Biogas Methane Explained & Other Articles

by Steve Last

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Introduction

Biogas methane energy is green energy.

In these articles I have endeavoured to explain why biogas is green and renewable when used as an energy source, and how it is produced by the anaerobic digestion (AD) process.

A number of methods of producing methane biogas using AD are also discussed, so that the reader will understand exactly what biogas methane is and the implications for our planet of its creation and use.

in subsequent articles we continue to explore the biogas theme and amongst other topics discuss biogas production for farms, how it can be used by the waste management industry, and the emerging political support which biogas is receiving from many governments.

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Biogas Methane Explained

Biogas methane is methane created from biologically created organic matter. The important thing to remember is that the term has entered common usage through the need to distinguish biogas derived methane from fossil fuel methane. Fossil fuel derived methane is known as 'natural gas'. Natural gas comes from mineral reserves, where it has been stored in the ground since its formation from living plants and animals hundreds of thousands of years ago. Natural gas/methane also comes sometimes from coal mines and coal measures which emit it.

So, in other words, biogas methane means 'green', 'renewable' methane, as opposed to natural gas which when burnt contributes to the greenhouse effect.

In addition to the biogas methane energy sources usually talked about, there are others which are not mineral gas created and these are either 'natural' and 'un-natural' (not part of the normal carbon cycle) in their origins, as follows:-

1. Gas being created naturally all the time in peat bogs and organic marine silts;

2. Methane produced in the stomachs of animals by the digestion of their foods (eg ruminants);

3. Biogas being created in farm slurry tanks etc, while farmers hold it waiting for dry weather when they can spread the manure/slurry on to their fields;

4. Landfill gas which is simply biogas created in landfills where the conditions are anaerobic.

If any sources of methane are emitted and rise from ground level into the atmosphere they are thought to be very potent causes of greenhouse warming. In fact, methane is about 20 times more active in absorbing the sun's heat, and causing global warming, than carbon dioxide.

Anaerobic decomposition in all these cases, produces methane biogas. At the same time it produces, carbon dioxide, some hydrogen, and other gases in traces. AD also produces a little heat, and a final product with a higher nitrogen content than is produced by aerobic fermentation.

The biogas production process which is usually inferred when people talk about biomethane is Anaerobic Digestion. This is a process which consists of feeding biomass to a large digester, in which methane-producing bacteria, under airless conditions, convert it into the energy-rich biogas.

The action of mixing and heating with the digester allows the bacteria to come into contact with the feedstock material, which provides food for the bacteria to multiply and convert the complex organic compounds into much simpler mostly soluble compounds. For example, sugars and starches, which then react in further stages giving off methane gas, which comprises about two thirds of biogas. The gas, a mixture of methane and CO2, is used for direct combustion in cooking or lighting applications, or to power combustion engines for motive power or electricity generation.

Methane (CH4) biogas technology is a renewable energy technology that uses various forms of biomass (animal dung, crop waste) and converts it into a useful energy source in the form of a gas (about 70% methane), via anaerobic microbial digestion. Methanogens are organisms that make methane via a unique metabolic pathway with unique enzymes. This produces a mixture of gases, primarily methane and carbon dioxide, and a nutrient-rich slurry. The CH4 rises into the gas holder where it is contained by a water seal. When the mixture of methane and air (oxygen) burn a blue flame is emitted, producing large amount of heat energy.

Methane biogas can be used for all the purposes in which natural gas is used, and can be used as the renewable equivalent of LNG as well.

Methane biogas has in the past been more expensive to produce that simply drilling for natural gas and pumping vast quantities of natural gas to our homes and industries. The biomethane needs "scrubbing" before it is clean enough to use in normal natural gas burning equipment. If it is not scrubbed, or not scrubbed adequately it will cause corrosion.

Methane biogas is about to become much more important as an energy source than it has been in the past, due to the ever rising cost of natural gas.

Thinking more about building a digester? Steve Last is web master for the fact filled Anaerobic Digestion Community web site where much more methane biogas and digester information is available.

