Report

AEAT/ED51487

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Treatment Technology Information for Municipal Waste in Darlington

Final Report Produced for Darlington Borough Council

January 2005

AEA TECHNOLOGY ENVIRONMENT

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INTRODUCTION

This report gives further details of the technologies introduced and modelled in the BPEO assessment. For each of the following technologies: -

- Anaerobic digestions
- Autoclaving
- Composting
- Gasification/pyrolysis
- Thermal treatment
- MBT/BMT

The following information is provided: -

- Description of process
- Products
- Reference plants (UK and international)
- Typical size of plants
- Relevance to Darlington's tonnage
- Indicative capital cost and typical gate fee

It should be noted that the prices quoted within the report are based on prices quoted by technology provides (particularly for the less proven technologies) and prices included in recent tenders that AEAT have been involved in. Costs should always be developed in a local context of capacity, construction cost, labour cost, the type of waste processed, the requirements for the flue gas cleaning, the resale and landfill prices for residues and the energy price.

The section on relevance to Darlington tonnages is based on the assumption that: -

- Darlington produces a total of approx 160,000 tonnages of municipal waste (household, CA site, arisings from council operations and small amounts of trade waste) per year in 2034 of which approx 38,000 tonnes is recycled or composted and an additional portion that will go direct to landfill due to its unsuitability for processing.
- Any treatment facility will be scaled to treat approx 115,000 tonnes in 2034 with no additional waste from either commercial sources or other local authorities being brought to the facility to be treated in that year (although operationally a contractor may take commercial and industrial waste in earlier years to utilise any spare capacity in the facility).

ANAEROBIC DIGESTION

Anaerobic Digestion (AD) is a biological method of treating waste. Bacteria decompose the wastes in the absence of air, in contrast to composting where wastes are decomposed by micro-organisms in the presence of air. Although anaerobic digestion occurs naturally in oxygen free environments such as within under-water sediments or within landfill sites, the term anaerobic digestion (AD) is normally used to describe an artificially accelerated operation in closed vessels at special plants. Sewage sludge and agricultural waste has been treated by anaerobic digestion for many years, and the process is now being used for municipal solid waste.

What are the technologies?

Anaerobic digestion can be used to treat Sewage sludge, agricultural waste, kitchen waste and garden waste, biodegradable fraction of MSW. MSW is usually mixed with other organic wastes (such as agricultural waste or sewage sludge) when treated using AD systems.

The waste is delivered to the plant and is initially sorted mechanically to remove remaining non-biodegradable contaminants. This may involve screens, air classifiers or magnets. The organic waste is then shredded and mixed with water and pumped to an enclosed vessel where it is heated, stirred and held for up to three weeks whilst the bacteria digest the waste and emit a gas consisting of about two thirds methane and one third carbon dioxide. After this the solid digested material is pressed to recover the added water. The solid digestate is placed in piles to aerate for about two weeks. Once the digestate has been aerated it can be used as a soil improver or growing media constituent in the same way as compost. If the material is derived from mixed wastes sources additional sorting may be required to remove contaminates. The liquid fraction can be recirculated in the process but some excess is generated and depending of the feedstock this can be used as a fertiliser or if the waste is contaminated it has to be disposed of to sewer.

The gas that is generated after simple cleaning to remove hydrogen sulphide and water can be burnt in gas engines to generate electricity or in boilers to produce steam. Alternatively in some locations it can be economic to purify the gas by removing the carbon dioxide so that the gas can be used to fuel vehicles such as cars, busses or lorries, or the purified gas can be piped in to the natural gas network.

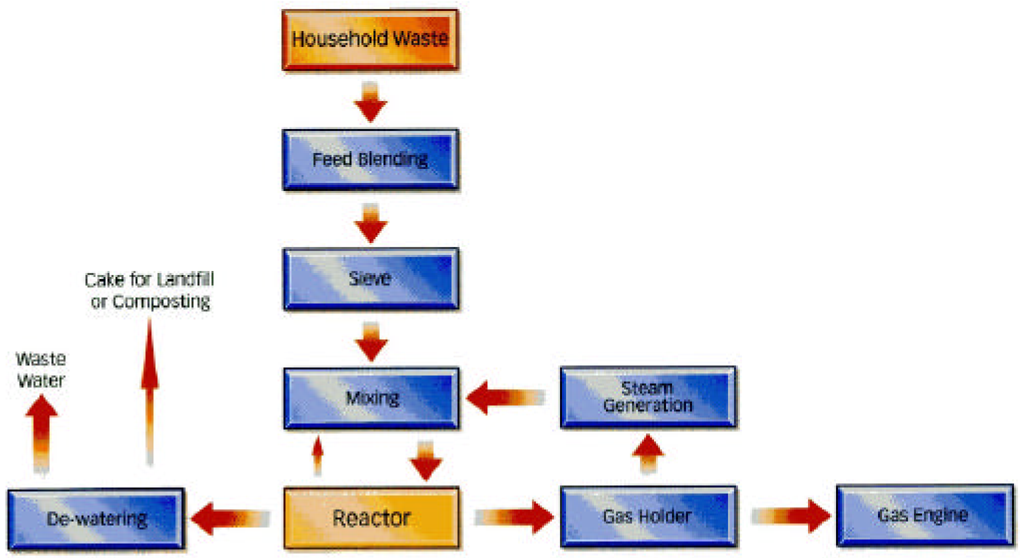

Figure 1 - Generalised Process Flow Chart for Anaerobic Digestion

What are the products?

