Application note
MTL biogas monitoring

September 2016
AN9043 Rev 3

CROUSE-HINDS
SERIES

The Biogas industry and the new MTL GIR6000 Biogas analyser

Eaton's MTL gas product portfolio, part of the Crouse-Hinds series, specialises in the manufacture of hazardous area (ATEX) certified Biogas analysers, wireless communications and surge protection equipment for anaerobic digester (AD) plant installations.

Biogas represents a truly sustainable renewable energy source. The use of Biogas has grown exponentially in recent years, a trend that is no doubt set to continue as the background market conditions, including increasingly scarce and expensive fossil fuels, drive the profitability of this renewable alternative. Generally used as a direct fuel source for power generation, Biogas can also be used as a provision of thermal energy either directly at the point of generation or increasingly as feedstock into a wider gas network grid.

What is Biogas?

Biogas refers to the gas produced when organic material (such as food waste, crops or animal slurries) decomposes in the absence of Oxygen, such as in an anaerobic digester or landfill facility (commonly called landfill gas), and typically containing around 60% Methane (CH_4) and 40% Carbon Dioxide (CO_2) with some other trace gases such as Oxygen (O_2), Hydrogen Sulphide (H_2S) and moisture. The exact composition of the gas will vary depending on a wide range of factors.

Organic matter decomposing in aerobic conditions (i.e. in the presence of Oxygen) will not produce Methane, just Carbon Dioxide, which is well known for being a harmful greenhouse gas. While Methane is twenty times more powerful as a greenhouse gas, by producing it through a controlled anaerobic digestion process, it allows it to be captured and put to good use.

Biogas can be used in a variety of ways including:

- It can be burned in a Biogas boiler to create heat.
- It can be combusted in a Combined Heat and Power (CHP) engine to create electricity and heat.
- It can be 'scrubbed' of CO_2 and other trace gases and then either:
  - Injected into the gas distribution network as Bio-Methane (Bio-Methane to Grid = BtG)
  - Compressed and used as a vehicle fuel.

All of these uses displace the need for fossil fuels and commonly attract government incentives. Examples include:

Feed-in Tariff (FIT), Renewable Obligation Certificates (ROCs), Renewable Heat Incentive (RHI), Renewable Transport Fuel Obligation (RTFO) and Levy Exemption Certificates (LECs).

In summary, Biogas produced from dedicated crops or unavoidable waste sources is a truly sustainable renewable energy.

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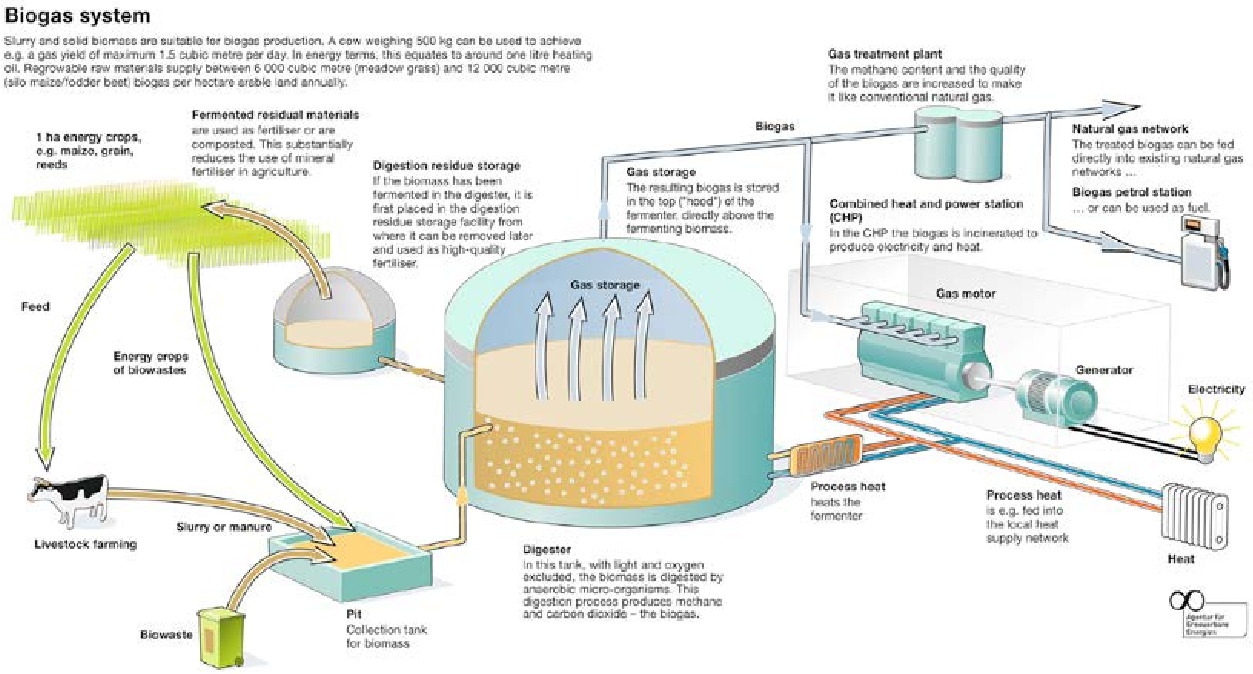


How does it work?

