Watch your waste

Mountains of waste, increasing environmental concerns and growing government pressure are intensifying the focus on waste management. Dr Tom Shelley looks at transformational technologies

According to a report by Research and Markets, 'Global Waste Management Market Assessment', municipal solid waste (MSW) generated worldwide reached 2.02 billion tonnes in 2006 and is expected to increase by 37.3% between 2007 and 2011. According to the Environment Agency, the UK alone produces 330 million tonnes of waste annually, a quarter of which is from households and business. The rest comes from construction and demolition, sewage sludge, farm waste and spoil from mines and river dredging.

Since 30 October 2007, liquid wastes have been banned from landfill, while solid waste now has to be treated. Treatment here means reducing its volume and hazardous nature, facilitating its handling and enhancing its recovery. The agency says: "Inert waste does not have to be treated if it is not technically feasible to do so," and "Waste … does not have to be treated if it would not reduce its quantity, or the hazards it poses to human health or the environment". However, close examination reveals these are small concessions – since by 'quantity', the agency means weight, not volume, so compacting doesn't help, except in terms of transportation.

Make no mistake: 'Big Brother' will be watching landfill sites, waste and water treatment facilities, and large industrial processors. And, while the Environment Agency cannot fine or order the imprisonment of miscreants, it can remove licences and effectively close down businesses that do not comply.

So what should you be doing? A first option is to sort it and recycle as much as practicable. Organic material can be composted and what's left, provided it burns, can be incinerated, with the heat used to generate electricity, or warm homes, offices or factories.

Ambitious engineering

However, doing this is not always as easy as it sounds. In the period 2004–2005, 168 million tonnes of waste were deposited at waste management facilities permitted by the Environment Agency in England and Wales. 106 million tonnes were treated, of which 72% went to landfill, 21% went for further 'treatment' and just 7% was incinerated. And of this 7%, only a tiny proportion was used as fuel to generate electricity.

In May/June 2005, Plant Engineer described the successful East London LondonWaste and Deptford SELCHP waste-fired generation facilities. Alluding to the Kent Enviropower plant at Allington, with its fluidised bed combustion chamber (due to handle 500,000 tonnes of non-hazardous waste

per year), SELCHP facility manager Stephen Tower (left) warned then of problems running fluidised beds with municipal waste. He was right: Allington has run into trouble with its fluidised bed, and waste in Maidstone is once more going to landfill.

All our attempts to interview the people concerned, visit the plant, or organise assistance by engineering professionals have been politely declined, so our advice remains as it was in 2005. It seems wise for now to stick to tried and tested technologies, such as German-designed moving grates. Even the 12.7MW poultry litter fuelled plant at Eye in Suffolk uses a conventional moving grate – and its feed stock is much more consistent than municipal waste.

Left: Eye power station in Suffolk – successfully burning chicken litter

Emissions

The plant at Eye, incidentally, has recently been equipped with a Quantitech multi-component FTIR gas analyser to monitor Cl, CO_2, NO_x, SO_2, HCl, H_2O, O_2 and particulates. Eye station manager Kevin Williams says: "The reliability and accuracy of the monitoring equipment are vitally important for the environmental performance of the power station. The data management regime that Quantitech has created not only helps us to ensure that we remain constantly within the emission limits, but to operate the plant as efficiently as possible."

Meanwhile, specifically on liquid wastes, given that they can no longer go to landfill, there will be increased interest in centrifuges to separate the solids in sludges. One company bound to benefit is Derbyshire-based Centriquip, which runs mobile decanter centrifuge rigs, housed in standard road vehicles, with equipment to plug into existing plant or provide standalone capacity.

Centriquip says its units can de-

Electronic waste

New technology is needed to cope with recycling some wastes and, in particular, electronic equipment, as now required by WEEE (Waste Electrical and Electronic Equipment) regulations. Professor Derek Fray, at the Department of Materials Science and Metallurgy, Cambridge University, is one that has been promoting a patented process flow sheet, developed to pilot plant, that recovers everything of value from old electronics.

Some 50,000 tonnes of printed circuit board (PCB) scrap is generated in the UK each year, which includes around £3 of gold and £3 of palladium in each kg, as well as copper, lead and tin. Fray's flow sheet starts with dissolving the solder and copper in dilute tetrafluoroboric acid at 60°C with an oxygen sparge. The components fall off and solder may be recovered from solution by electrolysis. Components can then be re-used or leached with hydrochloric and nitric acids to recover precious metals. The boards are shredded and may also then be leached to recover gold. Copper may be recovered from the precious metal leaching or by leaching with cupric solution. The remaining board material is burned in air at 600°C, with provision to recover the 3.5% of bromine released in caustic soda.

