Biogas in Asia

The development of biogas production and monitoring has had many twists and turns, from its early days in Germany to the heady days of support through the Clean Development Mechanism (CDM). The fall in the price of carbon credits, which rewarded reduction in emissions of methane (CH_4) – a potent greenhouse gas - and use of methane from waste as renewable energy, has hit Asia particularly hard. As a result, biogas plants now have to be built and operated based on a convincing business case.

> *"Whilst countries across Asia take different approaches to waste management, and the picture is often changing fast in an individual country, all are taking steps towards better use of land and resources, whilst managing local and global pollution."*

Biogas production has now become more driven by the economic factors of each application and country. Government incentives for renewable energy, local infrastructure and the characteristics of waste are now more likely to be key factors in biogas production, monitoring and use.

Booming in Asia

Asia lends itself to biogas production because of the climate and feedstocks available. Processing of large-scale crops such as palm oil, sugar and cassava produce large amounts of waste water heavy with organic matter which readily breaks down to produce methane-rich biogas.

Palm oil waste water lagoon & digesters in Malaysia

Large scale palm oil production is a major source of biogas from palm oil mill effluent (POME), as well as sugar and cassava processing. Malaysia, Thailand and Indonesia are key territories with over 1,000 anaerobic digestion (AD) plants in Thailand alone. Most sites have either portable or fixed biogas monitoring systems, although the figure is lower for sugar plants as they operate for a 4-month season.

The most efficient plants reduce the space wasted by open lagoons of waste water and pollution (both on the site and as greenhouse gas emissions) by covering lagoons and moving waste water swiftly into digesters. The time taken for complete digestion to take place varies between feedstocks, as does the gas mix produced. Whilst the 'bulk gases' of biogas are CH_4, usually 50-60% and carbon monoxide (CO_2), usually 30-40%, two other critical gases are hydrogen sulphide (H_2S) and oxygen (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 or 'gensets' 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 also state limits for H_2S content in biogas and biogas that is purified for 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 are only exposed to small amounts of the gas, so sensors generally have a long life. However, the increasingly popular fixed monitoring systems which communicate directly with site control systems (SCADA) must be correctly set up to ensure a reasonable sensor life. In addition, H_2S calibration gas, which is important to fine-tune 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.

Waste from sugar processing – taking place on a large scale in India in particular - produces particularly high levels of H_2S. Raw biogas often carries percentage levels (figures up to 4% are quoted), rather than ppm. At this level, 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.

Cassava feedstock in Vietnam

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Eco Energy's CNG station in Korea

Biological H_2S scrubbers are commonly used in Asia as they are cheaper to run than chemical scrubbers, which require frequent replacement of expensive chemicals. As well as checking H_2S levels, gas monitoring systems must also measure oxygen (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 target 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

Unfortunately an appropriate level of maintenance is difficult to achieve on many sites, due to the availability of trained staff or the inaccessibility of sites (a typical palm oil site in Indonesia may be more than a day's travel by plane, boat or vehicle from the source of spare parts or expertise). 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 and often require high maintenance and spare parts. Good monitoring system design and passive moisture removal offer a cheaper and ultimately more effective solution.

Using biogas

In Europe biogas is generally burned in engines to generate electricity, which feeds into the grid and can earn a considerable income for the operator, dependent on the KWh of power generated and the financial incentive offered for each unit of renewable energy from the national government. This model also exists in Asia, but it is dependent on the site being of a scale to justify the capital expenditure on 'gensets' 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 in Asia, which works in many scenarios, is to upgrade the biogas from 50-60% methane to over 95% to produce compressed natural gas (CNG). The gas composition requirements vary between application and country, with limits for use in motor vehicles, commonly taxis, being more relaxed than for injection to the gas grid. As well as checking that methane is consistently around 97-98%, it is also important to keep H_2S and O_2 very low. A good monitoring system can also manage the higher pressures involved in biogas upgrading, through carefully positioned regulators.

Geotech biogas analyser showing CH_4 upgraded from 66% to 98%

Palm oil – a major feedstock in Malaysia

A team at Ho Chi Minh University of Technology has carried out research into biogas generation by farmers in remote locations. The target is to improve the quality of biogas through adjustments in the anaerobic digestion process. A 10% uplift has so far been measured using their portable biogas analyser supplied by the Japan International Cooperation Agency (JICA): 75% methane is considered acceptable but 85% is the target for CNG. The scheme is being promoted by local government to protect the environment, as waste from pigs would otherwise cause pollution. 160,000 households are using the gas and a 20kW engine, receiving waste from 500 pigs, generates electricity, attracting a renewable energy subsidy from the Vietnam government.

Biogas from landfill and sewage

Municipal waste is managed differently across Asia, 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. For example, a site in Seoul that is owned and managed by EcoEnergy generates 50MW of power from landfill gas. 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. Another nearby site in Seoul combines a vehicle fuel filling station with a sewage processing plant. 5000m^3 an hour of raw biogas is upgraded to produce nearly 3,000m^3 an hour of CNG, which is sold primarily to taxi drivers.

Whilst sewage or human waste has historically been the most popular source of biogas in the UK, at least in terms of volume, it is much less common in Asia. Often this is a result of state, rather commercial, management of sewage processing. But sewage is a rich source of biogas, sewage processing can be extremely energy-intensive and it is reasonable to expect this to be a growth area across the region.

Much municipal waste in urban areas of China is now incinerated, but biogas from smaller or remote landfill sites, as well as the many large pig farms, is commonly used to produce CNG.

Whilst countries across Asia take different approaches to waste management, and the picture is often changing fast in an individual country, all are taking steps towards better use of land and resources, whilst managing local and global pollution. Landfill sites in Indonesia face challenges from the high rainfall but the government is investing in landfill site development and installation of the first biogas monitoring systems. Geotech is pleased to be working both at the forefront of development in countries such as Indonesia and Vietnam, as well as working with partners to refine technology in the many parts of Asia where biogas production and monitoring has become a core part of waste management strategy and sound commercial sense.

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