

Landfill Waste

Summary:

What is landfill waste? Whatever we produce for ourselves and then consume (useful things like food, clothes, books, houses, furniture and so on) there are bits and pieces left over that we don't want. And even when we try to reduce this unwanted production by reuse, recycling, or by conversion to energy, we are still left with something. So we put it in a landfill – and it becomes landfill waste – and unfortunately unless it is carefully monitored and controlled, it has the potential to produce unwanted emissions into the environment over a long period of time. This article quantifies landfill waste. About 750 million tons of household landfill waste are produced every year, world-wide. The article breaks down this figure for data collected by the UK Environment Agency, and contains a table of the waste categories identified by the EU. One of the features of the LDAT landfill waste degradation and transport model, is that it accepts the key waste categories, green waste, wood, food, paper, cartons, textiles, carpets, and inert material. LDAT then identifies the chemical compounds in the waste categories, and then links these into the bio-chemical stoichiometric equations of the chemical reactions that model the waste degradation. The decomposition of the landfill waste starts off by dissolving the non-inert waste into the liquid leachate, and then converts it into gas. The LDAT landfill waste degradation and transport model can estimate how the leachate quality and gas emissions will change with time.

Landfill waste in detail

Noise is often defined as unwanted sound. One woman's sound is another man's noise. Similarly waste can be defined as unwanted material.

We do our best to minimise waste because it is nuisance. But we produce it continuously. It is the inevitable by-product of production. Whatever we produce for ourselves and then consume (useful things like food, clothes, books, houses, furniture and so on) there are bits and pieces left over that we don't want. And even when we try to reduce this unwanted production by reuse, recycling, or by conversion to energy, we are still left with something. So we put it in a landfill.

A Physicist would say, "It's the 2nd Law of Thermodynamics"!

Worldwide, about 900 million tonnes of post-consumer waste are produced and about 85% of this is disposed to landfills or on land sites. The waste is predominantly inert but about 10% is degradable into the greenhouse gases methane and carbon dioxide, and contaminants in the waste have the potential to pollute neighbouring soils and groundwater resources, (Bogner, Ahmed et al. 2007).

The USA produces about 270 million tonnes of household waste per year, of which 52% is landfilled. China landfills 120 million tonnes.

The UK data is shown in the Table below. This gives details about how the waste is processed.

UK Waste 2016 tonnes	Total	Landfill	Energy recovery	Incineration	Recovery other than energy recovery - Except backfilling	Recovery other than energy recovery - Backfilling	Land treatment and release into water bodies
Household waste	27,589,196	15,659,467	6,507,468	3,370,762	1,898,523	152,975	-
Commercial and Industrial	186,698,033	36,611,995	823,600	2,313,790	102,104,202	16,657,017	28,187,428
Total waste treated	214,287,229	52,271,463	7,331,069	5,684,552	104,002,725	16,809,992	28,187,428

Household waste, which is currently being produced at the rate of 410 kg/person/year, accounts for just 13% of the total production. 25% of the total is processed by landfill. 57% of the household fraction goes to landfill.

In 2010 the total waste processed in the UK was 200 million tonnes and, as now, 25% went to landfill. However the percentage of household waste going to landfill was 81%, which indicates that the efforts to reduce the biodegradable fraction in landfills are being effective. Between 2010 and 2016 the energy recovery from waste has increased 10 fold.

UK Waste 2010 tonnes	Total	Landfill	Energy recovery	Incineration	Recovery other than energy recovery - Except backfilling	Recovery other than energy recovery - Backfilling	Land treatment and release into water bodies
Household waste	31,522,938	25,571,015	224,785	4,271,341	1,417,623	16,644	21,530
Commercial and Industrial	168,683,149	25,135,944	572,980	1,427,326	92,041,343	16,476,602	33,028,955
Total waste treated	200,206,087	50,706,959	797,765	5,698,667	93,458,966	16,493,245	33,050,484

Waste material may be characterised by dividing it up into components that can be identified and given descriptors and a unique code. The only problem is that there are a large number of components and they are being generated from a variety of waste sources. The coding system developed by the EU identifies 20 sources of waste, one of which is Household waste. The descriptors for these components and their codes is shown below as an example. The full list of waste sources, their component codes, and the methodology of application, may be found in (SEPA 2015).