Anaerobic Digestion of MSW has three products:

Biogas – has the same potential as any other combustible gas, e.g. in gas engines to generate electricity, however the cost of piping the raw gas can be prohibitive. Alternatively the gas can be upgraded to a suitable quality to fuel vehicles or to be added in to the natural gas pipeline.

Liquid – The liquid effluent contains a large proportion of the nutrients from the waste and can be used as a fertiliser. However, many countries prohibit the use of this fraction and hence it must be disposed of either by further aerobic treatment or disposal via the sewage system.

Solid Digestate – Compost – The solid digestate is the other product of anaerobic digestion and this can be used as compost. However, if this material is contaminated (particularly with heavy metals) the use of this material may be limited - or precluded by legislation.

Is the technology established?

AD is a well established technology for industrial wastewaters sewage sludge or agricultural wastes. Its use for municipal solid waste outside of landfill (essentially a large uncontrolled digestion plant) is becoming more wide spread with the majority of facilities processing source separated biowastes (kitchen and garden waste). However, increasingly AD is being adopted for the biological part of MBT processes. A survey in 2000[1] found over 165 plants operating or in construction and subsequently more plants have been developed In the UK, AD development has been more limited with only a few small pilot plant facilities for kerbside collected biowaste although there have been facilities for industrial and agricultural wastes. The largest use of AD for

[1] IEA Biogas and more, System and markets overview, July 2001, AEA Technology

MSW is the Leceister MBT facility that processes the organic fraction from Leicester's waste, with the digestate being mixed with sewage sludge to be applied to agricultural land.

Advantages and disadvantages

Advantages

- When used as part of an MBT process, AD has the advantage over in-vessel aerobic composting as it produces a bio gas product.
- The biogas produced during this process can be sold as a fuel or combusted. The sale of any electricity generated will be eligible for Renewables Obligation Certificates (ROCs).

Disadvantages

- Some apprehension in the UK over investing in AD as a result of some poor performance in the past.
- The biodegradability of the digestate produced will now have to be measured and assessed on a plant by plant basis. It is likely that only 50% reduction will be achieved.
- End-product standards and outlets for AD digestate from mechanically separated MSW are not guaranteed. Currently the Environment Agency has indicated that mixed waste composts and digestates are unlikely to be of an appropriate quality to be applied to agricultural land.

What are the costs?

Capital costs of a typical 50 ktpa plant have been quoted as around £8m but recent UK experience suggests that this could be significantly higher. Gate fees are typically £50-60/tonne.

Relevance to Darlington tonnages

Anaerobic digestion plants are typically combined with other processes (such as MBT) and are used to treat the biodegradable fraction of any waste. AD plant size is very flexible as they are modular and can essentially be any size, units range from 10ktpa up to 70ktpa depending on supplier.

Summary

Anaerobic Digestion systems for digesting MSW are widely used throughout the world. Much of the technology is based in Europe with Germany and Denmark leading the field in technology and in the number of successful plants in operation. The technology has gained a limited foothold in the UK.

AUTOCLAVING

Autoclaving is a mechanical method of treating waste. The wastes are 'stream cleaned' and physically degraded at a high temperature in a sealed container. This technology has been used to sterilise and treat clinical waste for some time.

What are the technologies?

The aim of the autoclaving process is to produce a cellulose product (paper/putrescible pulp) from the waste that can be used as a fuel for combustion. Inert materials such as glass, ferrous and non-ferrous metals can be separated for recycling. Initially the waste undergoes a pre-processing stage that uses screening, handpicking and shredding to recover recyclables and remove heavy items. The subsequent product is fed into a container where water and heat (through the introduction of hot air) is added. The output from the processing container is then manually screened to produce an undersize product, which is mainly either, the organic (paper/putrescibles) cellulose product or glass, and an oversize product that is mainly textiles, plastic and metals.