Low Cost Biogas Digesters Bring Big Advantages to Farmers

Biogas digesters are often considered to be something new by those in the developed nations, however, they have been widely used for many years in developing countries, especially India and China, as firewood for cooking becomes scarce. Other countries from Honduran farmers to the tiny South Pacific island nation of Tuvalu, are able to harness the methane gas created naturally from decomposing manure and other organic materials. Besides producing the fuel gas, these biogas digesters (using the process of anaerobic digestion) have the added potential benefit of producing a high nutrient slurry fertilizer and providing better sanitation on farms.

The win-win process goes even further though because the emission of pollution from the digester is very much lower than without the digester, as well, so they can help to reduce river and groundwater pollution at the same time. A functional biogas digester system applies the science of microbiology and involves the development of renewable energy.

With biogas technology, the farm or community/human waste (called slurry) is stored in specially constructed containers while being digested. Biogas digester systems can accommodate manure handled as a liquid, slurry, or semisolid depending on the type of reactor design used. Biogas digesters take the biodegradable feedstock, and convert it into two useful products: gas and digestate (solid and liquid). Both of these are useful, and this is certain to be one of the main reasons why more and more farmers around the world are beginning to install a biogas digester.

Biogas digesters are usually built underground to protect them from temperature variations and also to prevent accidental damage. They not only perform the necessary actions required to keep the bacteria happy and creating the biogas, but designs suitable for farms and communities have been devised for the developing nations which are able to be replicated using items that are cheap, easy to source, and easy to assemble.

The typical developing nation biogas digester is constructed in a pit which is excavated by a trained labourer with assistance from one or more members of the household or community. A very common design for biogas digesters has a volume of 8m3, some are larger at 10-15m3, and provide enough gas for a two-ring stove and a light.

A biogas digester can function well on human and animal waste. We know of one Anaerobic Digester which is based upon pig farming, and is built below the pigsty. The pigsty is insulated, and the digester produces some heat as well, which helps to keep both the pigs and the biogas digester in the warm conditions both need during cold winter weather.

A biogas digester consists of one or more airtight reservoirs into which a suitable feedstock such as cow dung, human waste, or even abattoir waste, is placed, either in batches or by continuous feed. It is mixed and the solid and liquid digestate is removed on a regular basis. The methane bubbles to the surface, and in the simplest systems, it is stored as a big bubble above the liquid. In more sophisticated systems the methane is stored in separate tanks, for use when needed.

There is an enormous potential for benefit from the increased use of anaerobic digestion in Africa. An AGAMA Energy fact sheet estimates that in South Africa there are 400,000 households with two or more cows and no electricity that could make use of biogas digesters. An article dating back to30 November 2005, in the Rwandan newspaper The New Times states that the Institute for Scientific Research and Technology in Kigali plans to install some 1,500 biogas digesters by 2009 in the imidugudu settlements. These are villages where rural Rwandans were relocated after the genocidal wars of the mid-1990s.

Worldwide, about 16 million households use small-scale biogas digesters, according to Renewables 2005: Global Status Report, a study by the Worldwatch Institute.

It has been reported that in India a domestic biogas digester unit capable of producing energy for an entire family's cooking needs can be installed for between R5 000 and R8 000, that is less than 200 US Dollars. Facilities best suited for biogas digester systems typically have stable year-round manure production, and collect and feed the digester with manure daily.

Thinking more about building a digester? Steve Last is web master for the fact filled Anaerobic Digestion Community web site where much more biogas digester information is available.

Anaerobic Digestion for Energy and Biofuel from Municipal Solid Waste

Globally refuse disposal is still one of the great growth industries of our time. The majority of what we buy and use, is destined for the dustcart, and in an ever shorter time and breaking all previous records for quantity as civilization becomes more affluent.

We purchase great quantities of goods which come with a relatively short lifespan and abundant quantities of packaging material. In times gone by many of us composted our putrescible waste in our gardens ad vegetable plots.

Gardens are getting smaller, we grow fewer food crops, and there is little room left for the compost heap and the garden bonfire is often banned due to clean-air regulations.

Dustbins are getting larger and refuse collection authorities are becoming more efficient and helpful in collecting ever larger quantities of household refuse and civic amenity wastes.

To reduce the sheer bulk of waste destined for our landfill sites, to extend their operating lives and to minimize the environmental and safety hazards of the materials delivered unto them, there is increasing public and legislative pressure to recycle and reuse a greater proportion of the discarded possessions we call "municipal solid waste" ("MSW").