A Biogas plant requires daily support and control as it has a sensitive biological process at its core, with the plant's performance closely tied to wide range of factors including the type of feedstock being used, the operating temperature, residence time and the rate of mixing of the substrate.

The Biogas production process consists of a number of key steps including, Fermentation, Processing, Purification and Storage. The fermentation step is the heart of any Biogas plant where the majority of the Biogas is produced.
Most agricultural anaerobic digesters are tower-like constructions with capacities of at least 1000m^3, part of which is often constructed below ground.

Feedstock is pumped into the digester and this slurry of organic material is constantly agitated to ensure a homogeneous mixture. Over time, the bacteria inside will break down the organic material into Methane, Carbon Dioxide and the other gases. Typically operating at temperatures from 40°C - 70°C, an often overlooked bi-product of this process is the spent slurry mixture or digestate; which after being removed from the digester can be used as a high quality organic fertilizer being rich in both phosphates and nitrates. After leaving the digester, the Biogas is then passed through condensers, knock-out pots and a series of filters to remove any remaining moisture and particulates.

Depending on the feedstock, the raw Biogas is often passed onto the desulphurisation unit. The Hydrogen Sulphide H_2S content is usually reduced in agricultural feedstock plants by injecting up to 5% air into the gas flow to cause oxidation of the H_2S into solid Sulphur. In co-fermenter units, H_2S can occur in considerably higher concentrations (up to 5000 ppm). In these instances, Ferric Chloride $FeCl_3$ is often used to react with the Hydrogen Sulphide H_2S. In both cases, the H_2S concentrations needs to be monitored closely to control and optimize the process.

From here the Biogas is either converted directly into electricity in a Combined Heat and Power (CHP) plant or further processed for injection back into the municipal network for later use. The quality of the Biogas produced will determine how much energy it can generate; with the Methane concentration being directly linked to the efficiency of the CHP process. An increase of around 5% Methane concentration would lead to an increase in the generated electrical power of around 10%.

Power generation by Biogas is possible not only in large plants, but also on a smaller scale where the electrical power is produced by generators driven by special Biogas fuelled engines. For the safe operation of these engines, the proportions of Methane, Oxygen and Carbon Dioxide must be measured.

The Sulphur in the Biogas damages the gas-fuelled engines as it forms sediment in the engine oil. By continually measuring the H_2S content, the oil change cycle can be optimised which, in turn represents a significant reduction in costs. Over time, Sulphur deposits can accumulate in the cylinder heads and if the concentrations are high enough, even the valve seats can become damaged resulting in considerable repair costs. The manufacturers of the gas engines demand upper limit values for the H_2S concentration of between 100 and 1000 ppm, with these values being subject to a downward trend. Presently most gas engine manufacturers will only guarantee their proper function if continuous proof can be provided that the H_2S limit has been observed.

In some installations, the gas can be fed back into the municipal gas network. In such cases, it is necessary to ensure that the Biogas meets the quality requirements. For corrosion prevention, Oxygen and Hydrogen content must be monitored. This is because of concerns of embrittlement of steel components by Hydrogen; as such the Hydrogen content must not exceed the specified limits. The purified Biogas is then piped via the gas network to the consumer where it can be used for power generation, heating purposes or as a fuel. In the rare event of a plant breakdown, gas can be flared off and / or stored in gas "bags" or "balloons" for later use.

Why measure your Biogas makeup?

It is important to understand the composition of your Biogas streams across the various stages in the production process for a number of key reasons:

CH_4

Methane Concentration Measurement - is the desired product, it is essential your plant maximises the percentage of CH_4 produced. With many installations being able to benefit from Government backed incentives, it is often essential to document and record the quality and composition of the Biogas being generated.

O_2

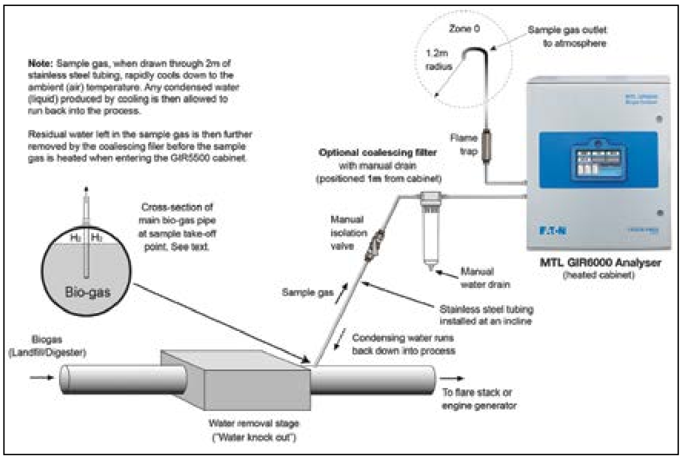
Oxygen Concentration Measurement - this is critical process indicator. Ensure you are not producing an inefficient or even explosive mixture of Methane and Oxygen gases. Increasing Oxygen levels could indicate performance issues leading to a decrease in microbial activity (poisoning) in the anaerobic digester or even air leaks into the system, both affecting productivity of the plant.

