The special requirements of slaughterhouse waste mean it is particularly well suited for large co-digestion plants.

Slaughterhouse waste: converting fatty waste into soap to improve biogas yield

The INRA* Laboratory for Environmental Biotechnology with the participation of the Energy-Environment Group of the FNEAP** and the SNIV***, has been carrying out experimental research aimed at managing fatty waste from cattle through the production of biogas. The research consists in applying thermo-chemical pre-treatment in order to process this waste and thus transform animal fats into soap which will improve the biogas yield during anaerobic digestion.

Link: http://www.international.inra.fr/partnerships/with_the_private_sector/live_from_the_labs/slaughterhouse_waste_convertin g_fatty_waste_into_soap_to_improve_biogas_yield
Demetrion’s specialty is the use of T i H® - Thermal induced Hydrolysis

Through this procedure, the heat of exhaust/waste gases is used to heat the fermentation substrates up to temperatures of 200°C by applying high pressure (> 20 bar) and then holding this temperature for about 20 minutes.

This results in the maceration/decomposition (“cracking”) of particularly solid material that is usually biodegradable with difficulty and leads to the controlled expansion of its structure (surface). Through this process, the micro organisms in the digester have easy access to such nutrients which would otherwise be difficult to decompose or even inaccessible. While biologically enzymatic hydrolysis for an individual fermentation substrate particle can take several days, the process itself takes less than one hour thanks to thermally induced hydrolysis. The products of hydrolysis are easily biodegradable intermediates and are directly (and therefore more quickly) converted in the biogas digester. Due to the effect of heat, such nutrients are also made accessible to micro organisms/bacteria which are normally resistant to enzymatic attacks. Improved and enhanced nutrient disintegration and increased decomposition speed lead to an up to 50% higher biogas yield (compared to “conventional” procedures that are currently employed elsewhere). The heat needed for substrate heating is entirely covered by thermal energy from exhaust/waste gases and through heat recovery.

Link: http://www.demetrion.com/?l=en
Biosolids as for example sewage sludge or biomass from renewable primary products, bring a definitely higher output if processed with ultrasonic tech. The effect is an intensification of the digestion process without the need to add chemical agents.

The sonication of biosolids is a process whose basics were analyzed at the University of Hamburg-Harburg (TU). The function of this technology can be explained as follows: Sonication treatment destroys parts of the cells of the biomass liquefying them. This liquefied material is definitely better decomposable by micro-organisms for example in the digesters of a biogas plant. This means that the digesting process runs off much better, increasing the biogas output by up to 50% and a corresponding reduction of residual substrate as waste. Further positive effects are: an important reduction of digesting-tower volume and an increased dehydration rate of the biomass.

One big advantage of ultrasounds in this field is also the possibility to increase production of environmental-friendly energy and to reduce the volume of waste materials (applies for waste water treatment plants) which must be disposed. The ultrasonic treatment turns out to be an economically and ecologically extremely reasonable process for urban and industrial waste water treatment plant operators as also for biogas plant operators.

The ultrasonic effect is very helpful for the treatment of biosolids because it generates a periodic compression and depression of the sonicated substance. If the ultrasonic intensity is high, the medium in the substance will be torn apart during the depression phase. This generates microscopic bubbles inside the liquid, which are filled with vapour or gas.

In the following compression phase these bubbles implode under extreme conditions in micro scale (cavitation). This generates pressures of over 500 bar and enormous shear forces at temperatures of up to 5,200 Kelvin. These processes tear up the walls of organic cells, bacteria, fungi etc.
Ultrasonic and cavitation principles

In the lower frequency range (20 kHz to 100 kHz) big cavitation bubbles are generated which excite extremely high shear forces and strong effects. In the middle frequency range (100 kHz to 1 MHz) the bubbles are smaller but the cavitation is more effective, generating radical sono-chemical reactions in the water. Sonicating such a liquid with a frequency of over 1 MHz, the liquid begins to flow on molecular level. The system works with the frequency of 20 kHz which gives the best reactions and effects in the biomass.