There is also a growing demand for energy and for that energy to be “green” and not from a fossil fuel based source which contributes to the greenhouse gas effect and climate change. There are lots of ways that waste, with its locked-in energy, can be used as a fuel source, but one of the very best, if not the best is a process called Anaerobic Digestion.

The scope for anaerobic digestion of MSW "putrescibles" becomes apparent when one examines the composition of household refuse and the limitations of existing recycling schemes. The big advantage possessed by anaerobic digestion is that using it to produce “biogas” can not only provide a fuel for ordinary diesel generators, but also can be converted into biofuel which can be used in the automotive industry. This can potentially provide us with green fuel in the place of fossil fuels which are saved. Anaerobic Digestion is still a technology which needs a lot of improving and developing though. There are quite a few problems in using it reliably for the fermentation of wastes, despite the fact that Anaerobic Digestion has been used for sludge digestion at sewage works for at least 50 years.

The problems become apparent when one examines the cost and complexity of the anaerobic digestion equipment and the need to find appropriate outlets for the "refined digestate" liquid it produces.

The incentives derive from consideration of the alternatives:

- The other alternatives, including refuse-sorting and incineration, refuse-derived fuels and refuse-reclaimed materials do not seem likely to offer an obvious straight forward quick-fix solution.
- Landfilling is generally considered to be cheap and effective, if it's available, if it's acceptable in the locality, and it will always be required as the ultimate resting place for a small proportion of our refuse.
- But landfill sites do fill up and the problem always remains of finding appropriate new sites..

To summarise this we would say that:

- Household waste is inherently putrescible (compostible), and provides a natural material for decomposition by methane bacteria.
- It will ferment naturally, in a landfill, which even when lined and capped is at comparatively little cost.
- But, landfills do bring with them considerable environmental and safety hazards. They require extensive gas abstraction and leachate control systems to protect neighbouring crops, neighbouring properties and underground water supplies. Even then possibly 30% to 50% of the methane produced leaks out and can’t be collected..
- Household waste will also ferment rapidly in anaerobic digestion plants to provide a convenient source of biogas as fuel and a stabilised "digestate" for landfilling, or refining into useful soil conditioners and soil substitutes for agriculture, forestry or land reclamation. .
- It will capture almost 100% of the methane produced, and this methane can also be processed into a automotive biofuel. It is carbon negative (helps reduce carbon emissions) and “green”. Anaerobic Digestion technology may not be as reliable as other processes and the cost is high at present, but further investment in research into the processes will almost certainly be able to improve reliability very rapidly.>

Shouldn’t you consider Anaerobic Digestion for your waste processing solution?

There is further information on AD, available at [the Anaerobic Digestion web site](#) .

The Magic of Combined Anaerobic Digestion with Composting of Municipal Solid Waste

The portion of the municipal solid waste (MSW) in developed economies, which is organic in nature, and derived from household, industry, gardens, public parks and the treatment of waste wood, has been commonly determined to comprise between 40% and 60% of the total by weight. The proportion is also expected to rise over the next few years, as increased recycling rates are achieved for man made re-useable materials. Therefore, as countries put in place sophisticated waste processing techniques to reduce the amount of waste generated, and then still wish to reduce the use of landfill still further, the degree of mass reduction, the manner in which this organic fraction is processed and the amount of readily useable and non-renewable energy (replacement fuel) produced by these processes is becoming of greater importance.

Two processes, which have always existed in nature, are popular for the processing of organic MSW, and these will remain favourites with the public because their use avoids burning (incineration). These two are composting, and digestion.

The defining difference between composting and digestion, which are both natural microbiological processes is that in composting decomposition takes place in the presence of sufficient free oxygen (air) to maintain the system aerated (aerobic), whereas in digestion there is no free oxygen, and the only oxygen present is in chemical compounds, and in the microorganisms such as the bacteria which are present.

