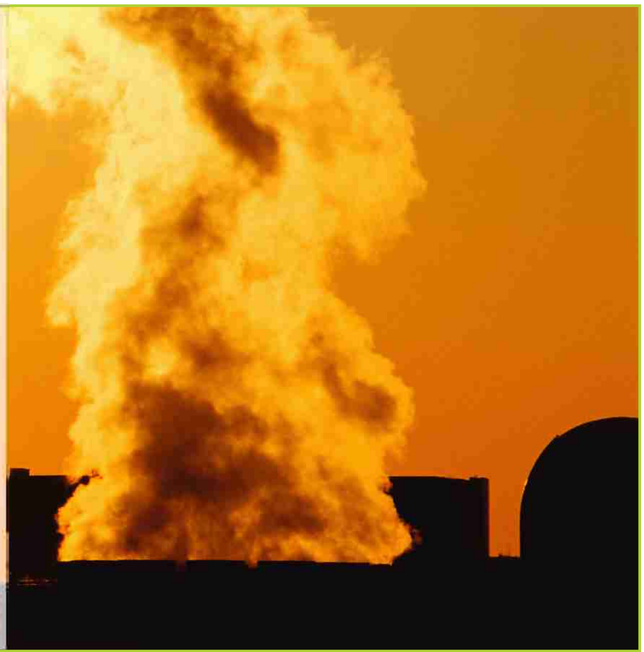
Safer, cheaper treatment of incinerator fly ash – a major step towards 'zero emissions' in waste management



New process for treatment of highly contaminated ash containing dioxins and heavy metals offers environmental benefits at realistic cost for incinerator operators

A new energy-efficient sintering process could offer a much cheaper and safer way of dealing with millions of tonnes of toxic fly ash produced each year at incinerator plants across the UK. The environmentally friendly solution has been developed at Sheffield University as part of a major waste minimisation initiative backed by government and industry.

Results of pilot-plant trials announced today (4th February 2002) confirm that the process could provide a commercially viable alternative to existing solutions such as special landfill, which is being increasingly tightly regulated, and vitrification, which consumes far more energy.

The technique could be applied to municipal, clinical and industrial incinerators, saving millions of pounds a year. Energy-efficient regenerative burners and specially designed cyclones are used in a sintering process that destroys toxic organic components, such as dioxins and furans, and converts heavy metals into an unleachable form. Residual ash can be turned into pellets for use in construction applications such as road foundations, or disposed of in normal landfill sites.

The process has been pioneered as part of the government's programme for Waste Minimisation through Recycling, Re-use and Recovery in Industry. The Engineering and Physical Sciences Research Council provided a grant of approximately £120,000 for the project and the main industrial partner Dyson Hotwork Engineering Ltd supplied the regenerative burners. Support was given by the UK Environment Agency and major municipal and clinical incinerator operators throughout the country who provided technical assistance and ash samples for the pilot plant.

According to its developers, the new process represents a milestone in the quest to achieve zero emissions from the waste management industry.

'Our target is to aim for zero net waste and that means we have got to make all the output useable,' says Professor Jim Swithenbank of Sheffield University's Chemical and Process Engineering Department. 'At the moment fly ash has to go in special landfill. It's expensive and there must be no possibility of toxic material getting into groundwater. So our philosophy of zero net waste is to detoxify the fly ash – and we have demonstrated a commercially viable way to do that.'

Extensive tests have been carried out on samples from the fully operational ash-detoxifying pilot plant. The results are regarded as exceptionally encouraging, eliminating any concern over the suitability of the sintered ash pellets for re-use. Concentrations of dioxins and furans are reduced below the detectable limit of 0.1pg/g. Up to 99.9% of some heavy metals are converted into metal oxides, reducing leaching potential by 96%, comparable to levels found in normal soil. Energy consumption and costs are cut by up to 50% by the heat regeneration process.

There could be a significant impact on future national and international codes of practice and standards for dealing with toxic fly ash.

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WMR3

(Waste Minimisation through Recycling, Re-use and Recovery in Industry) was a collaborative industrial research programme supported by £12m of funding from EPSRC and DTI during 1995 – 2003.

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'The results show this is a very cheap, very efficient and environmentally friendly technique,' comments principal investigator Dr Vida Nasserzadeh-Sharifi. 'We have proved on a pilot scale that the idea works and the results are excellent. This is a major achievement. The incinerator operators are very keen, and now manufacturers can take up the idea.'

Additional project details and background

Fly ash – what is it?

Fly ash is composed of tiny particles collected from incinerator flue gases by bag filters. It tends to be much more toxic than the main waste residue from the incineration process, known as bottom ash. Heavy metals such as lead tend to condense on the fly ash particles, which also trap tiny amounts of highly toxic dioxins and other hydrocarbons.

Impact of landfill restrictions

Under the Government's Landfill Directive, the amount of municipal waste going to landfill must be reduced. With tighter regulations for landfill sites, most wastes including incinerator fly ash will have to be treated before they are landfilled. The use of special landfill sites – the most common disposal method for fly ash in the UK at present – is being discouraged. Approximately 8% of municipal solid waste is currently incinerated each year and this figure is set to increase as more municipal and clinical waste incinerators are being built.

Alternative treatment methods

Environmentally acceptable fly ash can be guaranteed by using heat to destroy dioxins and furans, while removing or immobilising heavy metals. Vitrification processes originally developed to treat radioactive waste are one solution. However they are very energy intensive, typically consuming most of the power produced by an incinerator plant, and costing £100-£200 per tonne.

Pilot plant design and operation

In the new process, sintering takes place in an energy efficient regenerative system, which heats ash particles to around 850°C. Particles agglomerate as constituents are heated and softened. The regenerative ceramic burners, supplied by Dyson Hotwork Engineering Ltd, use up to 50% less energy than other thermal treatment techniques. The regenerator is made up of closely packed alumina spheres which maximise the area for heat transfer, making it possible to remove virtually all the heat from outgoing flue gases.

From the burners, sintered particles and flue gases are separated in cyclones specially designed to achieve maximum efficiency. High temperatures are maintained throughout the cyclones to ensure that there is no re-formation of dioxins and furans. Virtually all of the sintered particles are collected in airtight containers. Sample pellets have been produced from this material, showing that it could provide a premium aggregate for strengthening concrete.

Trial results

A number of major UK incinerator plants provided fly ash samples for the pilot plant. The highest concentrations of heavy metals were of lead and zinc. Tests on raw and treated ash showed the leachability of lead was reduced by up to 98% by the sintering process, which converts metals to stable oxide form.

Analysis of dioxin and furan content of raw and treated ash showed that levels were reduced to below detectable limits, less than naturally formed dioxin and furan levels found in typical soil samples. Such levels are considered acceptable for most forms of land use in Holland and Germany, including residential, dairy farming and children's play areas.

The use of heat regeneration achieved energy and cost savings of up to 50%. Fuel costs were reduced to between £4.50 and £10.90 per tonne compared to between £6.30 and £21.60 without regeneration, at a natural gas cost of £0.014 per kWh. Treated material can be used as construction aggregate instead of consigning it to landfill, which currently costs about £40.00 per tonne.

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