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Generating power from municipal waste – the challenges and opportunities

Energy lives here™

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Today, governments and world officials are under more pressure than ever to provide sustainable electricity and reduce pollution. As energy demand continues to grow this becomes a challenging feat. However, through advances in technology we are seeing more and more of our energy derive from unconventional sources such as the waste contained in landfill sites.

Historically, landfill has been the main way to dispose of waste efficiently, and has been particularly popular in countries such as the UK, Lithuania and Croatia[1] due to the amount of open space available. In the UK alone, 200 million tonnes of waste was generated in 2012[2]. If the waste generated per year continues to grow at its current rate, the UK can expect to run out of new landfill sites by 2020 .

Landfill sites can be divided into three different categories - those for hazardous waste, non-hazardous waste and inert waste. Whilst highly dangerous wastes are banned from going to landfill, the gases produced at these sites can be detrimental to the environment.

Following the need to reduce environmental impact and helped by advances in technology, more landfill sites are now controlling and capturing the gas that is released by the decomposing waste, using it to generate electricity. As a result, there has been a surge in popularity for installing gas engines on landfill sites.

This step change in energy production signals an exciting time for the power sector. Converting waste to gas from alternative sources can help reduce emissions that would otherwise be released into the atmosphere. Producing power from new sources can be cost-effective and reduce the global dependency on carbon-based fuels. However, with new gases come new challenges for gas engine operators.

The state of play

Biogas is a catch-all term for gases derived from waste sources. This waste is converted into gas, inside an anaerobic digester, where micro-organisms break down the waste into a gaseous mixture that is primarily made up of methane and carbon dioxide. Biogas can be produced from a number of raw materials such as agricultural waste, manure, plant material, sewage or food waste. This biogas can then be used in on-site gas engines to generate power that can either be pumped back into operations or into the grid.

Many European countries are contributing to the development and production of biogas – the UK, Italy, France and the Netherlands are all important markets. In the UK, electricity is predominantly generated from landfill gas. This trend is driven by the high amount of waste the UK produces every year and the shortfall of space to house this waste.

The challenges with biogas

There's no doubt that the benefits reaped from converting waste to gas for power production are manifold, however, there are significant challenges that need to be overcome, due to the aggressive nature of these gases compared to traditional and natural gas.

The main problem with landfill gas is its composition, which varies depending on the origin of the waste. It typically has a methane concentration of around 45 to 60%[4] and can often contain a number of harmful contaminants including, halides, volatile organic compounds and siloxanes.

Siloxanes are man-made organic compounds that contain silicon, oxygen, and methyl groups. They are used in the manufacture of personal hygiene and health care products such as deodorants and shampoos and as a result of their widespread use are often found in landfill sites.

During the combustion of biogas containing siloxanes, silicon can be released and can combine with other elements in the gas to form deposits in the combustion chamber that can lead to accelerated wear in liners and piston rings.

Enhancing engine performance

Lubricants are vital in protecting gas engines but this becomes particularly important in those running on aggressive biogases. Operators need to consider a lubricant that can help mitigate the risks posed by contaminants and help protect the engine. There are a number of considerations that should be taken into account when selecting an effective lubricant for engines running on such gases.

Operators should consider a lubricant that has a higher thermal and oxidative stability to protect the engine from deposits, lacquers and varnishes and avoid sludge formation. If a lubricant selected has poor oxidation stability, the fluid will begin to degrade and polymerize leaving the engine open to excessive heat and wear.

Extending oil drain intervals can elongate engine life and in return help to reduce maintenance costs and improve power output. Typically, engines running on biogas have comparatively short oil drain intervals, when compared to those running on traditional gas.

ExxonMobil's new gas engine oil, Mobil Pegasus™ 605 Ultra 40, has been designed specifically to help optimise the performance of engines running on gases derived from biomass and landfill. Importantly, Mobil Pegasus 605 Ultra 40 can help double oil drain intervals[5], resulting in more reliable power production.