All MSW contains both woody materials and “wet” organic material such as grass cuttings. The lignified (“more woody”) wastes have to be composted, wet and easily degradable wastes, and sludges, are suitable for anaerobic digestion. In addition these high moisture content wastes will cause odour problems in composting facilities, unless a very high degree of attention is paid to blending and mixing to ensure that a fibrous freely ventilating and completely aerobic composting (fibrous) material structure is retained throughout. In fact, although expert opinions vary, for more than one third of the total potential organic material digestion is a better solution than composting.

In many countries previously heavily dependent on landfill, and embarking on organic waste processing for the first time, it makes good environmental and economic sense to start by building composting facilities. Composting can be by simple windrowing, and the first waste streams treated are usually just those derived from kerbside collection of garden waste, which is readily mixed and composted in most climates.

Nevertheless, not only are the markets limited for the compost products produced, the undoubted value of this material is very difficult to realise as a financial return.

In addition, there is an increasing realisation that this readily compostible kerbside (source segregated) waste once catered for by the provision of suitable composting facilities, is only a first step on the road to achieving reasonable overall waste minimisation targets.

At a point, and probably not too far into the future for many developed nations, the waste industry, politicians, and the public will seek more useable products, and look for benefits in other ways from their waste. These will such as in the production of useable forms of fuels, and the avoidance of greenhouse gas emissions by using organic waste derived fuel as a fossil fuel replacement.

This is where the magic of combined composting and digestion plants will be realised.

Combined plants, where the digestion is directly integrated with composting, show many advantages, such as the appropriate treatment for different substrate fractions, use of the same machineries for the pre- and the post-treatment, self-sufficiency in energy and net energy production, as well as utilisation of the waste water derived from liquid-solid separation at the end of the digestion for the irrigation of the windrows.

Important advantages of digestion, and the synergies available fom combing the two processes are:-

* During anaerobic digestion, biogas is produced. The amount of renewable energy freed satisfies the energy need of the whole treatment plant, i.e. for digestion, pre- and post-treatment as well as for automatic turning and aeration of the compost. A very large amount of heat and - depending on the technologies applied - a surplus of electricity may be sold to other users. (In the UK this is considered a green energy and attracts a higher unit rate from the electricity company to which it is sold, under the ROCS Scheme, than for non-renewable or fossil fuel based electricity.)

* The waste heat from generation can be used in built-up areas in “combined heat and power schemes”, in which instead of the low grade heat after generation going to a cooling tower where it is wasted to the atmosphere,

this water (which is actually still very hot in terms of house heating use), can be pumped to provide heating for homes, or to warm factories etc.

* Instead of using all the energy to generate power, much of the biogas may be used as a fuel.

* The liquid generated during digestion of separately collected MSW and non-hazardous organic industrial waste is rich in nutrients. If used for irrigation on compost, it improves and eventually accelerates the composting process.

* This liquid is sterilised by the heat of the digestion process and provides an excellent liquid crop fertiliser in the place of chemical fertilisers. * Anaerobic digestion readily complies with the precautions necessary to ensure that infections like the Foot and Mouth disease cannot be spread by waste processes. For most organic waste composting with good practise hygiene techniques is sufficient, but for some “animal by-product” (high infection risk wastes) anaerobic digestion provides easy and dependable sanitisation as an inherent component of the process.

* If digestion plants are located near oil pipelines carbon shift technology can be incorporated for optimum carbon capture, by removing carbon gas (carbon monoxide and carbon dioxide) from the biogas and pacing it underground in long-term storage, thus providing the ultimate in the preservation of our planet as we know it.

* Furthermore, detailed investment and operating costs for aerobic and anaerobic combined process treatment plants are likely to be cheaper than composting alone, when all lifetime benefits are considered. These benefits include carbon emissions reductions (even without carbon capture), and a premium biogas which can be used (after scrubbing and compression) for fuelling motor vehicles.

Combined plants cost less over their lifetime than plants which treat the wastes exclusively by way of composting, especially if the increasing willingness of governments to provide operators with financial and tax reduction incentives toward carbon emissions reduction continues, and there is good reason to expect that such incentives will rise dramatically over the next five to ten years.

As described earlier, when all things are considered, combined anaerobic digestion and composting can not only be very significantly cheaper than composting alone, but the mass of the residue sent to landfill in the end will also be reduced, and global warming emissions are also minimised. Therefore, the treatment of organic MSW in combined plants is highly recommended, and all those involved in the planning and design of waste treatment facilities should consider these benefits.

