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incineration vs gasification [inc plasma arc]
Martin Williams
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Dear Ms Lilian Mok:

I would be grateful if you could circulate the following to members of the Panel on Environmental Affairs.

Best regards,

Martin Williams

Just seen waste management world has “debate” about up and coming gasification, vs established incineration.

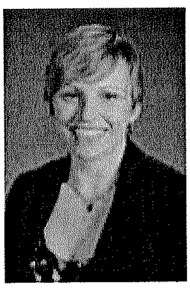
I’ve had quick read through, and seems to me the main supporter of incineration is a guy representing incinerator companies.
Experts who are more on sidelines seem supportive of gasification.

Best regards,
Martin

THE WASTE GASIFICATION DEBATE

While a number of major projects are underway globally, waste gasification has a chequered past. Many argue that when traditional thermal treatment with heat recovery is able to achieve such high efficiencies, gasification is complex and unnecessary. Others point to low emissions and the potential to produce products such as hydrogen. WMW asked some experts for their thoughts on the subject...

Natural Selection



Lisa Jordan
Business Manager for Bio-Energy at Air Products

With over 434 million tonnes of waste generated every year in the UK, much of which goes to landfill, the use of advanced gasification technology in waste to energy facilities is a vital element in tackling the problem and also has an important role in delivering renewable energy.

Air Products' Tees Valley Renewable Energy Facility, which is currently under construction, is largest advanced gasification plant in the world, and once operational in mid-2014, will generate up to 50 MW of electricity from municipal, commercial and industrial waste. The plant is expected to produce enough reliable, controllable, and renewable electricity to power up to 50,000 homes and will divert up to 350,000 tonnes of non-recyclable waste from landfill per year.

At the heart of the technology is an enclosed gasifier. Waste is fed into a vessel and treated at a very high temperature using plasma technology. This produces a gas commonly referred to as 'syngas'. The syngas is treated, cleaned and then used as fuel in gas turbines to generate electricity. Final emissions are minimised due to the high temperature used in the plasma gasifier.

There are a number of factors driving advanced gasification. The process is more efficient than many technologies for conversion of waste into electricity, and can generate a much wider range of additional outputs, including heat, hydrogen, chemicals and fuels.

The process also has a lower environmental impact than alternatives, emitting less CO_2 - it is the lowest-carbon large-scale waste to energy conversion technology currently available.

Why Tees Valley?

In the UK the North East of England is leading the way towards the sustainable production of energy from waste. The Tees Valley area itself has a number of advantages, such as available industrial land, accessibility to electrical infrastructure and excellent road links.

Advanced gasification has an exciting future in the UK, with the potential to develop hundreds of millions in new investment for up to five advanced gasification facilities. This would divert up to 1.5 million tonnes of residual waste from landfill and generate around 250 MW of base-load power – enough for 250,000 homes.

Waste is an underused resource for energy generation and gasification holds the key to unlocking its promise. It brings benefits to the environment by redirecting waste which would otherwise go to landfill, reducing carbon emissions and creating skilled jobs.

Waste composition is uncertain but Technology should not be

Edmund Fleck
the President of ESWET – the association representing the European Suppliers of Waste to Energy Technology towards the EU

Waste is a multifaceted topic: every country has its own challenges to solve, but some solutions are bound to be used everywhere. All countries that successfully moved away from landfilling wastes not suitable for recycling have done so through the use of waste to energy. But even this solution raises a question: which technology to use?

Whether called incineration, gasification or pyrolysis, these processes as built and operated have a combustion stage in common, releasing heat to convert water into steam in a boiler. Processes that shun the 'incineration' label do the same but in multiple steps, generally resulting in much lower energy efficiency and/or higher costs.

The only way to avoid combustion of residual waste is to cherry-pick it: anaerobic digestion and gasification have been around for decades and provide an alternative to combustion for specific and homogeneous waste streams. 'Alternative' waste to energy technologies however, keep falling short of converting mixed municipal solid waste into a fuel. Besides, the energy balance for a plant should include any energy usage for the pre-treatment of waste if it is required, and of course, any added fuel.

In order to move away from landfilling, waste to energy technology is best if it can accept all residual waste, while generating energy efficiently.

For MSW, the clear solution is grate combustion, i.e. by far the most widespread, proven, reliable and cost-effective technology. This explains why there is continued interest in the technology developed by ESWET's members, which is backed by their combined 1000+ list plants globally.

