The Lethal Consequences of Breathing Fire

When the Victorians first conceived of incinerators in the late 19th century they called them 'destructor units', as this perfectly describes what they do. In principle little has changed. Despite the best efforts of the industry to rebrand and clean up incineration, the fact remains that 'garbage in' means 'garbage out'. Pat Thomas reports

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Roughly 2 1/2 million tonnes of municipal waste are incinerated in the UK each year. More efficient filters make emissions look clearer, but just because you don't see the pollution, doesn't mean it isn't there. The same toxic chemicals that were in our plastics, paper, textiles and wood when they went into the fire are still there during and after combustion. And their release into the air is still associated with a range of human health problems including cancer, reproductive problems and learning difficulties in children.

But the intense heat of incineration also helps create a whole range of new compounds with a completely unknown potential for toxicity. Indeed, the way that incineration changes the seen into the unseen and the known into the unknown is one of its most dangerous consequences.

Gas

Modern incinerators have measures in place to control the emissions they release into the atmosphere. These incinerators have to comply with tough standards set by European and UK legislation, which are designed to control acid emissions (using 'scrubbers'. Devices that use a high-energy liquid spray to remove acid emissions from the air stream), dust levels (using electrostatic precipitators, essentially dust magnets in the incineration unit) and fine particles (using textile filters).

Even so, a large incinerator produces the equivalent of 300 wheelie bins of exhaust gases from its chimneys every second. These not only pollute the local area, but are also carried on the prevailing winds to neighbouring cities and towns. Human beings are exposed to them by breathing contaminated air, by absorbing them through their skin and by eating contaminated food, such as vegetables, eggs and milk.

Because of their acidic nature incinerator emissions such as nitrogen oxides, sulphur dioxide and hydrogen chloride contribute to the phenomenon of acid rain, which is destructive to forests and lakes and the animals that inhabit them.

While a few hundred of the gases emitted by incinerators have been identified (see table), the process of heating and releasing emissions into the environment creates the possibility of thousands of new chemical compounds. There are no formal air quality standards for many of these and many have never been fully studied with regard to their effects on human health.

There is no technology that can remove all the pollutants and there are too many uncertainties and variables to say whether anything that gets released into the air is categorically 'safe'. While the health effects of mixtures of chemicals are largely unknown, the effects of single emissions such as dioxins and heavy metals, and also furans, PCBs, PAHs, numerous VOCs, acid gases and particulates, is better understood.

These substances are persistent – they remain in the environment indefinitely – and bioaccumulative, meaning that even small amounts build up in the body tissues over time. Some cause cancer, some trigger respiratory problems such as asthma and some are mutagenic – capable of causing genetic damage.

All these substances are legally released into the air. Many are not or cannot be measured or monitored at all and the Environment Agency (EA) has admitted that **current emissions standards are based on what is technically achievable rather than what is safe for human health.**

Microscopic particles

Newer incinerators appear to burn 'clean'. But while newer filters may keep larger particles from being discharged into the atmosphere, they do little to prevent the release of microscopic particles measuring just 2.5 microns in diameter (PM2.5). These particles are released into the atmosphere when oil and solvent-based mixtures are burnt in incinerators, as well as by industrial processes such as smelting and metal processing. In the last decade or so the amount of PM2.5 in our atmosphere has risen astronomically.

The incineration process liberates a range of heavy metals such as lead, mercury, arsenic, chromium and cadmium from otherwise stable matrices such as plastics, into the air. Because they are released as microscopic particles, these metals have the potential to penetrate deep into the lungs where they enter the bloodstream and are deposited in organs and tissues throughout the body.

At the high temperature used in incineration, mercury is particularly problematic since it can be turned into a gas that evades the most commonly used filters. Incineration of municipal waste is a major source of mercury in the environment. Even if filters such as activated carbon are used to absorb mercury before it can be released, the question of what happens to the mercury that is captured by the filtration process and how often the filter is changed remains.

Ash

Around 30 per cent of what is incinerated ends up as bottom ash, which is the ash and non-combustible material left over, and is disposed of in landfill sites. A further five per cent of incinerated waste ends up as fly ash.