Change of the biomass structure through sonication

A. Sludge floc  1. not sonicated (0 s)
B. Bacteria  2. sonication of 30 s
C. Extracellular polymers  3. sonication of 90 s
D. Inert particles
E. Energy
F. Sludge liquor
The High Output Ultrasonic Reactor

Biosolids in urban and industrial waste water treatment plants as also in biogas plants can be effectively processed with systems of one or more ultrasonic reactors.

Function diagram of the High-Output Ultrasonic Reactor

1. Feed pipe
   The bio mass is brought from the clarification plant to the system by a pump (waste water treatment plant).
   The bio mass is brought from the digesting tower to the system by a pump in bypass (biogas plant).

2. Ultrasonic transmitter
   Generation of a cavitation field inside the biomass by several ultrasonic transmitters with 20 kHz.

3. Cavitation field
   Cracking of organic cells, bacteria and fungi inside the biomass through high shear forces.
   Release of cell ingredients.

4. Flow
   Cascade flow of the biomass through the ultrasonic reactor with the effect that every single flake is sonicated and led through the cavitation field.
   Upward gas and air exhaust.

5. Downpipe
   Discharging of the sonicated biomass into the digesting tower (waste water treatment plant).
   Backflow of the sonicated biomass in the fermenter (biogas plant).

6. Drain pipe
   To drain the reactor with water.
PLANT COMPONENTS

For a good blending and transportation within the plant system a variety of pumps, valves and mixing equipment has to be installed.

Link: http://www.eisele.de/english/start/start.htm
The Vielfrass infeed unit for solids is ideally suited for feeding solid dung, grass or maize silage and similar biomasses into a digester. Despite these high demands, the Vielfrass consumes very little power of its own. The screw conveyor and planetary gearing are particularly massive and robust. All parts subject to corrosion are made in V2A stainless steel. Intervall control ensures uniform, automated feed.

We designed the Paddelgigant especially for substrates with a high proportion of fibrous renewable resources. Four inclined paddles create a variety of flow directions. By this means the sustainable input materials and the manure in the digester are slowly mixed in a manner conducive to bacteria activity.
Fill level monitoring "at a glance" makes operating the plant easier. A focus test conducted by the German Agricultural Society (Deutsche Landwirtsgesellschaft, DLG) recently confirmed the excellent characteristics of Biolene. The principle of our biogas storage membrane is simple. Where maintenance is taking place or gas production fluctuates, the volume of stored gas constantly changes. In small gas storage vessels such fluctuations mean that biogas must be released and/or burnt unnecessarily; alternatively, CHPS utilisation is inefficient. With Biolene, all this is a different story. This flexible gas storage membrane from agriKomp is made from high-quality EPDM rubber. Placed over the fermentation residue vessel, this highly elastic cover captures and stores biogas as it forms.

High performance separator for manure and fermentation residue.

Simply separate using the Quetschprofi rather than going on with costly mixing! The optimum press-out pressure of the separator for manure and fermented residue depends on the composition of the feedstock. Its infinitely adjustable pneumatic cylinder responds flexibly to varying levels of dry material and delivers reliably consistent separation.
Successful substrate digestion system increases biogas yield by 5%.

Thanks to their robust technology, biogas systems made by agriKomp are operated using high contents of cheap feedstock like solid dung, grass and silage. The naturally high fibre contents in these substrates place great demands on both the technology and the biology. The raw fibre in the substrate is extremely difficult to "digest" for the methane bacteria in the digester. In the so-called "boiler" from agriKomp, the unprocessed contents of raw fibre are broken down in a thermal process so that they can be processed more easily by the bacteria.

Concrete structure with insulation.
OCTAFORM designs and markets concrete wall forming systems. These stay-in-place finished formwork products are the ideal solution for concrete projects of all shape and size.

