CATTLE MANURE

Energy from anaerobic digestion

Perhaps one of the more notable aspects of cattle manure digestion is the range of potential biogas production figures that may be achieved from this apparently similar substrate. As well as a wide variety of differing breeds, with different rates of manure production, different moisture contents and different volatile solids composition, there are also local factors within waste arisings that impact biogas productivity. These include the type of bedding employed, the method of collection of the manure, the extent of dilution during collection, the time between formation and use in an anaerobic digester and last, but not least, the diet of the cattle and the extent of feeding.

It is, therefore, either a question of carrying out site-specific waste stream analysis and testing, including the all-important Biochemical Methane Potential (BMP) test, or accepting that performance results may be unpredictable within a range of possibilities.

It is for this reason that it is a standard Organics' recommendation that a Front-End Feasibility Study (FEFS) is performed on a cattle manure waste stream, rather than accepting an estimate of performance, even contractually defined, which risks being wrong. It is in no-one's interest that an investment designed to last over twenty years is found to under-perform.

An FEFS would consist of a full characterisation of the manure production and disposal cycle. This may be summarised as: (1) the quantity and quality of production over time, (2) the method of management of the waste stream, including the time between formation and its availability for use in an anaerobic digester, and (3) the methane productivity potential, established by comprehensive BMP testing. It may be, for example, that changes in the method of management can increase bio-methane production potential.

Once the FEFS has been completed there will be a sound basis in place for the engineering design, construction and commissioning of facility which will meet performance expectations.

Organics

COMPONENTS INVOLVED IN A WASTE-TO- ENERGY SYSTEM USING CATTLE MANURE

Feed preparation

Front-end processing

Anaerobic digester

Ammonia control

Biogas pumping equipment

Biogas dewatering

Biogas clean-up

Instrumentation systems

Burners and/or power generation equipment

All of the above items are available directly from Organics using project-proven proprietary technology

ISO 9001 REGISTERED FIRM

ENVIRONMENTAL MANAGEMENT SYSTEM ISO 14001

CE

PROJECT ROUTE

Organics has developed a project delivery structure for anaerobic digestion projects over many years that ensures reliable completion and quality control whilst maintaining specification requirements, and time-schedules.

WASTE STREAM CHARACTERISATION

Waste stream characterisation involves two primary subject areas: (1) rate of waste arisings; (2) analysis of waste received. The first is achieved with a sampling campaign, the secondd with lab analyses and BMP testing.

SITE ASSESSMENT AND SPECIFICATION

Establishing a clear statement of the practiical design parameters is the first step determining scope. This will require a detailed study of each specific situation.

DESIGN

Each project is designed as a unique entity to ensure that all details are fully addressed.

PROCUREMENT

The procurement function takes full responsibility for maintaining delivery schedules. Their remit is from drawings and component specification through to all parts ready for final fit-out and commissioning.

MANUFACTURE

Manufacture may either be completed to “good engineering practice” or, where specifically requested, under the supervision of a Third Party Inspector, such as Lloyds.

INSTALLATION

Installation can be a complex process and requires careful planning.

COMMISSION AND HANDOVER

Established procedures are followed to ensure that equipment is fully operational at the point of handover.

ANAEROBIC DIGESTION

Anaerobic digestion involves the breakdown of organic waste by bacteria in an oxygen-free environment. It is commonly used as a waste treatment process but also produces a methane-rich biogas which can be used to generate heat and/or electricity.

Anaerobic digestion equipment consists, in simple terms, of an anaerobic reactor volume, a gas holder to store the biogas, and a gas-burning engine/generator set, if electricity is to be produced. Alternatively, biogas may be used to fire a boiler or to power converted spark-ignition vehicle engines. Organic waste is broken down in an anaerobic digester with up to 95% of the biodegradable organic content being converted into biogas. The rate of breakdown depends on the nature of the waste, the reactor design and the operating temperature. Biogas has a calorific value of typically between 50% and 70% that of natural gas and can be combusted directly in modified natural gas boilers or used to run internal combustion engines.

Organics offers a number of anaerobic digestion systems suitable for varying feedstocks and specific operating conditions.

The process of anaerobic digestion (AD) consists of three steps:

The first step is the decomposition (hydrolysis) of plant or animal matter. This step breaks down the organic material to usable-sized molecules such as sugar.

