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**Friends of  
the Earth**

# Briefing

# Autoclaving

## Summary

Autoclaving involves the high-pressure sterilisation of waste by steam, which 'cooks' the waste and so destroys any bacteria in it. This process is widely used to treat clinical waste, but is increasingly being proposed as a treatment for municipal waste.

The process creates a so-called 'fibre material' from the biodegradable portion of the waste, which is separated along with some recyclable materials. Although there are no facilities operating commercially to treat municipal waste in the UK, there are several plants being built or planned.

There are currently no clear markets for this 'fibre material', which will consist of a wide range of materials e.g. food, paper etc. This material would also still biodegrade if landfilled, so would require further treatment (e.g. composting) prior to landfill. It is therefore likely that much of the output from autoclaves will end up being burnt as 'refuse derived fuel'.

This briefing explains what the process involves, and what are the benefits and disadvantages - and uncertainties - of the process.

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## **Autoclaving**

### **How autoclaving works**

Autoclaving of municipal waste is a form of 'mechanical heat treatment' (MHT) - a process that uses thermal treatment in conjunction with mechanical processing.

Waste may initially be screened for the removal of any large items, and possibly shredded. The unsorted waste is sealed in an autoclave, which is a large, enclosed vessel about the size of a long fuel tanker that rotates to agitate and mix the waste.

Using the 'pressure cooker' principle, steam is injected at pressure - raising the temperature up to 160°C (degrees centigrade). The pressure is maintained for between 30 minutes and one hour. This sterilises the waste, by destroying bacteria present. It reduces the volume of waste by about 60 per cent, and reduces the moisture content.

The cellulose in all the organic matter – the biodegradable waste including food and garden waste, paper and card - is broken down into a 'mush' of fibre, sometimes know as floc or fluff.

After autoclaving, the waste is discharged and processed by mechanical separation technologies, similar to those used in MBT systems. Metals will be extracted for recycling, and possibly also plastics for recycling and glass for re-use as aggregate. There is a residue or 'reject fraction' that needs to be landfilled.

Typical outputs are<sup>1</sup>:

- 64% 'organic fibre'
- 17.5% recyclables
- 2.5% aggregate
- 16% other materials suitable for landfill
- 9% mixed plastics
- 4% glass
- 3.5% steel
- 1% aluminium

The water used in the process will usually be trapped and recycled, and wastewater will be discharged as an effluent stream, which removes pollutants from the process.

### **Options for the 'fibre'**

The so-called 'fibre' is the main output of autoclaving, as biodegradable waste makes up the largest proportion of municipal waste. It is still classified as a waste so requires a waste management licence and is subject to legislative requirements relating to its handling, storage and disposal. It is also still biodegradable, so would have to be further treated (e.g. by composting) before landfill.

It is clear that this 'fibre' will be made up of a wide mixture of material, from half-eaten food to cardboard and green waste.

After autoclaving, the fibre has a very high moisture content of up to 50 per cent, so it must be dried before further processing, which requires a significant heat input. It can be stored for over a week if dried to 5-8 per cent moisture, but if not dried it will begin to deteriorate (i.e. rot) within 24 hours.

This fibre may be contaminated by hazardous municipal waste, for example electronic and electrical waste or batteries, as there is no front end recycling to remove this from the waste stream prior to autoclaving. High levels of some metals have been found in the fibre<sup>ii</sup>, which could restrict its potential uses.

Various potential applications are being proposed for recycling or recovering the fibre, including composting, anaerobic digestion and creating a refuse derived fuel, each of which are outlined in more detail below.

All the options for the outputs outlined below are dependent on the availability of sustained markets and outlets, most of which are yet to be proven on a commercial scale in the UK<sup>iii</sup>.

This uncertainty makes autoclaving a risky choice for local authorities. If there is a problem with the fibre market, for example the recipient of the fuel no longer accepts it, then it is likely that this material would have to be landfilled and subject to potential fines under the Landfill Allowance Trading Scheme (LATS).

