Biogas in Europe

The development of biogas production and monitoring has had many twists and turns since its early days in Germany, and is now driven by the economic considerations of each varying application and country. Government incentives and generation of revenue for renewable energy, local infrastructure and the characteristics of waste are now key factors in biogas production, monitoring and use.

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Europe lends itself to biogas production because of the commercial incentives and feedstocks available. Processing of small and large scale agricultural and food waste along with sewage and waste water allows for production of organic matter which readily breaks down to produce methane-rich biogas.

Waste water treatment

Anaerobic digestion (AD) of waste water and sewage has been common in many countries for years but increasing energy costs now drive efficiency. In Turkey, at the $150m Antalya waste water plant, over 3,000,000m^3 of waste water are treated daily, with the biogas being used for a combined heat and power (CHP) engine. Similarly in the UK, at South West Water's Countess Wear Sewage Treatment, the gases produced from two anaerobic digesters fuel four 165kW CHP engines, which generate electricity and heat.

Since CHP projects are so common across Europe where there may be a lack of infrastructure or funding for complete upgrading systems, a rapid change in gas quality has potential to damage or increase the maintenance of the CHP engine being powered by raw biogas, so it is essential that the process is monitored frequently and is accurate and reliable.

Often controlled circuits in PLC systems receive signals for engine shutdown before any potential damage is caused by a fast-changing gas mix. Gas thresholds and trigger alarms are set and the engine is automatically shut down, with gas often diverted to flare. CHP systems are often totally dependent on gas analysis, with reliability and minimal downtime being essential.

Food and agricultural waste

Treatment of waste food and agricultural organic matter is a major source of raw biogas to energy throughout Europe, whether it is for CHP engines or biogas upgrading for use as a fuel or injection to grid. Many Eastern European projects have taken on processes which have been successful, with over 300 biogas upgrading facilities in Europe upgrading to grid or vehicle fuel. Most sites have either portable or fixed biogas monitoring systems. At one AD plant in Austria, organic household and garden waste is sorted, crushed and then digested in an anaerobic digester to produce biogas. The digestate is then processed, separated and screened to produce high-quality compost. The biogas produced is a valuable commodity and is monitored by a fixed biogas analyser to ensure the gas quality is correct for the CHP engines.

AD of agricultural waste, both small and large scale, is common across Europe. Many large agricultural processors install an AD plant to generate revenue and dispose of waste. This is usually from a single crop, such as potato in the UK. McCain Foods built a covered anaerobic treatment lagoon producing methane (CH_4) for burning from 77,000m^3 of waste water rich in potato starch. The lagoon's cover keeps out oxygen (O_2) and enables collection of CH_4 for burning in the CHP engine to produce electricity. Monitoring the process with a fixed biogas analyser


Waste water treatment plant in Turkey

enables McCain to ensure the protection of their CHP engine from dangerous hydrogen sulphide (H_2S) levels, which can corrode internal components.

The time taken for complete digestion to take place varies between feedstocks, as does the gas mix produced. Whilst the bulk gases of raw biogas are CH_4, usually 50-60% and carbon dioxide (CO_2), usually 30-40%, two other critical gases are H_2S and O_2.

Dealing with H_2S

H_2S is a challenge in biogas, as it readily forms sulphuric acid and causes extensive damage to the expensive engines used to generate electrical power by burning biogas. Whilst the boilers used to create heat for use on site may be more tolerant of H_2S, the turbines that may be used to generate power on smaller sites have limits for H_2S content in biogas, and biogas that is purified for compressed natural gas (CNG) must normally contain no more than 50ppm of H_2S.

H_2S is a toxic and corrosive gas and monitoring levels can be as challenging as removing it. The portable equipment used to 'spot check' gas levels is only exposed to small amounts of the gas, so


South West Water's Countess Wear Sewage Treatment

sensors generally have a long life. However, the increasingly popular fixed monitoring systems which communicate directly with site control systems, such as SCADA systems, must be correctly set up to ensure a reasonable sensor life. In addition, H_2S calibration gas, which is important to fine-tune and verify measurements at the low levels required, can be expensive, complicated, or even impossible to get to where it is required. As a result, pre-calibrated sensors or cross-checking with a portable analyser which has been calibrated elsewhere offer practical solutions to this problem.

Incoming H_2S in biogas will vary according to the process and feedstock and can be anything up to 3,000ppm in a municipal sludge plant, but may also be in tens of thousands for industrial or food related AD systems. At these levels, rather than monitoring H_2S in raw biogas, the challenge is to remove the H_2S effectively and monitor that it has been removed. Alarms are set to indicate any sudden increases which should shut down vulnerable equipment.

Many proven H_2S desulphurisation methods are used across Europe such as chemical scrubbing, biological or down flow systems. Biological H_2S scrubbers are commonly used as they are cheaper to run and maintain than chemical scrubbers, which require frequent replacement of expensive chemicals. As well as checking H_2S levels, gas monitoring systems must also measure O_2 in the biogas. Whilst a healthy biogas process will produce very little (close to zero) O_2, a leak which allows air into the system can prove catastrophic for an engine. In addition, biological scrubbers can introduce small amounts of O_2, particularly if following maintenance. Many biogas sites set a tolerance level of 0.5-1% O_2 with alarms set if this figure is exceeded. A reliable O_2 sensor is critical and the system must be carefully set up and managed to ensure long-term performance.

Maintenance

Often an appropriate level of maintenance is difficult to achieve on many sites, due to the availability of trained staff or the remote location and need for minimal downtime. The best fixed gas monitoring systems take this into consideration and require little on-site maintenance, from changing parts to calibration or management of the moisture, which is an unwelcome feature of biogas from many common feedstocks. Whilst complex gas chilling systems sound appealing and can reduce the humidity of biogas when working well, they are fragile, expensive and often require high maintenance and spare parts. Good monitoring system design and passive moisture removal offer a cheaper and ultimately more effective solution.

McCain's lagoon in the UK

Using biogas

In Europe biogas is generally burned in CHP engines to generate electricity, which can feed into the grid and can earn a considerable income for the operator, dependent on the kW/hr of power generated and the financial incentive offered for each unit of renewable energy from the national government. This model also exists in farther Eastern continents, but it is dependent on the site being of a scale to justify the capital expenditure and also local power infrastructure: if the nearest point of the electricity grid is far away, the cost of creating a connection could be prohibitive.

A popular model is to upgrade the biogas from 50-60% CH_4 to over 95% to produce CNG. The gas composition requirements vary between application and country, with limits for use in motor vehicles being more relaxed than for injection to the gas grid. As well as checking that CH_4 is consistently around 97-98%, it is also important to keep H_2S and O_2 levels very low. A good monitoring system can also manage the higher pressures involved in biogas upgrading through carefully positioned pressure regulators.

Biogas from landfill

Municipal waste is managed differently throughout Europe, depending on availability of land, government policy and incentives, public opinion, historical legacy and budgets. A well-managed landfill site will also yield high quality biogas in large volumes. As with biogas, some sites do not lend themselves to electricity generation, or for other reasons may find a better business case for generating CNG from landfill gas.

Many monitoring solutions are available for the wide range of biogas applications around the world, whether it is a fixed system installed to protect a CHP engine, or a portable analyser for spot checking gas levels throughout the AD process. A regular monitoring routine will assist with process efficiency and protect against potential damage, ultimately saving time and generating revenue.

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