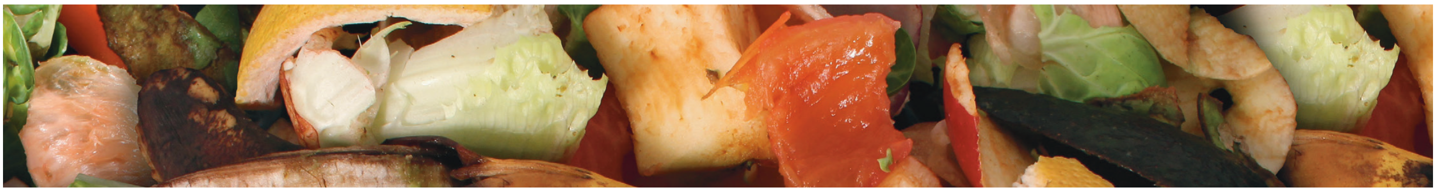
Understanding the make-up of your biomethane is crucial to a successful operation, writes UK infrastructure optimisation firm, Camlin Energy

Do you really know what is in your biomethane?



The use of municipal, agriculture, wastewater and other waste feedstocks to produce biogas is rapidly expanding as companies and governments aim to achieve their targets for reducing greenhouse gas (GHG) emissions. Methane is a considerably more potent GHG than CO_2 and the potential benefits from using waste feedstocks for biogas production to prevent methane emissions that would otherwise result from its natural decomposition is self-evident.

Many tariff and support mechanisms strongly incentivise and reward the use of waste over other feedstocks such as energy crops. In the UK, the Department for Business, Energy and Industrial Strategy introduced 'feedstock restrictions' to the Renewable Heat Incentive (RHI) in 2018, requiring that new applicants must generate at least 50% of their biomethane from waste or residue feedstock to receive RHI payments. This requirement has been carried over to the new Green Gas Support Scheme (GGSS) announced in March 2021, meaning that new plants must use waste as their primary feedstock to be eligible for support under the scheme. Furthermore, the Department for Environment, Food and Rural Affairs is aiming to introduce government policies that every household and business in England has a separate collection for food waste from 2023. These shifts in regulations show a clear trend towards the increased use of waste feedstocks in biogas production.

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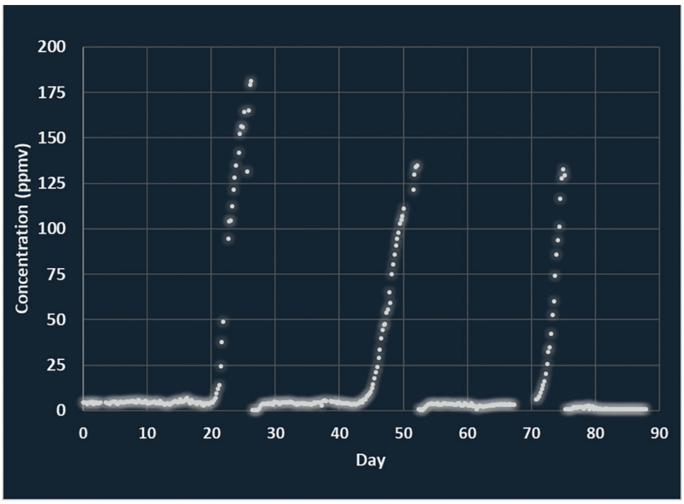


Figure 1. The measurement of MEK (2-butanone) after the activated carbon filter for VOC removal in a food waste biomethane plant. Using online monitoring technologies, the concentration of MEK (and other VOCs) was measured every few hours. Breakthrough occurred three times during these 90 days with the activated carbon media being replaced within a few days of the activated carbon beginning to saturate

Biogas produced from waste, particularly food and municipal waste, contains a plethora of volatile organic compounds (VOCs) and other contaminants that are not normally seen in energy crop biogas. For example, vegetables, fruits, garden waste and some agricultural wastes produce VOCs in the biogas such as p-cymene, d-limonene and pinenes that are typically present at concentrations from tens to hundreds of parts per million by volume (ppmv). At these concentrations, unless properly managed, VOC contaminants can have significant detrimental impacts, especially in those plants upgrading the biogas to biomethane, leading to increased operational costs, plant downtime and lost revenues.

For example, VOCs can reduce the efficiency in pressure swing adsorption and separation membrane upgrading systems. In extreme cases, the damage caused to membranes could result in the need to replace the membranes at a considerable cost (and often outside warranty if the gas specification of the membrane supplier has not been complied with). Some VOC components in biogas derived from food waste have pungent odours that mask the smell of the odorant on gas networks even at low concentrations, presenting a safety and compliance risk for gas-to-grid projects.