Suitable for any type of tank construction, the OCTAFORM Finished Forming System has been used to construct tank walls for water or waste storage, anaerobic digester tanks, air filtration systems and aquaculture tanks. Whether it’s 10,000 or 5 million gallons, the versatility of our system means you can build square or round concrete containment tank walls of any size or diameter.

Superior Finish. Enduring Quality.

Combining the strength of concrete with a finish that outperforms epoxy coatings and membranes in durability and maintenance cost over the lifetime of the structure, Octaform’s containment solutions will make you rethink conventional methods.

Unlike with other construction systems no heavy equipment is necessary for the assembly of digestion tanks.

http://www.octaform.com/

http://www.flickr.com/photos/octaform/?utm_campaign=LeadNurturing_Engineering+Campaign_Email5
A wide range of applications

The careful preparation of biomasses is extremely important to serve modern biogas plants. The simple but effective function of the Cross-Flow Grinder Bio-QZ (Querstromzerspaner Bio-QZ) from MeWa is very effective and makes efficiently use of all kind of substrates.

Flexible input materials
Whether packaged food, organic household waste, slaughterhouse waste, food leftovers, or energy crops such as maize and grass silage, manure, wheat or sugar beet, the Cross-Flow Grinder will take it all – this diversity makes the Bio-QZ unbeatable. The co-fermenter plants benefit from this flexibility the same way as a crop biogas plant which can use cost-efficient seasonal fruit.

In a matter of seconds rotating chains fray out the material and break open the cell structure of nearly all the material, thereby increasing the working surface for bacteria. The bladeless principle is resistant to metal parts and stones and completely unwraps all packaging.

Using the Bio-QZ can increase the economic efficiency of a biogas plant up to 30%.
In planning your biogas plant we take all the parameters of your operation into account, together with your individual wishes. And if no existing modular or mobile biogas system concept matches your requirements, we will develop and manufacture a custom solution for. The combined heat and power unit is the heart of a biogas plant. Converting the biogas produced into electricity efficiently is a decisive factor for the viability of the plant. Seemingly slight differences in efficiency exert a major influence on the revenue that can be obtained. Additionally, biogas places special requirements on the CHP unit. For this reason we use only trusted technology from leading manufacturers developed specifically for this purpose.
Capstone Micro Turbines can cleanly burn waste gases to create renewable power and heat.

Capstone MicroTurbines are efficient and clean burning. The CR65 line of micro turbines meet the strict exhaust emissions requirements of the California Air Resources Board (CARB) for operation on landfill and digester gases, and were the first power generation systems to receive this CARB certification. The CR65 is also available with an integrated heat recovery module, which is ideal for applications that need both heat and power – such as for anaerobic digesters. The CR200, CR600, CR800, and CR1000 will also be CARB certified for operation on these waste fuels, so you are sure to have low emissions for any project size.

Lipp builds tanks and containers: ingeniously simple and simply ingenious
The efficient on-site production allows for fast, inexpensive assembly of silos with a variable diameter between 3 and 30 metres and a height of up to 40 metres, with optional filling and removal technology.

The advantages at a glance:

- High quality and a long service life
- Excellent stability thanks to Lipp Dual-Seam System
- Free choice of RAL colours
- Expansion option
- Short construction time
- Construction without container boarding and scaffolding
- Type statics
- DIBT approval
- Broad assortment of peripheral accessories

**Lipp Dual-Seam System:**

the fastest, simplest way to

flexibly build reliable

containers and tanks.

Link: [http://www.lipp-system.de/36-lipp_system.html](http://www.lipp-system.de/36-lipp_system.html)
We can now offer a better fermenter technology based on an ingenious new development. The Thermo-Gas-Lift System is a multi chamber proofing system wherein the gaseous overpressure takes over the mixing process. Instead of expensive, mechanical vulnerable mixing equipment we use the fermenters own gas production for mixing of the substrate fill. These fermenters are considerable cheaper in building and in operation.