For more information on the Landfill Allowance Trading Scheme see the briefing at [www.foe.co.uk/resource/briefings/lats.pdf](http://www.foe.co.uk/resource/briefings/lats.pdf)

## Recycling

Those marketing Autoclave technology claim that there are potential markets for recycling of the 'fibre', for example using the fibre as a raw material in product manufacturing, for example as a sawdust replacement to make MDF fibre board, mixed with cement to produce building products or mixed with crushed shale and a resin to manufacture composite materials, for example floor tiles. Another use being considered is washing the fibre to extract the long cellulose fibres, to use in making paper pulp<sup>iii</sup>.

However, the mixed nature of this 'fibre' does raise real questions as to how realistic these markets are. Would half-eaten meat pies really make a good feedstock for MDF?

## Biological treatment

The fibre can be biologically processed - either composted or treated with anaerobic digestion (AD), which produces a biogas. In effect, this means that the waste is being treated with autoclaving prior to mechanical biological treatment (MBT). Because the heat will have destroyed the bacteria in the waste, the fibre may need to be mixed with compost to 'seed' it with microbes.

For more information on anaerobic digestion see the briefing at [www.foe.co.uk/resource/briefings/anaerobic\\_digestion.pdf](http://www.foe.co.uk/resource/briefings/anaerobic_digestion.pdf)

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For more information on mechanical biological treatment see the briefing at [www.foe.co.uk/resource/briefings/mchnical\\_biolo\\_treatmnt.pdf](http://www.foe.co.uk/resource/briefings/mchnical_biolo_treatmnt.pdf)

The end product will not be as clean as compost produced from food or garden waste that has been separately collected and processed, for example it may have high concentrations of some heavy metals<sup>ii</sup>. It will not be compliant with the UK specification for compost, BSi PAS 100 and will not be suitable for using as a compost on agricultural land and for horticulture.

The residue created when mixed municipal waste is biologically treated is known as a 'compost-like output' (CLO). This can be used as a landfill cover or spread on previously developed land to improve that land. If this is the end use of the fibre, the autoclave process needs to be designed so that as much non-biodegradable waste as possible is removed from the fibre.

The residue could also be sent to landfill. Biological processing reduces the biodegradability of waste, meaning it is 'bio-stabilised' - it has a lower potential to degrade and produce the climate change gas methane in landfill. As long as the stabilisation process meets the regulatory requirements set by the Environment Agency then it will not count towards a local authority's LATS allowances for landfilling biodegradable waste.

## **Refuse derived fuel**

Another market being proposed for the fibre is to convert it into refuse-derived fuel (RDF) to be incinerated and produce energy. This may take place at another site or as part of the same facility, as is planned for an autoclave and gasification pyrolysis facility being built in Bridgend, Wales by companies 3NRG and Prestige<sup>iv</sup>.

Friends of the Earth does not support processes which produce and burn RDF, as this releases harmful emissions, including fossil-fuel derived carbon dioxide, which contributes to climate change.

It is also a waste of resources, especially as it may mean that certain high-calorific elements of the waste stream, with combustible properties (e.g. paper, plastic), are left in the fibre rather than being separated for recycling.

For more information on the problems of incineration, see our briefing 'Up in smoke' at [www.foe.co.uk/resource/media\\_briefing/up\\_in\\_smoke.pdf](http://www.foe.co.uk/resource/media_briefing/up_in_smoke.pdf)

## **Potential benefits of autoclaving**

The claimed benefits of autoclaving municipal waste are similar to those of MBT:

- autoclaving involves removal of recyclable materials from the waste stream
- plants are modular - they are made up of small units which can be added to or taken away as waste streams or volumes change
- plants can be built on a small scale, which would not drag waste in from a large surrounding area.

However, it is not clear whether the autoclaving process has any benefits over MBT, particularly given the fact that autoclaving in itself does not reduce the biodegradability of the waste, and the important question marks over recycling the 'fibre'.

Technology providers claim that the amount of material that can be recycled, and the quality of recyclable materials, are higher than for MBT technologies, because of the changes to the physical characteristics of the waste.