The second step is the conversion of decomposed matter to organic acids.

Finally, the acids are converted to methane gas.

Process temperature affects the rate of digestion. Usually it will be maintained in the mesophilic range (30°C to 35°C - 86°F to 95°F). At higher temperatures the process requires a greater degree of attendance and understanding.

HYDROGEN SULPHIDE REMOVAL

It is essential to remove hydrogen sulphide for all activities other than direct flaring of biogas. Hydrogen sulphide can combine with water to form sulphuric acid, which is highly corrosive to engines, burners and all steel surfaces.

Determining the correct capacity-specification for hydrogen sulphide removal equipment is an important part of project specification. It is too easy to accept a low default level only to find out that it is too low and the equipment installed on site needs to be upgraded. Such increases in capacity can be costly and certainly more expensive than if the correct capacity were installed in the first place.

Generally, effluent from cassava root processing can be expected to produce hydrogen sulphide concentrations in biogas of between 1,000 to 2,500 ppm (mass). Palm oil mill effluent should normally be rated at 5,000 ppm and cattle manure at 4,000 ppm. However, each waste streami s unique and care must be taken to properly define hydrogen sulphide composition.

Organics normally recommends a bio-scrubber for this application. The bio-scrubber is easy to operate. requires no chemical additions and no special equipment. The bacteria involved are ubiquitous and can be produced anywhere. The great advantage in SE Asia is that ambient temperatures are such that external heating is not a requirement. However, heating can be managed as a standard add-on.

It is important at an early stage in the project design to determine from where the bio-scrubber make-up liquids will originate. The bio-scrubbing process requires that bacteria are kept moist. Excessively acidic liquors are removed and made up with nutrient rich wastewater. Such a feed can often be obtained on site from the AD facility effluent.

FLARING

Successful and safe flaring may no longer be considered an activity for the enthusiast or layman. There are a great many detailed regulations which must be adhered to in their entirety in order for safety and environmental concerns to be fully addressed. For example, the whole industry has been shaken by the rigorous depth of audits into data recording and record-keeping required by Designated Operational Entities under CDM protocols. Cutting corners and saving money in the face of such high standards can only be seen as a quick route to losing revenues.

Organics has worked on many biogas projects in SE Asia, China, South Africa and South America. The company has extensive experience in discussing detailed standards and results with both Regulators, Validators and Verifiers. Against this background Organics is confidently able to provide systems which will meet the applicable standards.

Instrumentation

The heart of the recording process is contained within the instrumentation used to record the destruction of greenhouse gases. Every project must be treated as unique and understood in its entirety in order to design the instrumentation system. Certain elements, such as flow recording protocols, may be similar but the overall quality of data recording and data integrity must be high. It is only to be expected that standards will continue to increase and become more demanding.

Instrumentation is a fundamental element in a successful project.

BIOGAS UTILISATION

Biogas may be used in several ways to generate both energy and carbon credits. Where methane is destroyed and fossil fuel is offset carbon credits will also be available.

The simplest route for biogas utilisation is to pipe gas to a boiler or a kiln. As with all green-house destruction, it is essential that the actual destruction of methane is proven beyond any doubt.

Should such an option not be available at a specific location, as is often the case at tapioca mills, the next option is to generate electrical energy, either for in-house use or for sale to the national electricity grid. In either case, the electricity produced should preferably be used to offset fossil fuel electricity, such as power from diesel engines, rather than power generated by means of clean biomass.

One further option is that of converting biogas into bio-methane. This involves the removal of carbon dioxide from biogas and the compression of the balance-methane to approximately 3000 psig. This technology draws upon global experience with CNG in vehicles. Compressed Bio-Methane (CBM) may be suitable for vehicle use and creation of carbon credits but careful attention must be paid to the problem of destruction-verification. Simply put, it is difficult to prove methane destruction in a vehicle that is travelling around.

As with anaerobic digestion, each technology has its own optimum point of application. The decision as to which route to take is a function of cost, opportunity, technology and practicality. Organics can assist in such decisions from a perspective of knowledge, experience and familiarity with all relevant costs.