**Flow conditions within the THERMO GAS LIFT process**

**PRINCIPLE:**

- Renewable energy from waste, e.g. liquid manure, organic waste from household, trade and industry
- Economic operation of small biogas plants by patented technology
- > 100 cattle units, = 25 - 50 kW electrical power
- No mechanical moving parts and no electrical parts in the fermenter
- Thermo-Gas-Lift gently heats and stirs the fermenter through thermal convection and rising bubbles.
- Better utilisation of substrates and improved gas quality
THE ADVANTAGES OF A SMALL SCALE!

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Bio4Gas</th>
<th>Conventional AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUBSTRATES FEEDSTOCK</td>
<td>Using existing biomass e.g. manure on site</td>
<td>Requires specially produced energy crops</td>
</tr>
<tr>
<td>FERMENTER TECHNOLOGY</td>
<td>Appling physics, for mixing &amp; heating requirement 10% higher gas production</td>
<td>Expensive and high maintenance mixers &amp; heaters</td>
</tr>
<tr>
<td>OPERATING COST &amp; MAINTENANCE</td>
<td>No moving parts, 3% of capital cost for maintenance p.a.</td>
<td>Frequent stops of production for maintenance, 15% maintenance cost p.a.</td>
</tr>
<tr>
<td>CONSTRUCTION &amp; BUILDINGS</td>
<td>Single fermenter and integrated gas scrubber</td>
<td>Large multiple fermenter and separate gas scrubber</td>
</tr>
<tr>
<td>FEED-IN-TECHNOLOGY</td>
<td>Pumping</td>
<td>Screws and pumps</td>
</tr>
<tr>
<td>MANPOWER</td>
<td>Few hours per week</td>
<td>Few hours per day</td>
</tr>
<tr>
<td>CONCEPT</td>
<td>Build in existing infrastructure</td>
<td>Green field site</td>
</tr>
<tr>
<td>HEAT USE</td>
<td>Locally used and can be converted to cold/air/water</td>
<td>Too much to use locally, mostly unused</td>
</tr>
</tbody>
</table>

BENEFITS:

- Power production as green energy - special feed-in tariff.
- Generation of heat - substitution of fossil fuel and gas.
- Farm-scale recycling of nutrients in the digestate.
- Digestate with higher nutrient availability for plants and reduced odour nuisance compared to dung/manure.
- Revenues for treatment of organic wastes.
- CO2 emission certificate for the standardised biogas plant.
HOW TO USE YOUR COW!

Beside the production of milk (or meat) your cow produces about 1.5 cubic meter biogas per day – which is about 3 kW/h electricity a day! Did you know that!? Why give it away?

Build your biogas plant in 18 days

Farm biogas plants for 100 cows ~ 20kW elk. CHP

prefabricated patent protected reactor ~220 m³
preinstalled, plug and start ~CHP 20kW elk.
connect reactor with preinstalled CHP– ready in 18 days
produce your own electricity and heat for house & stable
ideal for small farms and communities

Build your own reactor with prefabricated elements in 18 days. Connect the preinstalled CHP with your reactor. Now you are ready to produce heat and electricity (CHP). Methane (CH₄) could also be used to power your truck /tractor.
Minimum amount manure necessary: 2000 m³ (qm) per annum ~ manure of 100 cows. This produces about 150.000 kWh p.a. with a 20 kW elec. CHP (about 30kW term.).
The patent protected reactor was developed by the University of Innsbruck in Austria.

Starting from 150.000 €
According to your liquid manure amount and your individual needs we can offer following standardized fermenter sizes for 200, 300, 400, 500 and 600 m³ volume with the fitting cogeneration plants CHP of 30, 50, 75, 100, 120, 150, 220, 360 kW electrical power output.

Should one fermenter unit not being enough – or did your waste production increase after your first instalment – just build another one! Does it sound un-economical to you? No – it is absolutely not! If you consider possible repairs or mal functions in a large biogas unit – considering you might have to empty the tanks and shut down the whole plant for days (the mixing equipment in larger units do have the tendency to break down every now and than due to daily operation in a very aggressive environment) you are far better of with 2 or even 4 smaller units when you can continue energy production with the working units. The same situation goes if you should have a shortage in substrates – also here it is easy to limit your production without having to close the whole plant.

