Organic goodness?

While home-brew methane produced from anaerobic digestion might be cheaper and more environmentally friendly than North Sea fossil gas, customers still need to take care it is safe for their vehicles, points out Toby Clark

There is a strong incentive to use biogas – natural gas produced from agricultural waste and other biomass – as a fuel for heavy vehicles (see also pp12-14, and for details about Glenfidditch operation, pictured). Scania reckons that by switching to locally produced biogas, "operators can reduce both their own and their customers' climate impact by up to 90%". (Its latest 13-litre gas engine is pictured.) But not all biogas is created equal: whether compressed natural gas (CNG) or liquefied natural gas (LNG), it must have sufficient energy content and be free from engine-damaging impurities.

The Natural Gas Vehicle Network reported in May last year that 93% of the total dispensed volume of gas used in gas-powered HGVs was biomethane. But, as James Westcott, chief commercial officer at Gasrec, points out: "There aren't many vehicles that actually use biomethane in the truck. They're using gas from the grid, but it's a mass balance process." This means that a customer can buy a 'virtual' green fuel knowing that there is a corresponding quantity of actual green fuel somewhere in the network – the same principle that 'green' electricity suppliers use. Of course, this system only works if there is a similar quality standard for biofuels as for fossil fuels – and they include ISO 15403-1:2006 and European standard EN 16723-2:2017. On that point, EUROMOT (the European Association of Internal Combustion Engine Manufacturers) suggests that gas properties should always be quoted at the ISO 13443:1996 standard reference conditions of temperature and pressure (15°C and 1,013.25mbar).

Gasrec itself doesn't produce any biomethane: "Gasrec's place is to provide the facilities and the supply chain to fuel gas vehicles, with open-access facilities as well as dedicated refuelling sites for customers. We supply biomethane as both LNG and CNG – for Gasrec, the vast majority is LNG, as we find that suits the heavier market better."

Westcott mentions that BP confirmed an investment in Gasrec for long-term supply of biomethane in December 2021, adding: "I see that as endorsement for the market."

HOME BREW

Anaerobic digestion (AD) facilities are becoming a common means of generating energy from agricultural waste products that would otherwise contribute to greenhouse gas emissions (see box, opposite).

The biogas may be used to run a combined heat and power (CHP) plant, or injected into the mains gas network, or used to fuel an internal combustion engine – but whatever the use, it needs to be treated to remove contaminants.

Biogas (and to a certain extent also 'fossil' natural gas) can contain a wide variety of impurities, whether from the manufacture or extraction process, or sometimes from storage and processing (for example, compression). For a start, biogas typically contains significant

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levels of CO_2 (which may pool, with a risk of asphyxiation), as well as volatile organic compounds and toxic levels of gases such as hydrogen sulphide (H_2S). These last two may be removed using activated carbon filters.

Diluents are also present: these 'dilute' the gas by having no significant energy content, so reducing the overall calorific value of the fuel. These include nitrogen (N_2), carbon dioxide (CO_2) and even hydrogen (H_2), which has a much lower energy content per unit volume than methane. Hydrogen can also cause embrittlement of steel gas tanks.

Natural gas and biogas are largely composed of methane (CH_4) but can include varying concentrations of other hydrocarbons. These include 'light' hydrocarbons (those with one to six carbon atoms per molecule) such as ethane (C_2H_6) and propane (C_3H_8), and 'heavy' hydrocarbons (with more than six carbon atoms per molecule) such as compressor oils introduced during processing.

While these compounds can usually be burned, light hydrocarbons can affect the knock resistance of the fuel, and change the air-fuel ratio, upsetting mixture control. In fact, for some non-automotive purposes, propane is injected into biogas deliberately to increase its calorific value.

Heavy hydrocarbons can be more problematic, condensing or 'dropping out' of the gas and fouling fine components such as injectors.

Water vapour can cause similar problems: it may drop out of the fuel at low temperatures to collect as liquid water or even ice, blocking pipes and valves. It is also a diluent, and combines with other impurities such as hydrogen sulphide and carbon or nitrogen compounds to create acid solutions which corrode tanks and other components.

Sulphur compounds are a significant concern in the composition of natural

gas: some are added deliberately as odourants, while others occur naturally in extraction or biogas production. (Incidentally, the familiar smell of UK mains natural gas comes from 'odourant NB', a blend of t-butyl mercaptan (TBM) and dimethyl sulphide, which mimics the sulphurous stench of some natural gas.)

BAD FOR ENGINES

Hydrogen sulphide (H_2S) is a common byproduct of AD biogas production, but it and other sulphur compounds cause corrosion and damage exhaust catalysts in very short order. One study showed a 91% reduction in effectiveness after just 100 hours of operation in the presence of 4ppm SO_2. EUROMOT recommends a maximum of 10mg total sulphur per m^3 of gas; mains gas in some countries has a considerably higher level. It suggests that sulphur-free odourants (already common in Germany) be used.

Siloxanes are silicon-based compounds often found in biogas; they too can damage catalysts, and cause problems with exhaust oxygen (lambda) sensors. Bosch recommends a maximum silicon content of $0.1mg/m^3$.

Biogas is filtered to remove some of its impurities, but an obvious way to remove many of them is the liquefaction process to create LNG: the process of cooling to around -145°C 'sweetens' the biogas, removing heavy hydrocarbons, water and other components.

John Comer, product manager at Volvo Trucks, says: "It's much more energy efficient to send it to the grid – especially with LNG – and the beauty of LNG is that it's cleaner than natural gas." (Volvo recently supplied 12 LNG tractors to Gregory Distribution, pictured above.)

Whichever truck you run, your gas supplier should state the standards they are operating to, and give details of the specification of the gas, particularly in terms of sulphur and silicon content.

As Jonas Strömberg, sustainability director at Scania, says: "Biogas will be one of the key tools for decarbonisation of heavy-duty transport… [it] is not only one of the fuels with the lowest CO_2 emissions, it also solves local waste problems, creates local jobs and brings carbon and nutrients back to the soil. It is circular economy in practice." TE

WHAT IS ANAEROBIC DIGESTION?

Anaerobic digestion takes place in a digester, or reactor – essentially a tank which excludes oxygen, allowing micro-organisms such as bacteria to work on the ingredients inside. The biomass is made up of large organic polymers which are first broken down into smaller parts such as sugars by a process called hydrolysis; these in turn are broken down into smaller and smaller molecules by successive processes of acidogenesis, acetogenesis and methanogenesis. This final stage produces methane (CH_4), carbon dioxide (CO_2) and water. The remaining indigestible material is the digestate.