Let's Solve Water

Case study
Biological treatment • SBR

Managing Efficiency & Preventing Failure within AD Biogas Production

USING REAL-TIME ANALYSIS OF BMP & FOS/TAC

As more and more governments across the globe look to sustainable energy sources in an attempt to reduce carbon emissions, many are turning to the process of Anaerobic Digestion as part of their green energy strategy to compliment already existing solar and wind turbine programs.

Anaerobic Digestion (AD) is the process of microbial breakdown of biomass (the fuel) that, once ongoing, produces a viable source of methane rich biogas (the energy) that can be used as a direct fuel for transport (ref.: Anglian Bus Ltd. and Reading Transport Ltd.), as a heat source, or for generating electricity for local or even national consumption when connected to the grid.

Wastewater sludge currently provides the largest proportion of feedstock to the UK's AD Biogas industry with over 300 plants making up to 70% of the total biogas market; split 50/50 gas vs. electricity output (source: ADBA 2016).

Fig. 1: After wastewater sludge, both pastoral and arable farms contribute significantly to biogas feedstock supplies in the United Kingdom.

> "With over 400 Anaerobic Digestion plants operating in the UK alone, Biogas is now becoming a key part of our green energy solution."

However, as more local authorities introduce household food waste collection, a significant increase in organic AD Biogas production at local waste sites has been seen over the past few years, which is set to rise further as landfill sites become more scarce across the country and around the World. Additionally, schools, restaurants, supermarkets and food manufacturers including Coca-Cola, Heineken, Nestle, BV Dairy, (source: ADBA 2015 Annual Report) are also taking advantage of turning organic waste or spoiled product in to energy in an attempt to generate income and reduce disposal costs by installing AD plant at major sites. In fact, the sugar industry has always made good use of its waste by burning leftover cane or beet husks (bagasse) as fuel for electricity after the sugar juice extraction process but is now also adopting AD as a viable means of energy production.

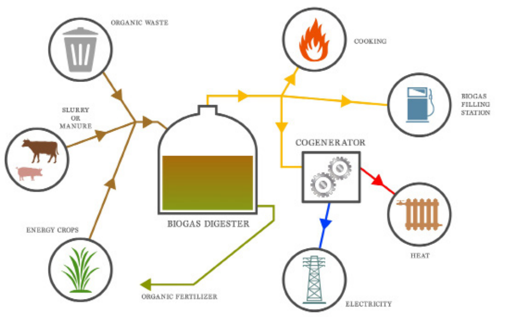

Fig. 2: Schematic of a typical AD Biogas plant showing the various feedstock used to produce green energy in the form of heat, biomethane and electricity.

Lab Solutions

Nevertheless it is farming that is the second largest feedstock contributor currently within the UK. Of course manure is prevalent throughout pastoral farming but notwithstanding, it is arable farming that contributes significantly to biomass stock, whether in the form of spoiled fruit and vegetables or (more so) from wheat crops such as maize that is deliberately grown as fuel. In fact, 17% of the maize crop grown in the United Kingdom in 2014 was destined for biogas production (source: ADBA 2015 Annual Report).

Many more AD Biogas plants - large and small - are being commissioned right across the globe thanks to a variety of feedstocks available, and local and national government incentives to encourage sustainable low carbon self-sufficient energy production.

Fig. 3: The pHotoFlex TURB is capable of providing pH, COD, turbidity and ammonia readings from a single handheld meter.

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It is important, however, to adopt proper control if biogas production is not to have a negative effect on the environment and ecosystems that feeds and surrounds it. Waterways and catchment ponds may become depleted or contaminated; ecosystems may be damaged through farmland expansion. Regulations and ongoing monitoring must therefore play an important role in the AD Biogas infrastructure.

Although it has been commonplace for small sized AD Biogas installations to use external contract laboratories for analytical assessment, many are now recognising that on-site monitoring of basic parameters has real-time benefits.

Fig. 4: SI Analytics TitroLine® 5000 auto-titrator with integral FOS/TAC method provides a simple means of monitoring a fermenter's stability so that catastrophic failure may be avoided.

COD and ammonia measurement made simple:

Instruments such as the WTW® pHotoFlex® TURB handheld photometer can not only provide an array of photometric data such as COD and ammonia for waterways and pond analysis but it also has the ability to measure pH and turbidity on a single meter. Meanwhile, the WTW photoLab® series of spectrophotometers offer additional methods and extended compatibility with tests kits for use within the laboratory. Multi-tube thermo-reactors are also essential for determinations of COD and total Nitrogen which require sample digestion prior to analysis.

Although the pHotoFlex offers great versatility for monitoring both process and environmental parameters, without doubt the most important measurement within the process itself is the FOS/TAC or alkalinity ratio; an ongoing indicator of the bio-fermenters stability based on Volatile Fatty Acids content (FOS) and buffer capacity (TAC) that prevents acidification in the reactor.

Real-time measurement of reactor alkalinity:

FOS/TAC is simply achieved by wet chemistry titration (ref.: Mc Ghee-1968 & Nordmann-1977) however, for relatively little investment, the SI Analytics TitroLine® 5000 auto-titrator, with built in FOS/TAC method and burette, provides daily analysis of how the fermentation plant is performing. Daily monitoring is the key to preventing plant underperformance due to an imbalance of feedstock load; which in a worst case scenario, may dictate that the whole process must be restarted at great expense in terms of time and lost biogas production.

Another method of optimising the performance of a biogas plant is by monitoring the bio-methane potential (BMP) of the variant feedstock samples under similar conditions to that of the fermenter (pH, temperature, pressure) over a period of 21 to 28 days using an OxiTop® Control respiratory system. Such monitoring emulates the fermentation process and as such provides data for process control.

Uniquely, the OxiTop® IDS/B measuring heads are specifically designed for the biogas industry due to their ability to withstand corrosion caused by hydrogen sulphide.

Fig. 5: OxiTop® measuring heads are specifically designed to withstand corrosive hydrogen sulphide gases and provide a means of emulating the fermenter's performance.

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"Daily monitoring is the key to preventing plant underperformance due to an imbalance of feedstock load."

There are of course many other parameters that could be measured including redox (ORP) potential, pH, temperature, turbidity, Dissolved Oxygen & Conductivity either in the process as an on-line measurement, in the field as a "grab sample," or in the environment surrounding the AD Biogas installation.

FOS/TAC measurement is the key to success:

It goes without saying though, that plant continuation represents the most important in terms of yield and profit as, if the bio-reaction fails, the costs and time involved to restart will not only have a detrimental effect on that particular fermentation, it will also directly affect the entire site's overall profit generated during any other active run. As such, continuous measuring of FOS/TAC is the most important measurement to be considered for local analysis at the biogas plant.

Fig. 6: Measure three parameters simultaneously with the digital pocket meter Multi 3630 IDS.

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