**TARGET GROUPS:**

- Agricultural farms, winery, poultry – pigg farms, horse breeder – stables
- Waste management companies respectively communes – waste water sludge
- Trade and industrial firms, food production

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But we still haven’t learned to use it right! Since Stone Age time human being knew only one form of producing energy – it was to fire up things that would burn. And ever since human beings appeared on this earth, nature was out of balance. It all changed with the, for humans vital, invention of fire. Fire – heat was energy and energy signified further development and with this also an impropriate use of nature. Along with human development, now that he learned to tame one element and started to exploit natural resources, he also created waste. Waste is unknown in nature. There is no such thing as waste – everything is energy, is being used and digested. And exactly this is the philosophy behind our efforts to use modern technology – leave no waste!
Also in the production we do have carbon dioxide as a by-product of fermentation, more so when burning methane gases to produce electrical energy. The idea now was, how can we use these gases in a productive manner?

The answer is ALGAE Culturing!

For the purpose of CO2 sequestration, the use of micro algae is a unique technology. For example, micro algae can assimilate CO2 within various ranges of concentration from ambient (0.04%) to 100% v/v CO2 by selecting adequate species. The technology also works under a wide range of thermal conditions, ranging from 25 to 100°C. Adapting micro algae for the use of CO2 sequestration also has the potential to produce useful by-products, and could function multi-purposely. In addition, it is an environmentally friendly technology. Two distinctive cultural systems have been proposed for CO2 sequestration with micro algae. One is the open pond system, and the other is the closed photo bioreactor system. There is ongoing discussion regarding whether the open pond system or the closed photo bioreactor system would be better for CO2 sequestration. Apparent advantages for utilizing the open pond system are low initial and operational costs. On the other hand, an advantage for the photo bioreactor system has a higher potential productivity due to better environmental control and harvesting efficiency.
The algae industry today is moving towards multiple applications including nutraceuticals, cosmetics, animal feed, carbon capture & recycle and waste water treatment, while research into cost effective bio ethanol, bio diesel and other bio energy production continues behind the scene. We have planned and completed our business model which reflects the shift from the algae-bio fuel hype to a sustainable business enabling satisfying returns on investment.

Micro algae as Feed

The use of micro algae as feed is unfortunately still in its infancies. And it is a never ending story. Micro algae and macro algae, cyanobakteria (pro-) and eukaryotes are known since many thousands of years as food and feed and valued especially in Asian countries. As first part of the food chain they are the basis of life for zooplankton and fish. More than 8 million tons of fresh algal biomass are marketed worldwide whereas app. 6 million directly as „algae vegetable“.

Successful conducted scientific studies to the topics algal substances and their value for a healthy nutrition, as feed, pharmacological and cosmetic raw material led since the 1960ies to the development of industrial micro algal production plants in America, Japan, Australia, Israel, Korea, China, France, Italy and Germany.

State of the art Reactor Technology:

![African Students get their education at the Algae Bio Reactor Plant from the German Power Supplier RWE](http://www.rwe.com/web/cms/en/2652/rwe/innovations/power-generation/clean-coal/algae-project/)
Why micro algae at biogas facilities?