Innovation in waste treatment is desirable: gasification and pyrolysis technologies have the potential to yield useful fuels or materials from specific waste streams. On the other hand, for mixed residual waste, the repeated shortcomings of alternative technologies show that they should look at other waste streams.

Innovation for mixed residual waste should hence focus on the technology that already works well. This is exactly what is happening with increasing efficiency of grate combustion plants, maximising resource efficiency and improving their economics. Such plants are already an integral part of the base-load electricity mix. Many other plants also supply district heating networks, or industrial customers, with heat.

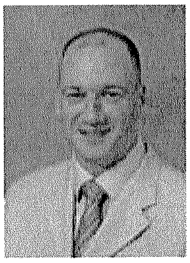
Any ground-breaking alternative would have to perform both the longstanding task of treating all waste while fulfilling today's expectations of efficient energy generation, 24 hours a day. Innovative systems such as dry bottom ash extraction are also available to maximise the recovery of useful minerals and superior quality metals.

If competition is to take place between technologies for the decreasing volumes of residual waste that recyclers reject, favour goes to plants that are reliably operating at the lowest cost and the best energy efficiency.

Whereas the composition of residual waste is uncertain, the technology to handle it should not be.

Which technology will you bet on to fulfil this challenge?

The Potential for Small Scale Local Waste Treatment



Simon Gandy
Principal Consultant for Resource Efficiency and Waste Management Practice at Ricardo-AEA

Gasification is combustion in low levels of oxygen, which produces a syngas. If that syngas is immediately combusted in excess oxygen and the heat used to raise steam, that (in my book) is two-stage combustion, not gasification, and delivers comparable thermal efficiencies to traditional combustion.

Two-stage combustion of residual waste and the gasification of wood waste have both been technically proven. Therefore, for me, the big question is whether or not we can successfully gasify residual waste at commercial scales, and utilise the higher thermal efficiencies that genuine gasification promises.

A 2011 study which I led for the Energy Technologies Institute (ETI) sought to understand which steps in the gasification process are the biggest stumbling blocks. The findings pointed to two stages - the preparation of the waste feedstock for gasification, and, especially, the clean-up of the emerging gases so that they are fit for a gas turbine or reciprocating engine that can deliver the higher thermal efficiencies.

Difficulties with these two aspects have often led to project development costs that are far higher than expected. This places pressure on companies towards premature commercialisation to attract private equity. The plants then run into issues during construction, commissioning and operation that are ultimately insurmountable.

Despite such difficulties, there has been, and continues to be, a real thirst for waste gasification, arising from two principal drivers.

Firstly, in the UK the Renewables Obligation sets gasification in a favourable light, offering 2 ROCs for every MWh of energy produced. Although this is far from set in stone, the prospect of this extra income stream makes gasification projects much more financially attractive.

Secondly, gasification is viable at a smaller scale, and I can see it becoming the preferred technology for 'city-wide' solutions, where individual cities wish to manage their own waste. At this scale, incineration is less commercially viable, so the door is open for an alternative thermal solution that is technically reliable.

In the UK, the ETI project has progressed to the stage where three companies – Advanced Plasma Power, Broadcrown and Royal Dahlman – have been commissioned to demonstrate an integrated system that would be commercial at between 5 and 20 MW.

Meanwhile, Bioessence in East London are constructing a gasifier using the same technology as the successful gasifier at Lahti Energia in Finland.

Perhaps the most notable development is the Air Products facility currently under construction in Teesside, which will use Westinghouse plasma gasification technology. Air Products seems to be supremely confident that they will be able to overcome the issues, both in preparing the incoming waste and handling the syngas produced.

I wish them luck. If things don't go to plan, I fear that the technology will be consigned to another 10 years on the side-lines, at least in the UK.

The proof of the pudding will be in the eating

Peter Jones
OBE is chairman of Waste2Tricity

Current conditions in the UK Waste sector, as it seeks to transition to a resources management role, are torrid to say the least. Short-term shifts in the global commodities markets, fuelled by uncertainties on Chinese growth rates, have knocked prices for recyclates in general.

Under the guise of quality complaints, real and imagined, container loads of post MRF material are being turned away from China, representing a big liability for some MRF operators. Furthermore, UK MRFs were already buckling under the revisions to the tax treatment for post reprocessing fines - representing £78 a tonne cost increments for at least 8% of their business tonnages. Recyclers have also suffered numerous fires in the last six months - one apparently due to a Chinese lantern which landed when still alight... a final cruel irony adding to their woes.