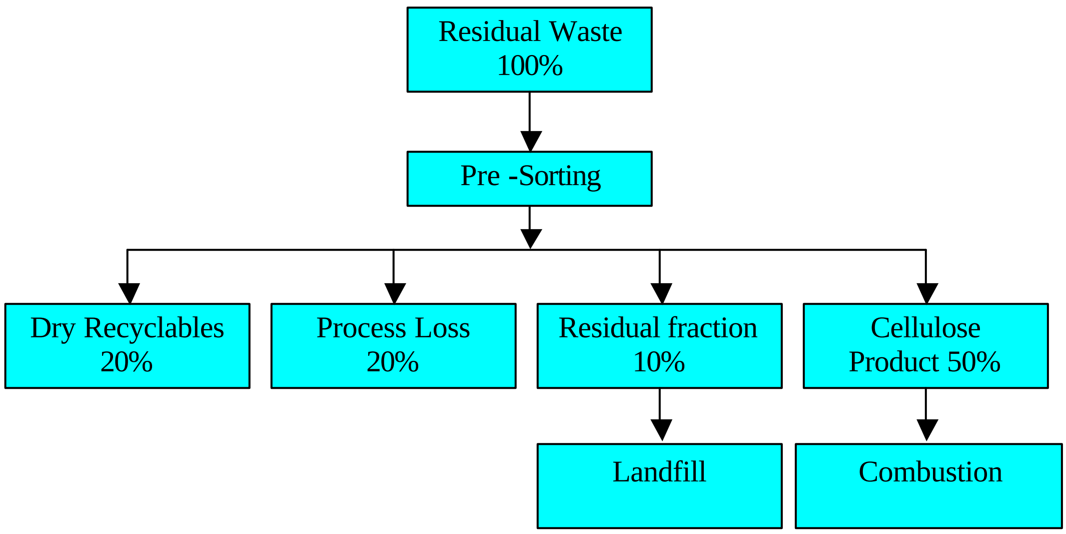

Figure 2- Generalised Process Flow Chart for Autoclave processes

What are the products?

Cellulose Product – Consisting of fibrous material that can, depending on the markets, be used in the production of fibrous products or in the production of a refuse derived fuel (RDF).

Recyclable materials – glass plastic metals and textiles can all be extracted from the process outputs. These materials will have been partially cleaned by the process. Plastics may also be deformed making them either more or less easy to recycle.

Is the technology established?

Autoclaves are well established technology for treating clinical wastes but have not been demonstrated widely for MSW processing. Currently in the UK several projects are being developed for the DEFRA demonstrator programme and some small pilot projects have been run by the four suppliers of this type of technology (Brightstar, Thermsave, Fairport and Estech)

Advantages and disadvantages

Advantages

- The process benefits claimed by the technology are that the autoclave makes the waste more suitable for subsequent sorting such that the fractions are cleaner and more marketable.
- The principle product is the fibre product that contains all of the organic and paper fractions and this can be used for digestion or composting or can be used as an RDF in traditional combustion systems or advanced gasification or pyrolysis units.
- The suppliers of this technology have been lobbying government in relaxing the renewable obligation certificate (ROCs) definitions of biofuel such that the non-biogenic fraction can be relaxed from 2% to 5-10% which these processes claim to be able to meet. If these rule were to be changed this would provide substantial economic boost to the process.
- The process has the advantage that it is relatively modular with the autoclaves being able to be sized from unit as small as 20 ktpa providing the ability to match processing ability to the waste feedstock. However the sorting plant associated with the process will need to be sized appropriately to the overall capacity which thus limits this flexibility to some extent.

Disadvantages

- The principle disadvantages are linked to the novelty of the process in its application to MSW and the overall energy balance.
- The technical risks on the performance are currently large until successful demonstration can be shown and any problems dealt with. It is also only part of the solution as the various product fractions require subsequent treatment through thermal or biological systems.
- The process does not provide any BMW reduction itself as all the BMW is concentrated in to the fibre fraction and thus the risk of marketing and LATs compliance is concentrated.
- The recyclate products are generally targeted in to established markets but the mixed plastics fraction does provided some challenges as the shrinkage caused by the heat may alter the perception of the existing markets and it is currently not known if any polymer degradation is occurring which could make the plastics unmarketable.

- Environmental concerns are concentrated on the odour and VOC emissions, as heating the waste will promote these emissions. Whilst the autoclave is operating it is closed, but it is the loading and particularly unloading that may provide problem areas and therefore will need careful plant design and control.

What are the costs?

Recent quotes suggest capital costs of £12m for a 70ktpa facility however to this needs to be added the combustion or digestion facility unless an RDF market is close by and willing to accept the products as a fuel.

Relevance to Darlington Tonnages

The scale of these facilities is dependant on the modular unit which varies between manufacturers and can be between 20 and 50 ktpa. The costs of the units will only be part of the solution as the downstream processes will need to be appropriately sized. However given the requirement in Darlington for approximately 100ktpa of processing capacity would appear to provide an appropriate match between the modular unit sizes and may allow some sculpting of the capital expenditure to match waste growth in the future.

Summary

The autoclave technologies are a potential solution for Darlington if combined with appropriate markets for the fibre product or if processing capacity in dedicated combustion or digestion plant is built. The manufacturer claims would make this a flexible and innovate process that would provide recycling and BMW diversion. However, there is currently substantial technical and market risk associated with the process due to the lack of long term operating experience and the claims have to be viewed with some caution. Even if capital costs can be determined with any confidence (which currently they can not) the operational costs have high uncertainties due to lack of knowledge of the wear and maintenance cost as the plant ages. It could well be that the plant only lasts ten years due to corrosion issues and thus the comparisons to other processes becomes less attractive than if a longer 15-20 year life were assumed. However, the greatest uncertainty will be the composition and fate of the fibre product and unless the treatment of this is contained within the project, the risk of having to landfill this will be the dominant factor in any assessment.