The production in of micro algae in connection with biogas production is a very favourable synergy – enough CO2 and nutrients, energy and heat. Since biogas very often aligns with feedstock breeding, dried algae biomass can also be used as nutrient rich feed supply.
Absorption heat cooling machines will use the aggregate heat from the gas engine for cooling. (here: BROAD – Outdoor Package Chiller)

Link: http://www.gasklima.de/broad.0.html

Absorption cooling

The aggregate heat from the cogeneration unit can be used in a refrigeration machine using ammonia and water as refrigerant – temperatures down to -70 degrees are possible.
Additional Information

From the Biogas Plant Producer BIO CONSTRUCT: http://www.bioconstruct.com/

HOW TO BUILD A BIOGAS PLANT:
http://www.youtube.com/watch?v=mCebM7a5XBQ&NR=1

From the Biogas Producer ENVITEC: http://www.envitec-biogas.de/

VIRTUAL TOUR THROUGH A BIOGAS PLANT:
http://www.youtube.com/watch?v=QPeGpwnXkZk&feature=related
Ammonia (NH₃)
Nitrogenous gas is produced when compounds containing nitrogen are decomposed, such as protein, urea and uric acid.

Anaerobic bacteria
Micro organisms that live and multiply in an environment containing no free or dissolved oxygen.

Anaerobic decomposition
Decomposition of organic substances caused by anaerobic bacteria, partially with release of biogas.

Base substrate
Fertiliser to be used for fermentation purposes.

Biogas
Product of anaerobic biological decomposition or organic matter. Contains approx. 45-70 % methane, 30-55 % carbon dioxide, small quantities of nitrogen, hydrogen sulphide and other trace gases.

Biogas plant
Plant for the production, storage and utilisation of biogas, including all necessary equipment and fixtures. Biogas is thereby produced by means of fermentation of organic substances.

Buffer capacity
The buffer capacity is the quantity of a strong acid required to adjust the pH to a predefined value (e.g. 4.4).

Carbon dioxide
Colourless, non-flammable, non-toxic gas with a slightly acidic smell, produced together with water when an organic compound is combusted.

Cogeneration of heat and power
Simultaneous conversion of energy used into electrical (or mechanical) energy and into heat to be used for heating purposes (useful heat).

Condensate
Biogas produced in the fermenter is saturated with water vapour and must be dried before it is used in the combined heat and power plant. This is done by installing a sufficiently dimensioned earth line in a condensate trap, or by drying the biogas.

Co-substrate
Organic material that is not a fertiliser and is destined for fermentation.

C/N ratio
Ratio between carbon and nitrogen in a substrate. The C/N ratio of the substrate to be fermented is important for a good fermentation process (ideal ratio: 13/30). The C/N ratio in the fermented substrate can be used to determine the availability of nitrogen for fertilisation (ideal: 13).

Decomposition
The decomposition of organic compounds consisting of many atoms into smaller molecules by means of biotic or non-biotic processes. Biotic decomposition is caused by biological processes (e.g. by enzymes or micro organisms). Non-biotic decomposition is caused by chemical reactions (e.g. slow oxidation, combustion, conversion) or physical influences (e.g. UV radiation).

Degradability
Property of a substance that can be decomposed by biochemical, chemical or physical reactions. The end products of the reactions are either other compounds (metabolites) or in the case of complete mineralization CO₂, H₂O, NH₃.
Desulphurisation

Biological or chemical process for the removal of sulphur from biogas.

Dry substance proportion (DS)

Dry content of a substance mixture after drying at 105 °C.

Dwell time

Average retention time of the substrate in the fermenter.

Emission

Release of fumes, gases, dust, affluent or odours into the environment. Emissions also include noise, vibration, light and heat radiation.

Fat separator

Device for the separation of non-emulsified organic oils and fats, installed for example in wastewater systems of restaurants, commercial kitchens, meat factories, meat and fish processing plants, margarine factories and oil mills (see DIN 4040).

Fermentation residue

Material left over in the fermenter after biogas production, biogas production by-product.

Fermentation residue storage tank (slurry storage tank).

Container or pit in which slurry, liquid manure as well as fermented substrate are stored before further use.

Fermenter (reactor, vessel, fermentation container, digester)

Vessel in which the substrate is decomposed by microorganisms and biogas is released in the process.

Full load hours

Time of the full loading of a plant when the total usage hours and the average degree of utilisation within one year are converted to an utilisation rate of 100%.

Gas dome

Structure placed on fermentation vessel in which biogas is collected for further use.