20	Municipal wastes (Household waste and similar commercial, industrial and institutional wastes)
20 01	separately collected fractions (except packaging)
20 01 01	paper and cardboard
20 01 02	glass
20 01 08	biodegradable kitchen and canteen waste
20 01 10	clothes
20 01 11	textiles
20 01 13*	solvents
20 01 14*	acids
20 01 15*	alkalines
20 01 17*	photochemicals
20 01 19*	pesticides
20 01 21*	fluorescent tubes and other mercury-containing waste
20 01 23*	discarded equipment containing chlorofluorocarbons
20 01 25	edible oil and fat
20 01 26*	oil and fat other than those mentioned in 20 01 25
20 01 27*	paint, inks, adhesives and resins containing hazardous substances
20 01 28	paint, inks, adhesives and resins other than those mentioned in 20 01 27
20 01 29*	detergents containing hazardous substances
20 01 30	detergents other than those mentioned in 20 01 29
20 01 31*	cytotoxic and cytostatic medicines
20 01 32	medicines other than those mentioned in 20 01 31
20 01 33*	batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries
20 01 34	batteries and accumulators other than those mentioned in 20 01 33
20 01 35*	discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components
20 01 36	discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35
20 01 37*	wood containing hazardous substances
20 01 38	wood other than that mentioned in 20 01 37
20 01 39	plastics
20 01 40	metals
20 01 41	wastes from chimney sweeping
20 01 99	other fractions not otherwise specified
20 02	garden and park wastes (including cemetery waste)
20 02 01	biodegradable waste
20 02 02	soil and stones
20 02 03	other non-biodegradable wastes
20 03	other municipal wastes
20 03 01	mixed municipal waste
20 03 02	waste from markets
20 03 03	street-cleaning residues
20 03 04	septic tank sludge
20 03 06	waste from sewage cleaning
20 03 07	bulky waste
20 03 99	municipal wastes not otherwise specified
	Hazardous component

The main biodegradable components of waste may be grouped under the self-explanatory headings, Green waste and wood, Food, Paper, cardboard, cartons, and Textiles and carpets. Most of these arise from the Household waste source, although a small fraction finds its way into the waste processing stream from Commercial and Industrial sources.

The breakdown of the 52,271,463 tonnes of waste received by UK landfills in 2016 is given below and is compared to the analysis waste entering the Las Iguanas landfill serving city of Guayaquil, Ecuador.

Source	UK	Ecuador
Waste component	Dry fraction by weight %	
Green waste and wood	7	4
Food	6	58
Paper, cardboard, cartons	6	8
Textiles, carpets	2	8
Inert	79	22
Total	100	100

Guayaquil is one of the world's largest suppliers of banana products. The Ecuadorian waste data contains a large food processing industrial waste, and this clearly shows up in the data.

The non-inert waste materials decompose in the landfill, starting off by dissolving into the liquid leachate, and then converting into gas. It is possible to estimate how the leachate quality and gas production will change with time in the landfill. This is done by first identifying the chemical compounds in the components and then linking these into the chemical reactions that model the decomposition (or degradation).

1.6% of the waste landfilled in the UK in 2016 was hazardous and dealt with in specialist landfills dedicated to these waste streams. Where appropriate, some of the large fraction of inert waste is received by 'inert only' facilities, which are able to operate under a lighter regulatory regime.

Bogner, J., et al. (2007). "Waste Management, In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change." [B. Metz, O. R. Davidson, P. R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, UK and New York, USA.

SEPA (2015). Guidance on using the European Waste Catalogue (EWC) to code waste, Scottish Environment Protection Agency (SEPA).