On the policy front, an energy strategy with the gestation of an elephant and the logic of a Fawlty Towers training manual continues to scare investors wanting certainty in a turbulent world. Thus the wish to expand in this arena must be abating, surely?

Well...maybe. The fact is that if one observes two basic sets of rules there is some good that can come from all this. The first is that facilities should be sited adjacent to the exit market for the product.

The second batch of rules lays in maximising the percentage recovery of gigajoules of matter for any given tonne of input, selling those gigajoules for the highest possible price (as recyclate, energy or soils) and doing so with the lowest CO_2 emissions per tonne of inputs.

The 'H Bomb'

Adhering to these simple precepts better than others means more margin per tonne and greater capability to out compete others for the preferred feedstock - and longer term rendering the process an asset.

Therein lays the attraction of gasification, especially if adapted for the recovery of hydrogen. As an enclosed process, more of the material is converted into syngas rather than being lost as heat up a chimney, with the effect that electrical yield per thousand tonnes of waste input is at least doubled on a like for like calorific value.

Without a doubt the process is of dubious provenance for many. However, there are already major investments, such as on Teesside where world class engineers familiar with the complexities of oil refineries and chemical plants are building a major new facility. Such firms do not see gasification as a challenge when it is a mainstream chemical engineering solution in their core business sectors.

Of course it is naive to ignore the reality that it is a new entrant - placing it roughly where anaerobic digestion for wastes was in 2000, even though it had been mainstream in the water sector for decades.

The proof of the pudding is always in the eating of course. And at Waste2Tricity's 120,000 tonne per year plasma gasification facility in Bilsthorpe, Nottinghamshire, for that we will have to wait until 2016.

The changing waste stream and the need for Feedstock preparation

Dr Stuart Wagland
Lecturer in Renewable Energy from Waste at Cranfield University, UK.

Recently we have started to see gasification emerge as a key next generation technology in the treatment of residual wastes for the production of clean energy.

One could say that the increasing popularity of gasification is a result of a few perceived short-falls of incineration, namely efficiency, flexibility and public perception. The uptake of incineration was partially due to the need to move away from our reliance on landfill, and the associated costs of landfill disposal increasing significantly in recent years.

Gasification has potential benefits over incineration, including efficiency, but also the flexibility in the way in which the energy is utilised. For instance, the syngas can either be combusted directly, used as a fuel in gas engines/turbines, stored, or processed through catalytic processes (for example, Fischer-Tropsch) to produce liquid fuels or chemicals.

The liquid fuels can be very versatile, and with the Road Transport Fuels Obligations [RTFO] providing an incentive for this route, this adds to the case for furthering the development of gasification technologies.

The process of gasification produces syngas. However, it is the composition and quality, as well as what happens to this syngas, which are all of great interest.

An influence of this is the quality of the material which is put into the gasifier. In general a poor feedstock will yield poor quality outputs. As the recycling rate increases, the composition of the residual waste which would become the feedstock for gasification plants changes. Some of the changes are positive, for example the theoretical decreases in food waste (and so the moisture content decreases too) within the residual stream as food waste collections are rolled out. However increased recycling of plastics lowers the overall calorific value of the waste.

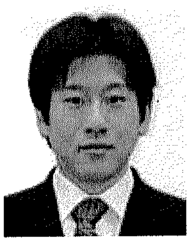
Another notable change in residual wastes is the actual quantity. This plays to another advantage of gasification technologies - scale. While incineration typically is scaled for 150,000 tonne per year and over, gasification can operate at lower capacities (for example, the Energos facility on the Isle of Wight).

The pre-processing of waste is of key importance, to remove materials with a commodity value but of no value for energy recovery (i.e. metals) and to refine the fuel to a desired quality.

The recovery of materials from waste is becoming more common, through the development of more advanced MRFs and the development of mechanical biological treatment (MBT). MBT facilities which produce refined fuels of much higher calorific values than unprocessed waste, could present a good synergy with gasification facilities.

Gasification could benefit from the changes in our waste, including the decrease in the quantity of residual waste. There will always be a residual waste stream, and considered processing options, recovering valuable materials in the process, could provide future gasification plants with high quality feedstocks enabling the reliable production of energy or high value liquid fuels and chemicals.