H_2S

Hydrogen Sulphide Concentration Measurement - this is a highly toxic and corrosive gas and it is essential its concentration be monitored. High levels of H_2S must be prevented as it is corrosive to engines and can condense and form Sulphuric Acid within the process resulting in large operational and maintenance costs. Most engines typically require less than 200ppm H_2S, but as the concentration can often rise well above this it is important to know when this is occurring so appropriate steps can be taken. Considerably more stringent requirements are applied to the feeding of gas into a network grid.

CO_2

Carbon Dioxide Measurement - In a similar way to the measurement of the Oxygen levelspresent, the Carbon Dioxide composition is a good indicator of the performance of the plant, ensuring that the anaerobic digester is operating efficiently. Rising CO_2 levels would indicate a drop in quality of the fuel being supplied to the Combined Heat and Power (CHP) generator.



How best to measure your Biogas?

Selecting the correct analyser to match your process requirements is only part of the solution. Ensuring your installation is configured correctly is critical to the accurate, reliable and trouble free operation of your plant.

Our experienced application specialists are available to offer technical support and assist in the design and development of tailored sample conditioning systems.

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What we offer?

Our MTL GIR6000 Biogas analyser has been developed with the specific requirements of Biogas applications in mind. Over the past 30 years we have worked closely with Plant Operators, Biogas OEMs and Gas Engine manufacturers alike to develop the latest generation of Biogas instruments. Reviewing the existing products and the issues associated with other competitor's analysers helped us develop the MTL GIR6000's feature set.

Key benefits we can offer include:

• A proven solution with over 30 years experience in manufacturing hazardous area equipment.

• Our unique sensor design utilises a hybrid combination of the latest specialised extra long-life galvanic cell and Infra-Red sensing technologies for optimum performance and durability.

• With our ATEX Zone 2 hazardous area rating, the instruments can be installed in the widest variety of locations. As global Biogas industry standards are increasingly moving towards a hazardous area rating by default, selecting our instruments ensures you will have the correct equipment installed should changes in the enforced safety standards be made.

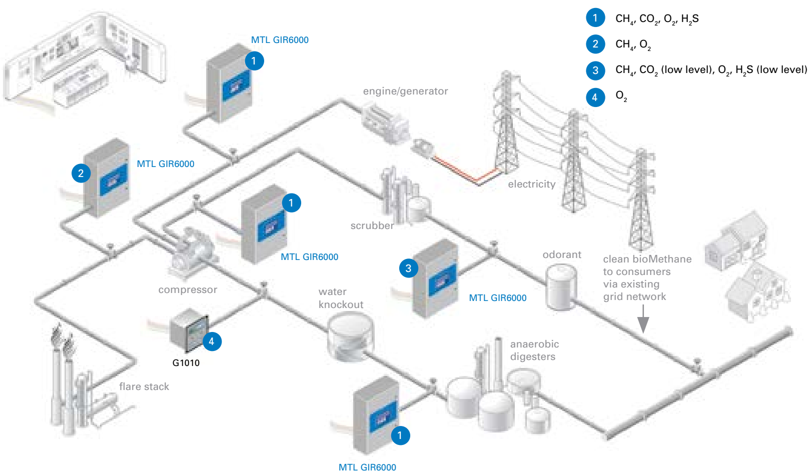
• Designed for continuous online sample measurement (not batch sampling), our analysers provide real-time process data.

• With no maintenance or consumable cell changes typically required within two year intervals, our analysers are designed for trouble free operation. To complement this, our sensor overhaul kits are readily available and competitively priced, making the cost of ownership significantly less than that of rival products.

• No hidden expensive service contracts required. Our instruments are designed specifically with simple onsite operation and maintenance in mind. Should you need any sensors or electronics to be changed, this can be easily performed on site, eliminating the need for the complete units to have to be sent back to the factory leading to lengthy downtimes and expensive overhauls.

• We offer an extensive range of Intrinsic Safety, Industrial Network, Visualisation and Surge Protection accessories to the Biogas industry to complement our range of gas analysers, all from the same supplier. Further, as industry experts, we can offer advice, guidance and training in all aspects of site hazardous areas safety.

• With our regional offices and global distributor network, we are well positioned to assist you and your customer needs wherever they may be.



We specialise in the manufacture of hazardous area (ATEX) certified MTL Biogas analysers, wireless communications and surge protection equipment for anaerobic digester (AD) plant installations.

We bring a wealth of knowledge and expertise alongside an enviable reputation as a leading global provider of Intrinsic Safety explosion protection devices and systems for use in process control applications. We have been an international manufacturer of fixed and portable gas analysers for over 30 years, supplying process industries with gas instruments for both safe and hazardous area applications. Instruments manufactured include portable, fixed and custom built analysers, complete with sample conditioning systems. For further details on this or any other of our products, please visit our website **www.mtl-inst.com**

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