COMPOSTING

Composting is the aerobic decomposition by micro-organisms of biodegradable material to produce a residue, namely compost. It is a process primarily used for readily degradable organic materials, such as source separated green garden wastes and kitchen wastes.

The waste is degraded by thermophilic micro-organisms, which are "heat-loving" micro-organisms with an optimum growth temperature of 50°C or more). This is a biological process that oxidises the organic matter to break it down to a more simple form. A high temperature within the process is important to eliminate pathogens that may be present in the source materials.

The composting operations must ensure that the micro-organisms are kept supplied with moisture, oxygen, food and nutrients and that conditions such as temperature remain in the optimum range. A large number of procedures and engineered solutions have been developed to achieve these objectives for the treatment of organic wastes.

What are the technologies?

Open Composting Systems

Open composting has been practised for many years and relies on placing the organic waste in piles exposed to the air. The waste is commonly formed into elongated triangular piles that are called windrows, which allow optimum exposure to the atmosphere whilst minimising the land area taken up. Once the waste is prepared for composting the principal control mechanism for the process is the air requirement of the micro-organisms and the dissipation of the heat generated. Introduction of air into the waste can be achieved either though active pumping of air into the waste or through the mechanical lifting and mixing of the waste to introduce air into the pile. These two approaches are called static aerated pile and turned windrow.

Turned windrow composting – the material is turned periodically to introduce air into the material.

Aerated static pile composting - Static aerated pile systems, as their name suggests, are not turned during processing. Air is forced through the composting material by means of a fan and perforated pipes or floors.

Open composting is suitable for the treatment of source separated garden waste from HWRDS or garden waste only collections.

In-vessel Composting Systems

Reactor or enclosed composting is a relatively new composting development that provides a faster active biodegradation process, reducing the area required. The use of a 'closed' vessel allows much greater control over the process and this helps both with the speed of the process but also the consistency (hence quality) of the compost product.

The reactors come in a variety of forms and have varying degrees of automation. However, the basis of reactor composting is that materials are enclosed in a drum, silo, or similar structure and air is injected into the composting material to maintain the optimum conditions for composting.

Following the foot and mouth outbreak in 2001, any waste which contains or could have been contaminated by meat or meat products has to be treated at a certain temperature for a minimum period of time, thus any source separated waste which includes the collection of kitchen waste from households, would need to be treated in an in-vessel system.

What are the products?

The main product from the composting of waste is compost. This stabilised organic material consists of the refractory and slowly degradable cellulosic materials. The main use of this compost is as a soil improver. The quality of the compost is largely determined by the feedstock provided to the process. Relatively uncontaminated feedstocks will give rise to uncontaminated products and these are generally composted from source-separated materials.

The residues from the composting process are those materials that do not readily degrade, such as wood and these can either be returned to the front of the process to be shredded or they can be disposed of.

The ratio of soil improver product to reject fractions will vary markedly with the feedstock and process but typically the product material might only be 50 to 60% of the incoming waste with 15-30% loss of mass through the biodegradation for source separated materials whilst residual (mixed waste) compost may only generate 10-20% compost product with up to 60% being reject to landfill.

Is the technology established?

Windrow composting is well established in the UK with a large number of facilities treating source separated garden waste.

In-vessel composting facilities are not as well established, with less than 20 operational in the UK. However, in Europe the number of facilities is large with in -vessel composting becoming the norm for organic wastes other than green garden wastes.

Advantages and disadvantages

Advantages

- Windrow composting is a relatively low cost operation.
- High quality product which is likely to be more acceptable to end use markets.
- Composting treats the organic fraction of waste, which needs to be diverted from landfill. Composting can thus form part of an integrated system to treat and divert organic waste to meet landfill directive targets.

Disadvantages

- Systems are not able to process mixed residual waste
- Cost of separate collection of feedstock material.
- Quality controls will be needed to ensure high quality product.
- Only organic waste can be treated, other recyclable wastes will need to be collected and treated separately.
- Composting requires substantial land areas to operate although in-vessel systems require less land than open windrow systems.
- Composting systems are very prone to odour problems and careful operation as well as equipment design is required to ensure the operations remain trouble free.

What are the costs?

Windrow composting of green wastes are typically quoted at between £20 and £25/t although there is strong regional effects due to the potential for markets of the compost.

In vessel composting processes are more expensive and there are a range of systems on the market that will lead to gate fees in the range £35-£50/t.

Relevance to Darlington tonnages

Composting can only treat organic waste so only going to be a small element of Darlington's strategy to deal with source separated organic waste.

Summary

All though composting processes cannot be used to treat mixed residual wastes. Composting is a useful and proven technique for treated source separated organic waste. The cost of systems to collect organic waste separately should be considered when making decisions on how to treat organic waste.

GASIFICATION/PYROLYSIS

Gasification and pyrolysis are two upcoming technologies that promise improved performance over traditional combustion technologies.

What are the technologies?

Gasification

Gasification is the conversion of a solid or liquid feedstock into a gas by partial oxidation under the application of heat and is shown schematically in Figure 3. Partial oxidation is achieved by restricting the supply of oxidant, normally air. For organic based feedstocks, such as most wastes, the resultant gas is typically a mixture of carbon monoxide, carbon dioxide, hydrogen, methane, water, nitrogen and small amounts of higher hydrocarbons. The gas has a relatively low calorific value.