Fortunately, the removal of VOCs is straightforward. Most commonly, adsorption by activated carbon is used to filter out the contaminants from the biogas before the upgrading process to safeguard the upgrading technology. While activated carbon is also commonly used to remove inorganics such as hydrogen sulphide, different types of activated carbon media are used for organic and inorganic components.

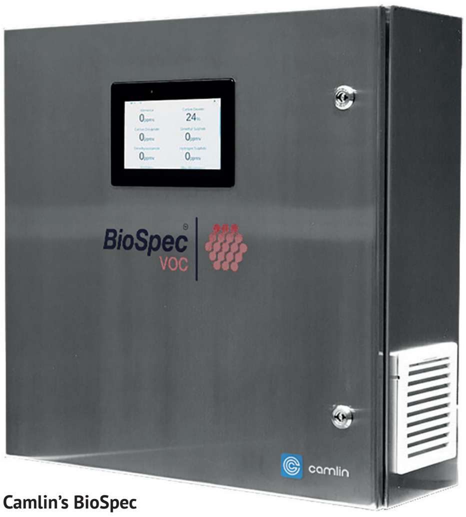
An activated carbon vessel can adsorb a certain amount of contaminants before it becomes saturated and needs to be replaced. Where feedstock is constant and homogenous, it is possible to calculate or determine when filters would need to be replaced. But this is not possible where the feedstock is partially or wholly waste. There can be significant variation in waste feedstock supplied from batch to batch, as well as broader seasonal variations, and hence a time-based approach to activated carbon filter replacement is not practical. Without knowing when filters are saturating, activated carbon would either be replaced before it is fully utilised thus increasing ongoing operational costs, or else be replaced too late after saturation has occurred and potential damage to upgrading equipment caused. It is, therefore, extremely beneficial to analyse the composition of the biogas across the biogas upgrading plant to validate the effectiveness of the treatment processes and determine the optimum point at which to replace the activated carbon filters.

While taking periodic gas samples and sending them to a laboratory for analysis is possible, the costs can become significant over time. Unless the sampling frequency is very high, there is a risk that saturation and contaminant breakthrough of the activated carbon filters happens between samples. Figure 1 shows how the saturation of activated carbon filters and subsequent breakthrough of the VOCs can be very rapid. Within a few days of starting to saturate, the filters are no longer adsorbing the contaminants and they are breaking through downstream in the plant. The breakthrough point varies slightly for different contaminants, with ketones such as MEK and acetone breaking through before larger terpene molecules.

Real-time monitoring technologies provide the accuracy and resolution of data necessary to enable timely decisions to be made by the biomethane plant operator. Initially, lab-based instruments such as gas chromatography were repurposed for field use, but are often cumbersome, prone to failure, costly to install and require gas consumables creating a significant ongoing operational cost.

Optical spectroscopy-based instruments are increasingly being viewed as the technology of choice for online monitoring of contaminants in biomethane plants. Each component in the gas has a unique spectral fingerprint and through optical spectroscopy, the type and concentration of each contaminant can be accurately measured. With appropriate product design, optical solutions do not require gas consumables, specialist servicing or recalibration. This overcomes many challenges of other technologies and reduces the cost of ownership. Furthermore, analysers that operate in the ultraviolet portion of the optical spectrum are ideal as they avoid the main absorption features of methane and CO_2, enabling VOCs and other contaminants (such as hydrogen sulphide and ammonia) to be readily measured to sub-ppmv concentration levels.

Knowing what is in the biomethane is vital to the efficiency and uptime of biomethane plants and is becoming increasingly important due to the growing number of plants using waste feedstocks. Online monitoring solutions provide vital data to the plant operator enabling timely decisions to be made on carbon filter replacement to protect the upgrading plant from damage from VOCs and mitigate against unforeseen downtime and the consequent revenue losses.



Camlin's BioSpec VOC analyser

Camlin Energy works with many major biogas upgrading equipment manufacturers for VOC analysis. Its BioSpec VOC solution, based on optical spectroscopy, has rapidly become the technology of choice for real-time detection and measurement of VOCs and other contaminants at multiple points in a biomethane plant.

Camlin's solutions deliver data-driven insights that enable operators to monitor their plants and networks, optimise performance, reduce risk and secure greater commercial returns on their investments. ●

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