Gas storage

Room or area where the gas tank is installed.

Gas tank

Gastight vessel or foil bag in which biogas is temporarily stored.

Heating / power station

Unit for the production of electricity and heat by means of an engine with an attached generator.

Hydrogen sulphide (H₂S)

Combustible, strong toxic gas with an unpleasant pungent smell like rotten eggs which can, however, be tolerated in low concentrations.

Hygienisation

Process step for reduction and/or elimination of disease agents and/or phytopathogens. BioAbfV or EC Hygiene regulations give information about the process.

K value
Heat transfer coefficient, also known as K value, is a measure for thermal insulation properties. It corresponds to the heat that is conducted through a surface of one square meter of a material at a temperature difference of one degree Celsius. The smaller the K value, the lower the heat loss.

**Methane (CH\(_4\))**

Colourless, odourless and non-toxic gas. Releases carbon dioxide and water when combusted. Methane is one of the key greenhouse gases and is contained in biogas, natural gas, sewer gas and landfill gas.

**Nitrogen oxide**

The gases nitrogen monoxide (NO) and nitrogen dioxide (NO\(_2\)) are also referred to as NO\(_x\) (nitrogen oxides). They occur in all combustion processes (especially at high temperatures) when the nitrogen in the air reacts with the oxygen, or where compounds containing nitrogen are oxidised.

**organic dry substance proportion (ODS)**

Organic content of the substance after removal of the water and any inorganic substances. Normally determined by drying the substance at 105 °C and combustion at 550 °C.

**Preparation**

Preliminary treatment of a material (e.g. chopping, removal of unwanted substances, homogenisation, etc.).

**Potentially explosive areas**

Areas in which an explosive atmosphere might occur, due to local or operational conditions.

**Rate of degradation**

The rate of the biological or chemical degradation of organic compounds.

**Renewable raw materials (RRM)**

Collective term describing any biomass that is used as a material or for the generation of energy (not including foodstuff and animal feed). Normally, they consist of products from agricultural production or forestry, such as timber, flax, rapeseed, sugar and starch extracted from sugar beet, potatoes or maize that are used for a secondary purpose.

**Solid transfer**

Method for the transfer of non-pump able substrates or substrate mixtures to the fermenter.

**Sulphur dioxide**

Colourless gas, with a pungent smell, produced by combusting sulphur or roasting sulphides. The corresponding aqueous solution is known as sulphurous acid.

**Substrate**

Organic bio-degradable material collected for the purpose of fermentation for the production of biogas.

**Throughput**

Quantity of material feed to and processed in a plant per time unit.

**VOA/TAC**

VOA/TAC is the ratio of volatile organic acids to total anorganic carbon (carbonate buffer capacity).

**Volume load**

Organic content of the material brought into the fermenter relative to the usable fermenter capacity per time unit. Expressed in kg ODS/m\(^3\)*d.
Sintex Bio Gas Plant

Innovative steps have been taken by Sintex Industries when introducing biogas plants that are ideal for people having 1, 2, 3 or 4 cows, buffaloes / livestock.

In evolving the new biogas plants Sintex have combined time tested design of "Deenbandhu" type of model with superior characteristics of plastics.

Sintex biogas plants are thus the first portable and ready-to-use plants anywhere in the world.

Sintex Bio Gas plant is

- Ready to use and Easy to install
- No Problems of Leakage
- Requires very less maintenance
- It is cleaner than conventional system
- Easy to relocate, if required
- It maintains inside temperature even in winter for more efficient Gas production

All you need with a Sintex Bio Gas Plant is waste
SIZE DOESN'T MATTER!
MAIN THING IS - IT WORKS!
A BIOGAS PLANT IS BEING BUILT IN KAMBODIA

SOMETIMES BIOGAS EVEN CREATES WONDERS!!!
MAYBE THEY INHALED IT??

AS YOU CAN SEE: PETROL HAS NO FUTURE!!!

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