KEY FEATURES

FRONT-END FEASIBILITY STUDIES, INCLUDING BIOCHEMICAL METHANE POTENTIAL (BMP) TESTING

TURNKEY DESIGN, MANUFACTURE AND INSTALLATION OR COMPONENT SUPPLY ONLY

FINANCE AVAILABLE THROUGH AFFILIATED COMPANIES FOR BUILD, OWN, OPERATE AND TRANSFER PROJECTS

OPERATION AND MAINTENANCE SERVICES PROVIDED

A ONE-STOP SOLUTION FOR A COMPLETE

The objectives of a project designed to recover energy from cassava processing waste are:

- The installation of an anaerobic digester which will generate and capture waste gases currently produced from the factory's treatment lagoons
- Reduction of odours and harnessing energy in the form of methane
- Generation of renewable electricity to offset the use of fossil-fuels
- Improvement of factory wastewater treatment
- Where applicable, reduction of greenhouse gas emissions and creation of Certified Emission Reductions (CERs) by reducing greenhouse gas emissions

Organics is equipped to supply individual components within a complete system or all of the components required to make up a complete system. Organics has been active in this sector in SE Asia since 2002 and has a wide experience with all elements of such systems, from equipment design, instrumentation set-up for CDM compliance and CDM compliant gas flaring to gas production technologies as well as energy generation using engines operating with biogas.

CATTLE MANURE

There are several different methods of animal housing and manure collection. These may be grouped into four different types:

Solid manure: Defined as manure with a solids content of greater than 20%. Such manure which is aged before collection or has been left out in the field where it is deposited and allowed to dry out may not be suitable for anaerobic digestion. The organic biogas forming carbon content may have been substantially lost. However, if it is collected regularly it may still be viable.

Semi-solid manure: Defined as a manure with a solids content of 10-20%. Such manure is typically scraped. Water is not added to the manure and the manure may be stored until it is spread on local fields. Fresh scraped manure may be used for biogas and energy production.

Slurry manure: This manure will have been diluted to a solids content of 5-10%. It is usually collected using mechanical methods. It can be pumped and is often treated or stored in tanks, ponds, or lagoons. It can normally be used for biogas production.

Liquid manure: This manure is typically flushed from where it is generated to produce a liquor with a solids content of less than 5%. This manure may be pumped to treatment and storage tanks, ponds, or lagoons. It can be used for biogas production.

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BMP TESTING

A BMP test, or Biochecmical Methane Potential test, is a laboratory-scale test conducted under ideal conditions. The BMP test subjects feedstock samples to an anaerobic environment and empirically measures the material's biogas production.

BMP test results should determine the optimal biogas production rate, the methane and hydrogen sulphate content of the biogas, the total volatile solids that is converted to biogas, and the COD/BOD reduction in the digester.

It should be noted that BMP tests are conducted under ideal conditions, requiring results to be adjusted to actual field conditions. Actual biogas production will normally be less than that measured by a BMP.

Anaerobic digesters can use single or multiple feedstocks. Digesters that co-digest manure with other feedstocks (e.g. fats, oils & grease, food wastes, cheese or wine wastes, etc) can increase biogas production. Additional pre-processing equipment and holding tanks may be required for codigesting.

Codigestion can also increase the amount of nutrients in the effluent, so farms considering co-digestion should ensure that they will still comply with their nutrient management plans.

Co-digesting various feedstocks will require a BMP test to assess biogas production, as well as compatibility. Tests from each individual feedstock will not accurately determine the BMP for the final, co-digested feedstock blend. Once a feedstock blend has been identified and its relative volumes established, it is best to create a composite sample and perform a composite BMP test. By use of BMP testing, it is also possible to identify major issues, such as poisoning with antibiotics, which may have a detrimental impact on anticipated revenues.

TYPE OF DIGESTER

There are several choices of digester suitable for cattle manure. These range from the plug-flow covered lagoon to the continuously stirred tank reactor (CSTR).

The simple plug-flow arrangement has the advantage of lower costs, but temperature control is generally more difficult to maintain, should this be required. The CSTR itself comes in various forms with differeing attributes for differing environments. The primary requirements of a CSTR are to maintain stable conditions whilst providing optimised mixing.

Organics will match the requirements of each situation to the optimum technology on a case-by-case basis. There are no universal solutions. Each site is different, and it is important to recognise the differences and how they will impact on long term, viable biogas production.