Along with outstanding anti-wear and anti-scuff performance, Mobil Pegasus 605 Ultra 40 offers exceptional carbon and varnish deposit control. This can help mitigate the impact of contaminants such as halides, sulphides and siloxanes, which can accelerate wear and compromise engine durability.

During extensive field tests conducted on a customer's engine in Auckland, New Zealand, Mobil Pegasus™ 605 Ultra 40 showed its ability to improve engine cleanliness and prevent scuffing. Over an 18,000-hour test period, Mobil Pegasus 605 Ultra 40 more than doubled the engine's oil drain intervals[6] from 300 hours to 1,000 hours.

Following the product's performance, the customer now uses Mobil Pegasus 605 Ultra 40 in all of its engines on site.

Keeping operations running smoothly

Due to the varying operating conditions gas engines have to cope with and the inconsistent nature of gases produced from landfill, regular monitoring of oil and equipment is highly recommended to help maximise productivity and reduce maintenance costs.

To optimise operations it is recommended that operators carry out a fuel gas analysis and used oil analysis when using gases from landfill sites, in addition to using high quality lubricants.

By law operators must carry out a fuel gas analysis annually to measure the sulphur content and siloxane levels found in the gas before it is used – the regularity for which may vary depending on the country. For biogas operations, it is recommended that this analysis frequency is increased to at least once a quarter. This is due to the variability of biogases – compounds can vary from week to week, depending on the location and area the gas has been extracted. Through this fuel analysis operations can be more closely monitored and oil drain intervals adjusted to match the levels of contaminants expected to be present in the gas over the course of its use.

It is also important to conduct used oil analysis. ExxonMobil's proprietary online Mobil Serv℠ Lubricant Analysis programme for equipment maintenance professionals can help operators improve power operations.

Examining changes in the oil analysis data over time is necessary to assess the condition of the oil. Regular used oil analysis can help operators anticipate oil drain intervals, reduce maintenance and, in turn, improve safety. Supported by expert guidance, maintenance professionals maximise the application of high quality lubricants and identify early warning signs of contamination to help take greater control over managing downtime and extending equipment life.

The oil analysis includes measures of fluid viscosity, waste content, particle count and dissolved metals to determine how well the system is operating. When running landfill applications, ExxonMobil recommends trending oil analysis weekly until a stable condition can be determined which will help operators proactively address the undesirable conditions before they become a problem.

Making alternative energy sources work

As the world looks to meet the growing demand for energy, efficiencies will continue to be made and alternative sources considered. Producing power from these sources will help to reduce global emissions and help operators be more cost-efficient. However, as we have seen, these gases can cause complications and careful consideration needs to be made on lubricant choice to ensure performance isn't compromised.

Using advanced technology, operators can now look to improve productivity and reduce maintenance costs all while helping to reduce the world's dependency on carbon-based fuel. Choosing a lubricant that can mitigate the effects of pollutants in such gases will become more important than ever for reliable operations.

For more information about ExxonMobil's range of products or other Mobil-branded lubricants and services, please visit www.mobilindustrial.com.

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[1]http://www.zerowasteeurope.eu/2013/03/recycling-stagnates-in-the-eu-need-to-change-eu-waste-resource-policy/
[2]Department for Environment Food & Rural Affairs, UK statistics on waste. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/416471/UK_Statistical_release_UPDATEv6_19_03_2015.pdf
[3]Eunomia, Residual Waste Infrastructure Review, Issue 8, p.6 http://www.eunomia.co.uk/reports-tools/residual-waste-infrastructure-review-8th-issue/
[4]Methane content http://www.atsdr.cdc.gov/HAC/landfill/html/ch2.html
[5]Field tests using GE Waukesha APG 1000 gas engine demonstrated a doubled oil drain interval when compared to Mobil Pegasus 605 over a period of 18,000+ hours
[6]when compared to a conventional biogas engine oil