While it must always be recognised that although combined anaerobic digestion will not always be the best option for all district locations, residents and ratepayers would do well to press their local politicians to ensure that combined anaerobic digestion is considered carefully by their municipal engineers, before alternative waste treatment technologies are promoted.

For more information on Anaerobic Digestion of Waste, including Municipal Solid Waste click here.

Biogas Plants Receive Political Backing in Many Countries

The green benefits from AD are substantial and in an increasing number of countries grants, subsidies and tax breaks are becoming available for these plants, backed by governments, politicians, and a wide range of political parties.

Biogas plants can be found in countries such as India, China, Philippines, Germany, Austria and Turkey. India and China have both had large government-backed schemes to encourage the adoption of these systems for use in the household for cooking and lighting. It is well reported fact that AD systems in Nepal help save 400,000 tons of firewood and 800,000 liters of kerosene and prevent 600,000 tons of greenhouse gases from escaping into the atmosphere annually. Denmark already has 20 centralized biogas plants and more than 35 farm scale plants.

There are biogas plants for farm and community sanitary wastes, for biofuel using specially grown crops, and large commercial plants which treat municipal solid waste usually taking the segregated organic content. These plants can be installed at sewage works as well, and can create gas from high Chemical Oxygen Demand (COD) industrial effluents.

The farm type biogas plant digests dairy cattle manure and organic residues originating from the farm and the surrounding food processing units. These plants implement biogas production from manure waste, chicken litter, and during waste water treatment. In fact the possibilities are so wide ranging that it is impossible to list them all in a short article.

A biogas plant normally consists of two components: a digester (or fermentation tank) and a gas holder. The reaction in the plant takes place in the absence of oxygen and the gas contains up to 70 percent methane and 30 percent carbon dioxide. Acidogenic bacteria, through the production of acids, reduce the pH of the tank. Care is needed to ensure that the pH range is maintained within limits or the biological process will be inhibited and gas production will reduce.

The following points should be kept in mind when deciding on a site for biogas plant construction. The success or failure of any these systems mainly depends upon the quality of the design and of the construction works. From small fermenting to large city CHP plants the many components must be precisely matched to one another ensure long life for the equipment and overall systems. There must be careful work before the design starts to assess the available feedstock materials and to ensure that the design matches the quality, type, and quantity of those materials which will be available.

All owners of biogas plants appreciate the need for high calorific feedstocks in their feed mix, and many are digesting food waste which is a very good feed material, and also waste fats are good high methane producing feedstocks for digestion within their plants.

Production

Production of biogas is inefficient if fermentation materials are too dilute or too concentrated, resulting in, low production and insufficient fermentation activity, respectively.

It must be noted that segregation of the input to ensure that the right nutrients are present to feed the process, and this is of utmost importance for smooth running of all AD plants. Success of any biogas plant depends a great deal on proper segregation of the kitchen waste from large pieces of material grit and dust which can clog and block the plant.

The Future

The future will see greatly increased use of biogas as a fuel. This is a primary target in many countries to help reduce greenhouse gas emissions, water pollution and soil degradation.

Last, but not least, the adoption of this waste processing technology will change the agriculture sector in many countries worldwide to produce both food and energy - not just food. This diversity will help farming businesses to remain more profitable in years when the market price for their food crops is low.

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There are many other ways to treat waste, such as Composting, Mechanical Biological Treatment (MBT), Thermal Heat Treatment, etc.

For more information on UK Waste Technology, including Anaerobic Digestion, Composting, and MBT, etc - click here.

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Anaerobic Digestion News

Tuesday, January 01, 2008

Come on Gordon Let's Get on with Bio-Energy Production in 2008

Happy New Year all subscribers! Here's hoping for a great new year for Anaerobic Digestion and biogas projects generally.

Here is a rallying call to all for the start of 2008...

Considering that about 80 % of the total amount of UK animal manure could be handled at biogas plants in future, the potential of primary energy from biogas is a small but significant percentage of the UK renewable energy target.

Using renewable energy from biogas eliminates greenhouse gas production and reduces the use of non renewable fossil fuel. So why is this target not being pursued more vigorously by the UK government?

About

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