- During autoclaving, the heat disintegrates label glue on bottles, jars and tins, so that labels are removed and form part of the fibre. These packaging materials should also be cleaner, with most of the food waste removed.

- The quality of metal recyclables is increased by stripping away labels and glue from food cans, so they may be worth more and be easier to market to reprocessors, who will not have to clean materials themselves. However, there may be some fibre trapped inside containers, which could cause a quality issue for reprocessors<sup>iii</sup>.

- The heat shrinks certain types of plastics, possibly making them easier to remove. However, the heat has different effects on the different types of plastics. Depending on the process and the polymer type, this can make the plastics more or less difficult to recycle. Some, such as dense plastics like PET and HDPE, are deformed but retain a recognisable state. Others, especially plastic films, form hard balls of dense plastic. These balls trap food contamination meaning they cannot be recycled into similar products.

In Friends of the Earth's view, all types of plastic should be recycled if possible, as that would deliver greater greenhouse gas benefits than landfilling or incinerating it.

The sanitisation of the waste via the destruction of bacteria is said to have storage, transport and handling benefits. Odour may also be reduced. However, this sanitisation effect will be short lived, as bacteria will soon re-enter the waste.

### Carbon and energy balances

Autoclaving has been used for many years to sterilise hospital and surgical equipment and for the sanitisation of some clinical wastes, prior to landfill. In these uses the key feature of autoclaving is that it will kill infectious bacteria and other materials, preventing the spread of disease.

However, the application of the technology to municipal waste is fairly recent. There is little commercial experience of using this feedstock and very few municipal waste facilities operating commercially elsewhere in the world. Most of the operational experience for autoclaving municipal waste is based on small scale or mobile demonstration plants. There are no commercial scale plants currently operating in the UK, although several are in the planning stage.

So far none of the companies planning to operate in the UK have stated their technology's greenhouse gas balance figure compared to landfill. Some say that they will once their process is optimised or they have received an independent life-cycle analysis<sup>v</sup>.

One company, Yorwaste, has released information on the energy requirements of its

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process. It states that its autoclave could require 285 kilowatt hours of gas and 40 kWh of electricity to treat each tonne of waste. Although it expects to reduce these figures, they do not compare favourably to a typical MBT plant, which requires around 70kWh of electricity per tonne of waste<sup>v</sup>.

A recent report for the Greater London Authority by Eunomia compared the greenhouse gas emissions of various waste management scenarios<sup>vi</sup>. One scenario involved autoclaving followed by gasification of the organic fraction, which was rated highly based on the data provided by technology providers. It suggested that 'autoclave technologies, if implemented and operated as planned by technology suppliers, have potential to be part of relatively well performing scenarios'. However the authors were not able to base their assumptions on actual performance, due to the lack of operational facilities. They warn that the study was did not assess the technical viability of technologies and since autoclaving is not proven commercially only "limited conclusions" should be drawn from its rankings<sup>vi</sup>. A major reason for the high score for scenarios involving autoclaving was the claim that this technology would make it easier to separate larger quantities of recyclable materials, e.g. plastics.

It is clear that independently verified data is required on the energy efficiency of the process and its carbon impact compared to other technologies before it can be established how effective each autoclaving system is for dealing with municipal waste.

### **An alternative to separate kerbside recycling collections?**

Some companies are proposing that autoclaving is an alternative to a separate collection of recyclable materials, for example in high rise flats where it may be difficult to store and collect recycling. It is claimed that this reduces collection costs and simplifies the life of householders.

However, this approach should be avoided, and where possible all households should be provided with a doorstep collection service. Keeping recyclables separate from the residual waste stream in the first place provides more recyclables that are of a better quality, uses less energy and will have a lower impact on the climate.

It avoids the energy used in autoclaving, and the energy then required to separate the recyclable materials from the waste stream. It also avoids them getting contaminated, for example with food waste.

Some materials that can normally be easily and efficiently recycled will not be suitable for recycling if it is separated from mixed waste. British Standard BS EN 643, supported by the main trade associations of the paper recycling sector, states that 'Recovered paper from refuse sorting stations is not suitable for use in the paper industry'.