Now is the Time for Energy & Material Recovery



Nobuhiro Tanigaki
Chief Technical Manager at Nippon Steel & Sumikin Engineering Europe

The time has now come for waste gasification technology. Firstly, interest around the world is increasing in the use of waste gasification as an alternative thermal treatment. Gasification and melting technologies have already been deployed in Japan and South Korea, with more than 100 gasification and melting plants operating for many years.

Furthermore, in Europe and Canada some gasification technologies are operating at pilot scale and could come to the market in the near future. This indicates that there are gasification technologies that are proven and ready to enter the market.

Secondly, gasification offers the possibility to achieve both the energy and material recovery from waste without further treatment. In Japan, bottom ash from incineration plants is not allowed to be recycled and is transferred for final disposal in landfill sites because of high heavy metal concentrations.

As such, gasification and melting technologies are recognised as solutions to reduce landfill and recover valuable materials from waste. The Direct Melting System (DMS), which originated from steel making technology, can produce slag and metal without any toxic heavy metals via high-temperature gasification.

High temperature gasification can process various types of waste such as clinical waste, asbestos, sewage sludge or household waste. Co-gasification of various kinds of waste with household waste helps to maximise resource recovery and to minimise final landfill amount.

Additionally, the slag which is produced can be directly recycled (without any further post-treatment such as aging), not only as secondary materials for road construction, but also for fertilisers and agriculture.

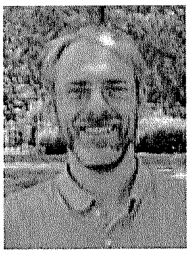
Therefore, from the viewpoint of material and energy recovery, gasification technology is a viable solution.

Finally, gasification has a potential to produce a variety of liquid fuels and chemicals. Some industrial companies have already been developing these applications, particularly using biomass or waste tyres as a feedstock.

Commercial waste tyre gasification plants, which produce carbon black, steel, diesel oil and syngas are already in use. However, unlike plants which process municipal wastes, the feedstocks for both biomass and waste tyre gasification facilities are relatively homogeneous materials.

Waste gasification technology is already marketed in Asia, and is coming to European markets as soon as it can contribute to a recycling orientated society and is suitable for areas with dwindling landfill capacity.

The Benefits of High Operating Temperatures



Edward Dodge
Author of a previous WMW feature on the subject, Plasma Gasification: Clean Renewable Fuel Through Vapourisation of Waste, and founder of ZeroWasteMethane.com

There is a question out there, 'is waste gasification something that should be pursued?' The question should be, 'why wouldn't we pursue waste gasification?

If zero waste and ecological sustainability is the goal, then some form of thermal treatment for waste is critical. If costs and risk avoidance are the primary concerns then stick with the status quo.

Today the waste management hierarchy is 'Reduce, Reuse, Recycle' , followed by composting and digestion. Unfortunately this leaves a significant proportion of residual waste left over and in need of disposal. In the U.S., since there is plenty of room for landfills in rural areas this process can continue for a long time.

Waste sent to landfill is often too contaminated to be recycled or biologically treated. Instead, if it is to be diverted from landfill, it must be treated thermally.

Thermal treatment used to mean incineration or burning, which requires the emissions to be scrubbed and also produces toxic ash. It is also not flexible, because the outputs are limited to heat and power.

One of the advantages of gasification however, is the flexibility of the process. Not only can many inputs be used, but many outputs are available as well. Gasification produces syngas that can be upgraded into a variety of products including liquid fuels, chemicals, methane or electrical power. This means the process is adaptable to local conditions and needs.

Some types of gasification also operate at much higher temperatures than tradition incineration. At 4000°F (2200°C) organic hazards are completely destroyed and minerals are melted, allowing all the material to be safely converted into useful products.

Gasification should be viewed as a component in a holistic waste management system. The overall process of waste management is challenging: waste is difficult to handle and waste streams vary by region and over time. A complete system needs to accommodate contaminated and dangerous waste and this is where gasification comes in.

Yes the technology is complex and expensive and there is some art to making it all work right, but the technology is viable enough to move forward. Globally there are thousands of potential sites to employ waste gasification. There is ample opportunity to innovate and improve and drive down costs.

The critical driver is that gasification enables us to convert toxic liabilities into assets, where as landfill is a long term problem that costs money to manage.

Our waste management processes must be robust as well as comprehensive. Waste gasification fulfils a role that cannot be achieved through any other process and is absolutely necessary.

Dr Martin Williams. Writing. Photography. Multimedia.
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