Fly ash has a fine consistency and has to be sealed into containers and disposed of as hazardous waste in special landfill sites that are licensed to accept toxic rubbish. Bottom ash has a more gravel-like consistency and is 'recycled' by processing it into a suitable aggregate type material for use in the construction industry. In the EU bottom ash is considered a toxic residue. However, after 'ageing' (that is washing it, treating it to reduce its acidity and allowing it to stand for a period of one to three months), it is considered suitable for some construction purposes.

In addition to fly and bottom ash, the lime and carbon used to clean the filters are also considered toxic waste. The cleaning and scrubbing substances are highly contaminated with all the same chemicals as fly ash and need to be disposed of carefully.

The ash and cleaning substances generated by incinerators contain toxic chemicals. How these are eventually distributed into the environment and how they affect human health is less well studied than the effects of gases and microscopic particles.

Much depends on where the ash ends up. Incinerators produce about a million tonnes of contaminated ash each year and this ash is difficult to dispose of. 'Creative' attempts at disposal have included spreading ash on allotments and footpaths, as was the case in the late 1990s when decades of this 'recycling' of mixed fly ash and bottom ash from the Byker incinerator in Newcastle resulted in the worst dioxin contamination ever seen in a local area. Ash samples were found to contain 1,950 nanograms of carcinogenic dioxins, massively above the five nanograms they would have expected to find in a polluted area.

These days bottom ash cannot be mixed with much more toxic fly ash. However, this has occurred in the past, as was the case with waste from London's Edmonton incinerators, and used to build roads and car parks. Selling off toxic ash means incinerator operators can avoid expensive disposal costs and generate income. While the ash may be mixed with concrete, erosion takes its toll and some toxins are eventually returned to the environment.

The health fallout

Epidemiological and environmental studies show that certain types of diseases and health problems can and do occur with greater frequency in those who live close to incinerators. Operators often dismiss these health problems as coincidence. Since many incinerators are sited in impoverished areas where the residents are already at a higher risk of every type of illness, it could equally be argued that the strategic citing of incinerators in generally neglected areas is designed to hide human health effects.

Dioxins are arguably the best studied of all incinerator emissions, while operators argue that levels emitted from incinerators are small, this needs to be weighed against several important factors, not least of which is the unacceptably high background levels of dioxin already in the environment. Since many dioxins are known hormone disrupters, and since hormone levels are tightly controlled in the body, even small amounts – as little as one part per trillion in the blood – may translate into substantial hormone disruption, a risk factor for cancer, growth disruption and immune system dysfunction.

Dioxins also readily enter the food chain when they are deposited on grass and crops. It is estimated that, in one day, a cow grazing near an incinerator could put as much dioxin into its body as a human being would get if he or she breathed the air next to the cow for 14 years. Likewise, one litre of contaminated milk would deliver as much dioxin to a human being as he or she would get from breathing the air next to the cow for eight months.

Even small daily emissions of dioxins can, over time, build up in the environment and in the bodies of exposed populations, and while European regulators are more laissez faire, the US EPA says there are no safe levels of dioxins.

But dioxins are only one part of the complicated health equation related to incineration. According to Dr Dick van Steenis, a retired GP and anti-incineration campaigner whose research into the toxic effect of incineration fallouts has helped stop four incinerators from being built in the UK, the total cost of this virtually unregulated industrial air pollution is nearly 34 billion pounds per annum. That figure takes into account known emissions and van Steenis notes, there will be cumulative impacts in the body and synergistic effects, for example cadmium and lead in the body will multiply the effects of mercury by 50 times which will facilitate the development of ADHD and autism.

Once in the lungs, PM2.5s are capable of causing serious health problems ranging from asthma, allergies, type 2 diabetes, immune system problems and multiple sclerosis. US data links PM2.5s to greatly increased rates of heart disease.