For most waste feedstocks, the gas will contain tars and particulate matter, which may need to be removed before the gas, is suitable for combustion in engines or turbines although direct combustion in simple boilers requires limited pre-treatment. The degree of this contamination will depend on the gasification technology used.

Gasification is not a new technology, although its application to waste feedstocks is still being developed. Coal gasification has been used since the early 1800s to produce town gas and the first four-stroke engine was run on producer gas in 1876.

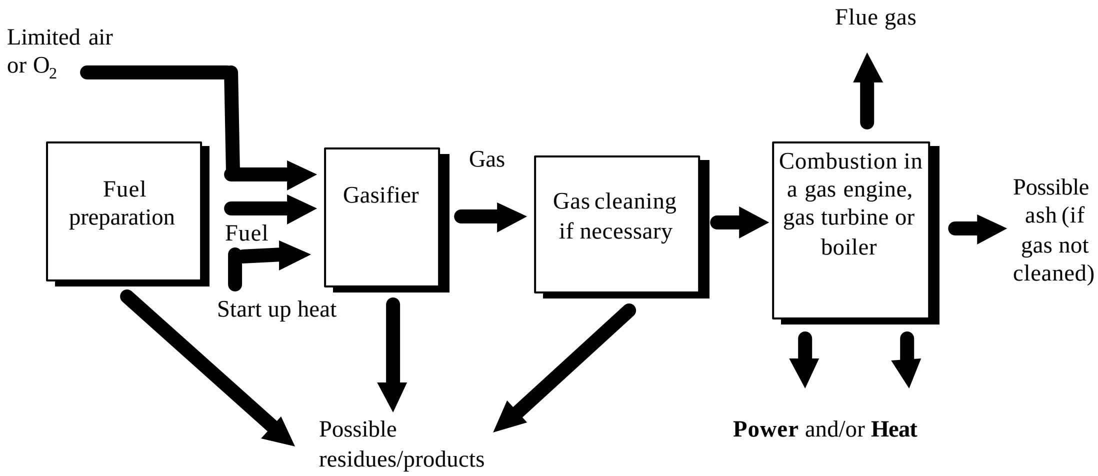

Figure 3 - Schematic representation of the gasification process

Pyrolysis

Pyrolysis is thermal degradation of a material in the complete absence of an oxidising agent (e.g. air or oxygen). In practice, complete elimination of air is very difficult and some oxidation is likely to occur. The process is shown in Figure 4.

Typically the process occurs at temperatures in the range 400-800^{o}C. When applied to waste materials, the action of heat breaks complex molecules into simpler ones. This results in the production of gas, liquid and char. These products can have several potential uses depending on the nature of the feedstock, however for waste based feedstocks the most likely use is as a fuel for energy generation.

The relative proportions will depend on the temperature the material is subjected to, the time for which it is exposed to that temperature and the nature of the material itself. If a gas is the principal product, then it is likely to have a higher calorific value than that produced by gasification (in which the gaseous species are partially oxidised).

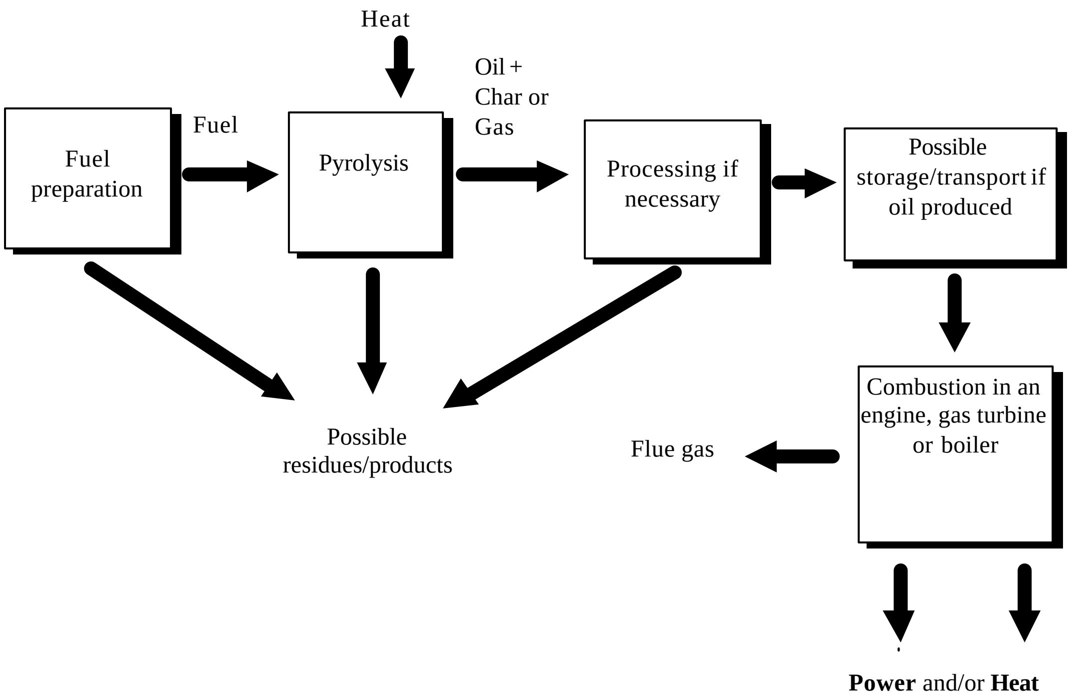

Figure 4 - Schematic representation of pyrolysis process

What are the products?