He says that the cost of a plant to process 10,000 tonnes of PCBs per annum would be about £3 million, and estimates that the profit per tonne of materials treated at about £90. This does not include the value of any recovered components, which he believes, "would be good enough to use in toys", and could fetch £1,500 per tonne. Fray reports a good deal of interest, but no licences as yet.

Recyling tetrapaks

Another Cambridge development is a pilot plant that can be used to recycle aluminium and polymers in Tetrapaks. According to Dr Carlos Ludlow-Palafox (right), director of Enval, 900,000 tonnes of drinks cartons, foil pet food pouches, coffee bean bags and toothpaste tubes are thrown away in Europe every year – of which 300,000 tonnes are recycled, leaving what he describes as "600,000 tonnes of plastic-aluminium mess" that contains 15% aluminium, but which mostly goes to landfill.

His approach is to pyrolise the mixture, using microwaves. The plastics, typically polyethylene, degrade and cleave into smaller molecules: alkanes and alkenes in the case of polyethylene, in the form of gases, oils and waxes. The gases are collected, and the oils and waxes condensed. "We are about to commission our first pilot plant on the Science Park," he says, adding: "The aluminium industry is happy to receive the aluminium in the form we produce."

As well as working with local authorities to process consumer waste, Enval is in discussions with packaging manufacturers to recycle their laminate offcuts and factory seconds. This unsoiled waste is ideal for recycling, as it requires no pre-cleaning. "Companies like Marks and Spencer and Tesco are constantly striving to improve their green credentials and reduce their waste footprint," says Carlos. "Food companies generate a lot of laminate waste during packaging, and we are working with them to capture this and turn it to their advantage. By 2008, we hope to have the first of our micro recycling units operational. These will be deployed to customers' own sites to undertake recycling of laminate waste material."

And he adds: "We simply cannot afford to send aluminium to landfill. Global consumption of aluminium is predicted to double between now and 2020, and producing virgin metal from ore requires 95% more energy than reclaiming used aluminium. There is a serious incentive for getting this right."

Anglia Water's Flag Fen water treatment plant in Peterborough: using a mobile decanter to supplement treatment facilities on plant

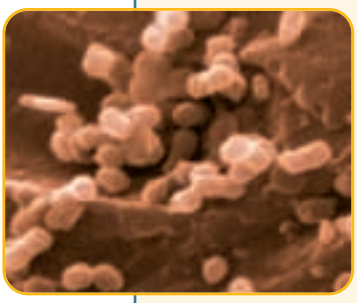
water industrial sludge or sewage and reduce it to disposable cake that can be safely and legally disposed of to landfill, recycled to agriculture or incinerated. The most common uses are: to provide extra resource to meet seasonal demand; for lagoon dewatering; to cover during routine maintenance; or to provide for disaster recovery.

Some plant managers also use it to evaluate the technology prior to purchase of fixed equipment. It's worth noting that the company provides training for staff or an engineer to operate the equipment and provide analysis of the feed, dry solids, polymer consumption and output quality. The engineer can also provide technical advice. One happy customer is Anglia Water, which used a mobile decanter to supplement its treatment facilities at its Flag Fen water treatment plant in Peterborough. The firm subsequently replaced its mobile unit with a CQ6000 decanter. PE

Bugs clean batteries

A Malaysian professor has come up with methods for using bacteria to remove hexavalent chromium from industrial waste water and to recycle non-rechargeable batteries, which come under the scope of a separate Battery Directive coming into force in September 2008.

A team, led by Professor Dr Wan Azlina Ahmad at the Universiti Teknologi Malaysia, has developed a process flow sheet that begins with shredding the batteries themselves, washing them and sieving them to recover any metallic zinc and iron for separation magnetically. The remainder is heated at 300°C for three to five hours and then leached.



Key to the whole process is a bacterium called thiobacillus ferrooxidans, which lives by successfully converting ferrous iron in solution to ferric oxide, while also acting as a leaching agent to dissolve the manganese. Manganese is then recovered as a precipitate and the remaining zinc recovered, using solvent extraction processes.