Biological Treatment
of Household Waste

Biological Treatment is using the latest technologies to treat biodegradable wastes using tightly controlled biological processes.
Biological Treatments

All biological waste treatment processes involve the decomposition of biodegradable wastes by living microbes (bacteria and fungi), which use biodegradable waste materials as a food source for growth and proliferation.

Microbes excrete specialised enzymes that digest biodegradable waste constituents (e.g. cellulose and other complex polysaccharides, proteins and fats) into simple nutrients (e.g. sugars, amino acids, fatty acids), which they absorb.

As the microbes grow and multiply a significant proportion of this is converted into heat, carbon gases and water, which can result in large losses in mass during biological treatment. (See box A).

Microbes live in two main types of conditions

There are two main types of conditions in which such microbes live, and therefore two main classes of biological processes used to treat biodegradable waste:

Aerobic – in the presence of oxygen; and

Anaerobic – in the absence of oxygen

Uses

Biological treatment can be used for garden waste, food waste and also for the biodegradable fraction which has been separated from mixed residual municipal solid waste (MSW) at a mechanical biological treatment facility (MBT).

Further information can on MBT in Greater Manchester can be obtained from our fact sheet.

www.recycleforgreatermanchester.com/recov/er/how-we-recover-energy

Biological treatments are designed and engineered to control and enhance natural biological processes, and as such can only act on biodegradable organic materials. The biodegradable organic materials within municipal waste are known as BMW (biodegradable municipal waste).

The output from biological treatments is usually in the form of compost or digestate (the remnants after anaerobic digestion) which can safely be applied to agricultural land*.

* Compost that has been produced from source segregated waste is currently only allowed to be applied to agricultural land.
There are economic reasons as well as regulatory objectives for reducing the amount of waste going to landfill. Landfill tax from April 2014 is £80 per tonne. This will then remain at least at this level until 2020.

Biological treatments can be used as:
- A pre-treatment of waste going to landfill, to reduce its biodegradability, if unsuitable for application to land;
- Diversion from landfill by producing compost or a digestate.
- To divert biodegradable MSW going to landfill if using biological treatment within an MBT by:
  - Reducing the dry mass of BMW prior to landfill
  - Reducing the biodegradability of BMW prior to landfill
  - Stabilisation into a compost-like output (CLO) for potential use on land
  - Deriving a combustible biogas from the organic waste for energy recovery; and/or
  - Drying materials to produce a low calorific organic fraction for use as a fuel (Refuse Derived Fuel - RDF).

For more information, contact us:
www.recycleforgreatermanchester.com
E: communications@recycleforgreatermanchester.com
### Types of Biological Treatment

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<td>Composting</td>
<td>Biodegradable material such as garden and food waste is decomposed into carbon dioxide (CO₂), water (H₂O), and heat which are lost to the atmosphere. This process occurs through microbial respiration in the presence of oxygen (aerobic) leaving a stabilised residual solid material i.e. compost. If source segregated biodegradable material is treated, oxygen is often supplied passively through the presence of air or through mechanical turning. A large amount of biologically produced heat is created as the microbes respire. This produces high temperatures of 60-70°C. These high temperatures have the advantage of killing potentially pathogenic organisms in the waste.</td>
<td>A mixture of non-biodegradable materials; recalcitrant (hard to break down) organics; microbes and microbial remains; and a complex of decomposition by-products called humus. This stabilised and dried mixture is known as compost.</td>
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### Anaerobic Digestion

### Key Features

- During Anaerobic Digestion (AD), biodegradable material is converted into methane (CH₄) and carbon dioxide (CO₂) (together known as biogas), and water.
- This takes place by microbial fermentation in the absence of oxygen leaving a partially stabilised wet organic mixture.
- AD is either a ‘wet’ process used for materials with moisture contents more than 85% or a ‘dry’ process used for materials with moisture contents less than 80%.
- Anaerobic processes require less energy input than aerobic composting and create much lower amounts of biologically produced heat. Additional heat may be required to maintain optimal temperatures but the biogas produced contains more energy than is required i.e. the process is a net producer of energy.

### Outputs

- Biodegradable material is converted into a combustible gas known as ‘biogas’ primarily consisting of a mixture of methane and carbon dioxide. Biogas can be burned for heat and/or electricity production, or cleaned for use as a fuel or injection into the gas national grid.
- The material remaining consists of a wet solid or liquid suspension of non-biodegradable materials; recalcitrant organics; microbes (biomass) and microbial remains; and decomposition by-products. This partially stabilised wet mixture is known as ‘digestate’.
- This wet mixture can be de-watered into its solid and liquid fractions.
- The untreated, de-watered, solid fraction can be used as a soil amendment provided it meets the appropriate regulatory standards. It can also be aerobically treated to produce a compost-like material. Alternatively it can be used as an RDF and sent to a combined heat and power plant (CHP) to be burned.
- The liquid fraction may be recycled in the process, used directly on land as a liquid fertiliser (provided it meets the appropriate regulatory standards) or used to maintain moisture during the aerobic treatment of the solid digestate.
- Alternatively the liquid fraction may be treated and discharged in accordance with the site permit requirements.
The Energy Balance in Anaerobic Digestion

Energy based on fossil fuels is a limited resource. Anaerobic digestion (AD) is a highly efficient process for producing energy from the organic fraction of waste.

When determining the sustainability of waste as “an energy source the overall energy balance must be taken into consideration including parasitic inputs and beneficial outputs” (Salter and Banks 2008).

The parasitic inputs include energy required for feedstock growth, collection and preparation. In the case of AD the outputs are energy in the form of biogas and digestate which can be used as a bio-fertiliser. “With most organic feedstock materials the energy available in the biogas exceeds that of producing and processing the feedstock.” (Salter and Banks 2008).

The biogas produced has a range of uses including heat, electricity through combined heat and power units and as a vehicle fuel. The bio-fertiliser replaces mineral fertilisers with the associated saving in energy and greenhouse gas emissions. “The energy balances and yields compare favourably with other biomass based fuels” (Salter and Banks 2008).

References