Fuel – The main products of gasification and pyrolysis processes is a fuel in the form of a gas oil or char. The calorific value of these fuels will depend on the composition of the waste feedstock and treatment technology.

The residues from the gasification and pyrolysis processes contain carbon but will be biologically inert and thus will not contribute to methane generation in landfill. However, many of the processes use RDF pre-treatment and this will result in unburnt residues for landfill or biological treatment that will contribute to the biological load to landfill.

Is the technology established?

About forty advanced thermal conversion plants for wastes have been identified and about 26 of these are known to have treated MSW or RDF. The scales range from small laboratory plants to about 50 kt y^{-1} demonstration plant. The majority of the plants being developed are likely to operate commercially at less than 100 ktpa.

Advantages and disadvantages

Advantages

- May be more publicly acceptable than traditional EfW technologies.
- Potentially higher energy efficiency than combustion
- Smaller scale operations

Disadvantages

- Technologies for MSW have not been proven on a commercial scale for most systems
- Costs are high
- Markets for products are unknown apart from burning them directly for energy

What are the costs?

There seems to be no perceptible difference in capital cost between gasification and pyrolysis systems. Pressurised gasification systems have higher capital costs but offer a potential cost saving at the power generation stage due to the lack of gas compression required and higher system efficiency.

From the data available in the literature, gate fees for the advanced conversion technologies currently being developed are in the range £22-56[2] per tonne of municipal waste. These gate fees are for plant designed to operate to old emissions standards. Gate fees for plant designed to meet tighter standards introduced by the EU for waste combustion are likely to be higher at about £56-882. However, gate fees from bid information is scarce

[2] year 2000 costs

and the data available currently suggests that gate fees are likely to be at the higher end of the scale.

Relevance to Darlington tonnages

These plants operate al lower tonnages 50-100kpta they may therefore be more suited to Darlington tonnages.

Summary

Gasification and pyrolysis technologies tend to operate on lower tonnages than traditional EfW facilities and may be more suitable to Darlington's Tonnages. These technologies also tend to be more expensive than traditional EfW technologies but benefit from potentially higher energy efficiency.

THERMAL TREATMENT

Energy Recovery is the combustion of waste under controlled conditions in which the heat released (energy) is recovered for a beneficial purpose. This may be to provide steam or hot water for industrial or domestic users, or for electricity generation. Combined heat and power (CHP) energy recovery facilities provide both heat and electricity at very high efficiencies. The technology is also known as energy from waste (EfW), but sometimes is incorrectly referred to as incineration.

What are the technologies?

Inclined grate

Conventional EfW systems (see below) are based on either inclined grate technologies – these are capable of burning waste that hasn't been pre-treated. Waste is delivered to the site where it is then tipped into a concrete pit. From there it is loaded by grabber-crane into a hopper. From the hopper it falls onto the grate, where it burns in an updraft of air blown into the combustion zone by fans from below. Modern plants typically use moving grates. The waste is moved through the furnace by a mechanically propelled grate.

In this way waste continuously enters one end of the furnace and ash is continuously discharged at the other. Hot combustion gases flow upwards from the grate across banks of boiler tubes where heat is transferred to water generating steam. The steam can be passed through a steam turbine that can be used to drive an electrical generator.