Unlike source separated food and garden waste treated with composting or anaerobic digestion, the biodegradable part of the mixed waste stream will not create a clean enough compost to apply to land.

## **Autoclaving Proposals**

Autoclaving is being offered by a range of technology providers in the UK. Several plants proposed four years ago have not emerged (Estech plants in Herefordshire and Worcestershire), but several facilities are currently being built or planned, including<sup>Y</sup>:

### **Graphite Resources**

- **Gateshead, Tyneside**  
300,000 tonnes per annum (tpa)  
Under construction, to be operational winter 2009

### **Sterecycle**

- **Rotherham**  
100,000 tpa  
Planned to start operating in 2008, expected to initially treat unsorted commercial waste. Output will be treated with either AD or 'biomass' CHP.

### **VT Group**

Bought Estech Europe in 2008.

- **Wakefield, Yorkshire**  
150,000 tpa  
Applied for planning and environmental permitting in June 2008, preferred bidder for Wakefield's waste private finance initiative document.
- **Hartlebury, Worcestershire**  
100,000 tpa  
Under review, but has planning and environmental permitting.
- **Madley, Herefordshire**  
100,000 tpa  
Under review, has planning permission but has not applied for environmental permit.

### **Yorwaste / Waddington Recycling**

- **Bradford**  
300,000 tpa  
Has planning permission but has not applied for environmental permit. Plan to be operational by spring 2010. Preferred bidder for Bradford's interim waste contract.

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## Conclusion

The companies providing autoclave technologies make bold claims about the benefits of this process. However, these assertions should be treated with scepticism until companies are willing to provide information to show whether their technologies provide any overall benefit for the climate and how much energy their processes use overall. In addition, Friends of the Earth is very sceptical about the claims made regarding the potential for recycling the so-called 'fibre' produced by the autoclave process.

There is also doubt over how cost effective autoclaving is and how beneficial it is in terms of improving the quality of recyclable materials, compared to source separated systems and MBT systems.

As things currently stand, it should probably be assumed that most of the output of autoclaves will be burnt in some way as refuse derived fuel. Friends of the Earth opposes the burning of refuse derived fuel.

An autoclave may achieve better separation of recyclables than some MBT approaches (though there is a lack of data in this area), but it will not stabilise the outputs, so councils will need to use up LATS permits if the output is landfilled.

In summary, it is unclear what advantages an autoclave would have when compared with a flexible MBT system that is designed to maximise recycling and stabilise the residue, which is Friends of the Earth's preferred residual waste technology.

Given that Friends of the Earth opposes the burning of refuse derived fuel, it seems unlikely that we will feel able to support autoclaving proposals.

## References

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<sup>i</sup> Estech Europe, [www.estecheurope.com/home.htm](http://www.estecheurope.com/home.htm)

<sup>ii</sup> E. K. Papadimitriou, J. J. R. Barton, E. I. Stentiford, 'Impact of hydrothermal treatment of non-segregated MSW on levels of heavy metals in compost / digestate', *Orbit conference paper* (2006)

<sup>iii</sup> Defra (2007), *Mechanical heat treatment of municipal solid waste*, [www.defra.gov.uk/environment/waste/wip/newtech/pdf/mht.pdf](http://www.defra.gov.uk/environment/waste/wip/newtech/pdf/mht.pdf)

<sup>iv</sup> M. Flynn & R. Bingham, 'Black bag energy – Thermal treatment of waste using autoclaving and pyrolysis', *Waste management world* (Nov-Dec 2007)

<sup>v</sup> 'First autoclave plant for non-clinical waste', *ENDS Report* (July 2008)

<sup>vi</sup> Eunomia Research and Consulting (2008), *Greenhouse gas balances of waste management scenarios - report for the Greater London Authority*, [www.london.gov.uk/mayor/environment/waste/climate-change/greenhousegas.jsp](http://www.london.gov.uk/mayor/environment/waste/climate-change/greenhousegas.jsp)