Incinerators emissions are also linked with other diseases such as:

Cancer

Researchers have found significant clusters of cancer, which is thought to be due to exposure to dioxins. In residents living close to an incinerator in France, for instance, there was 44 per cent increase in soft tissue sarcoma and 27 per cent increase in non-Hodgkin's lymphoma. In Italy and the UK, studies show an increased incidence of cancer of the larynx.

UK data on people living near municipal waste incinerators and hospital waste incinerators show double the risk of dying from childhood cancer. And one of the largest ever studies in the UK, involving 14 million people living within 7.5 kilometres of incinerators, found a 37 per cent increased risk of death from liver cancer.

Hormone disruption

In residents living near an incinerator in Scotland the incidence of twins/multiple pregnancies is double the national average and in residents living near an incinerator in Belgium it is nearly three times as great.

It's not only reproductive hormones that are affected. Lower levels of thyroid hormone have been detected in children living near a German incinerator.

Birth defects

A report released by the Office of National Statistics (ONS) in 2005 examined the rate of birth defects in children living near incinerators over an eight-year period. Compared to the national average for England, 11/1000 children living downwind of incinerators, cement works, oil refineries, power stations and steelworks were significantly likely to be born with birth defects. In rural mid-Devon – where the local incinerator was the most significant source of pollution, the birth defect rates are 62/1000, compared to Bexley in London where, at the time of the survey, traffic, rather than the local incinerator, was the major source of pollution and the rate was 23/1000. The defects are the likely result of maternal exposure to particulates measuring 2.5 microns or less in diameter.

The report notes, in particular, that Bexley's birth defects rates are likely to increase following the decision to allow the White Rose incinerators to burn unlimited amounts of radioactive waste, such as that generated by hospitals.

The appearance of birth defects would suggest that the toxins released from incinerators can cause DNA damage. This is worrying enough. But newer evidence in the field of 'epigenetics' suggests that certain defects can be programmed into the body without making obvious damage to the DNA and that these defects are heritable – passed on down the generations.

Commonly defined as the study of heritable changes in gene function that occur without a change in the DNA sequence, epigenetics is reshaping the way scientists look at traditional genetics and their real world influence on health and disease.

The ONS data is consistent with a previous study linking industrial PM2.5 emissions with birth defects which was carried out at McMaster University, Canada in 2004. The McMaster study, although based on animal data, found that compared to mice breathing clean, filtered air, those exposed to ambient air near highways and steel mills containing PM2.5 developed mutations that were passed down through the generations, even though they showed no detectable signs of DNA damage.

What goes into the environment?

The table below does not represent the entire scope of possible health effects. Nor does it represent the full range of identified chemicals emitted by incinerators, which number up to 250 individual substances. The effects of mixtures of chemicals, for instance, are largely unknown. There may be more generalised problems that never get studied or reported such as hospital admissions or GP visits for vague complaints such as 'respiratory distress'. In addition, these effects are human effects and do not take into account damage to the ecosystem due to acid emissions.

Substance	**Health Effects**
Antimony	A number of effects, including respiratory
Arsenic	Class 1 carcinogen
Cadmium	Class 1 carcinogen
Carbon Monoxide	Reduced oxygen in the blood
Chromium III Chromium VI	Type VI is a Class 1 carcinogen
Cobalt	Class 2b carcinogen
Dioxins	Class 1 carcinogen (*as TCDD9*). Affects development and reproduction. Highly toxic, persistent, bioaccumulative. Can contaminate food
Hydrogen Chloride	Acid, irritant to tissue including respiratory tract
Hydrogen Fluoride	Irritant, affects bone formation
Lead	Class 2b carcinogen
Manganese	Neurological effects
Mercury	Neurological effects. Damages kidneys
Nickel	Class 1 carcinogen (as compounds of nickel)
Nitrogen Oxides	Respiratory effects (and is a precursor of ozone, which also contributes to respiratory problems)
PAHs (polycyclic aromatic hydrocarbon)	Some are carcinogens
Particulates/PM10s	Respiratory effects; no know safe threshold
PCBs11	Properties similar to dioxins
Sulphur Oxides	Respiratory effects
Thallium	May affects several organs and nervous system
Vanadium	Respiratory effects