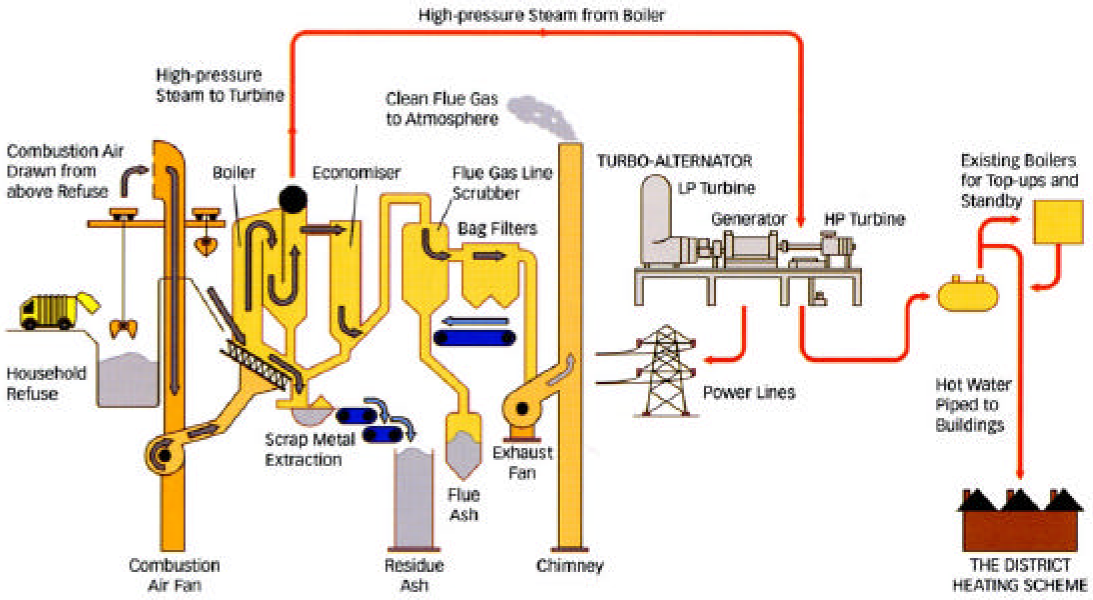

Figure 5 Schematic of a conventional system (source: Household Waste Management in the UK)

Fluidised Bed (FBC)
In a fluidised-bed, the burning fuel is suspended in an upward flowing stream of air. This takes place in a furnace section containing a bed of refractory sand or limestone supported by an air distributor plate or nozzle system. The bed resembles a violently boiling liquid. The refractory sand or limestone bed material is usually present in larger quantities than the waste itself, and this gives it a high thermal mass, which allows operation with waste of highly variable properties. Fluidised beds have a number of characteristics that enable them to achieve low air emissions.

What are the products?

Energy - to provide steam or hot water for industrial or domestic users, or for electricity generation – the process is 20 – 25% efficient if only electricity is generated but can be up to 80% efficient where the heat is also utilised.
Ash - The conventional combustion process produces two types of ash: bottom ash (about 20wt% of input waste) and fly ash (about 5wt% of input waste). Bottom ash is inert and can be used in the construction industry. Fly ash is a special waste and is normally consigned to landfill.
Metals – In conventional systems metals are separated from bottom ash and sent for recycling.

Is the technology established?

Conventional EFW technology is well established and fully commercialised with systems based on inclined and rotary grates being widespread. Systems based on FBC are less well developed and not yet fully commercialised.

Currently there are 13 energy recovery facilities operating in the UK, of which all but one are conventional systems. The other, an FBC system is deployed in Dundee - incoming waste is pre-sorted, for removal of ferrous metals and before it is fed to a fluidised bed boiler. Whilst the Dundee plant is the only one of its type in the UK to employ fluidised bed technology, use of fluidised bed systems, with waste throughputs of between 75,000 and 120,000 tonnes per annum, is well established in Scandinavia and Japan.

Most other European countries make more use of waste for energy recovery than the UK. There are around 300 energy from waste facilities in 18 European countries, treating approximately 50 million tonnes in total each year.

Advantages and disadvantages

Advantages

- Proven technology
- Achieves BMW diversion compliance
- Can yield very high recycling levels if combined with source segregation as part of an integrated strategy.

Disadvantages

- Public opinion over emissions and impact on recycling making it difficult to get planning permission
- Capital intensive requiring long term waste supply contracts
- Very limited market for heat contracts in UK limits process efficiency

What are the costs?

Capital costs for conventional energy recovery systems vary from around £40m for a 100 ktpa plant up to £100m for a 400 ktpa plant. Gate fees are typically £35 - £55/tonne.

Relevance to Darlington tonnages

EfW plants tend to be large scale facilities typically treating 200kpta. Facilities treating smaller tonnages can be built however the gate fees for such facilities tend to be higher. However, there are systems on the market that appear to be cost effective at scales of 50ktpa which may offer a potential option for Darlington

Summary

Energy Recovery Facilities can offer a very high recovery from the municipal waste stream, if managed effectively as part of an integrated waste management strategy. In the conventional form the technology is well established and fully commercialised. Energy Recovery remains the most cost effective and proven method of maximising the diversion of residual waste from Landfill.

MECHANICAL BIOLOGICAL TREATMENT (MBT)/ BIOLOGICAL MECHANICAL TREATMENT (BMT)

Mechanical Biological Treatment (MBT) is a generic term that encompasses a wide range of technologies that aim to process waste by a mixture of biological treatment and mechanical separation. In MBT the biodegradable fraction is treated post sorting, whilst in BMT the biological treatment or a thermal treatment such as autoclaving or thermal drying of the waste in undertaken prior to the sorting of the waste.

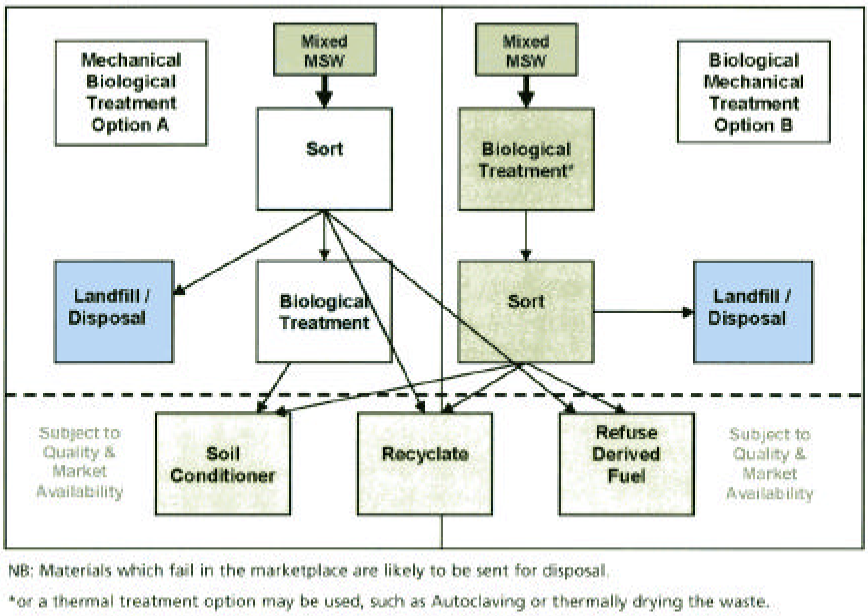

Figure 6 - MBT and BMT process. (Source – Defra)

What are the technologies?

MBT

Mixed waste is first sorted via a series of mechanical treatment options that separate out recyclable materials (e.g. metal and glass). All systems have sorting processes that separate various fractions and mechanically degrade the organic fractions through shredding, wetting and tumbling, or through the addition of steam. The main effect is to concentrate these fractions for further processing. The key difference between various systems is the choice adopted for processing the higher calorific value materials. Options include producing a substitute for fossil fuels (RdF), or removing the higher calorific components such as plastics and processing the residue to produce compost.

The main biological process can be carried out either aerobically (composting) or anaerobically (digestion - AD). Whilst biologically these are different processes the final degraded solid products are similar, with anaerobic digestion having the added benefit of generating a gas with a high methane content that can be used as a fuel.

BMT
Bio-mechanical treatment (BMT) is a special case of MBT where the whole of the waste is treated biologically prior to sorting. This biological treatment is principally to dry the waste thus making subsequent mechanical separation more effective.

Waste is aerated within composting vessels; as temperature rises so the moisture is driven off. After one to two weeks the waste is dried and undergoes mechanical separation to generate a fuel (RdF) fraction. The fuel is then prepared for market. The reject waste is still high in organics and can undergo further composting to generate a poor quality compost for landfill cover, but typically this fraction is simply landfilled as the most readily degradable materials are lost in the initial composting stage.

What are the Products?

The main outputs from the various MBT/BMT processes are:

- **Recyclables** - such as metals and plastics.
- **Organic rich fraction** - that is then composted or digested to generate a compost product
- **Fuel fraction** - that is either burnt on-site or sent for combustion in a remote combustion facility
- **Ash** - if the material is thermally treated there is the potential recovery of ash following combustion
- **Residues** - that have to be landfilled

Most configured to produce RDF or compost

The proportions of these fractions vary between the different proprietary processes but generally, depending on the feedstock, are within the ranges below:

- Recyclables 4 - 14%
- Organic/compost 38 - 70%
- Fuel (RDF) 0 - 46%
- Ash Recovery 0 - 25%
- Rejects 10 –25%

Is the technology established?

The various technologies that are available have relative strong reference plant lists in Europe and plants in the UK are being/have been developed in Leicester, East London, Dumpries and Galoway, Neath Port Talbot, Fife and Kinross etc. These facilities are all relatively recent and do not have a long track record. The technology itself is well established but the production of marketable products is less secure.

Advantages and disadvantages

Advantages

- MBT can make a significant contribution to compliance with the landfill directive and maximising recycling and recovery levels, providing the RDF and compost materials are utilised.
- Can be used to produce a consistent and stable fuel with a reasonable calorific value that could be used in a variety of ways.
- Considerable experience in Europe.

Disadvantages

- Potential problems in finding markets for BMT derived composts, the current views of the Environment Agency mean that mixed waste composts are likely to be limited to land restoration projects.
- A market for RDF in the UK is limited to cement kilns and this has an overall capacity of less than 300ktpa. Other markets are currently awaiting development as power stations and other potential markets will need to be WID [3] compliant.
- To date there is limited proven commercial experience in the UK.

What are the costs?

Cost information on MBT/BMT is based on European experience. Capital costs have been reported at around £32m for a 130,000 tonne MBT plant Operating costs, excluding collection, are quoted at between £30-£70/tonne. However, recent bid data is suggesting cost may be higher than this in the £60-£100/t range

Relevance to Darlington tonnages

MBT does have financial benefits at smaller scales but as with any process there are economies of scale. Unit scales are typically of 100ktpa and thus just within the Darlington's range.

Summary

MBT/BMT isn't a total solution to managing MSW but it could have an important role as part of an integrated approach. The main barrier to the technology is the marketing and quality of the products, if you want MBT just as a pre-treatment to landfill it is well proven, although this treatment may not meet the Landfill Directive targets. The uncertainty comes when the process is used to produced products to be sold to markets.

[3] Waste Incineration Directive