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Profiles

Trace elements and fly ash utilisation

'Fly ash properties may change as plant adapts to meet new emission legislation'

'Unless the use of the activated carbon is controlled, the ash may become unsaleable'

'Ash sites are monitored to ensure any leaching does not pose a risk to the natural environment'

This report discusses trace elements in fly ash and how they may affect fly ash use now and in the future, as control technologies change to meet tightening emission legislation.

The study of trace elements in fly ash is complex. In addition to requiring state of the art analysis techniques to measure the low concentrations involved, appropriate sample treatment technologies must be employed to ensure that the sample is analysed appropriately.

The amount of any trace element in fly ash from coal combustion depends less on the initial trace element concentration of the coal and more on the combustion conditions and the volatility of the element itself. The majority of trace elements will partially volatilise during combustion and then become deposited on the fly ash particles in the cooler areas of the plant, generally on the smaller particles with a greater surface area to mass ratio. The one element which does not follow this rule is Hg. To some extent, the more Hg which enters the plant through the coal, the more Hg ends up in the ash. However, this is highly variable with factors such as temperature and the presence of other chemical species in the combustion zone and ash. The introduction of other fuels such as waste and sewage sludge to the combustion zone with the coal can increase the concentrations of some trace elements such as Cd and Hg.

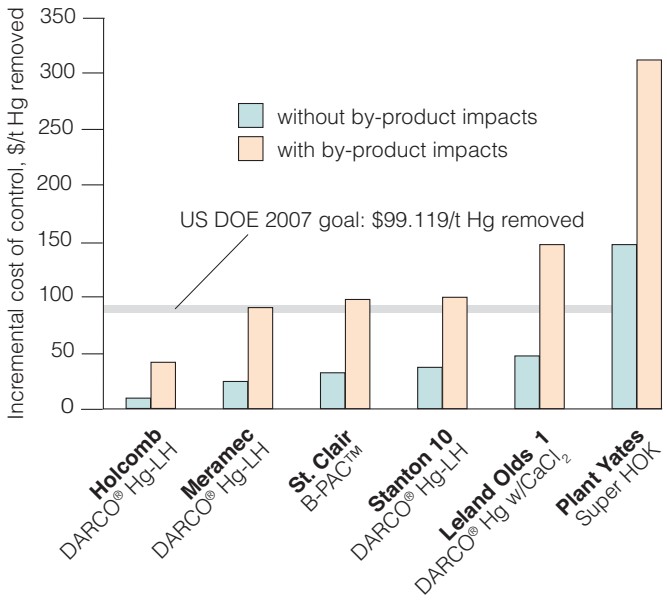
Any increase in unburnt carbon in the ash, either due to a lower combustion efficiency and/or the use of low NOx burners, can enhance the capture of Hg in fly ash. The use of manufactured activated carbons for Hg control will obviously increase the Hg concentration of the solid product. Unless the use of the activated carbon is controlled, the ash may become unsaleable. This is due more to the effects of the activated carbon itself on cement and concrete characteristics rather than any effect due to the increase of Hg. The majority of studies indicate that the Hg is trapped within the activated carbon and is not likely to pose a leaching threat.

Advanced particulate control technologies, such as COHPAC and Toxicon, will also produce ash which is higher in trace elements such as Hg. The US DOE is carrying out ongoing studies on plants fitted with these emerging technologies to ensure that there are minimal negative effects on ash sales since loss of fly ash sales can significantly affect the economics of mercury control options (*see the figure overleaf*).

The capture of trace elements in FGD systems is well characterised, with most elements ending up in the solid by-product material. Sorbents and reagents being developed to enhance FGD systems will enhance the capture of trace elements, including Hg, in the solid by-products. The majority of data suggest that Hg is stable in both fly ash and FGD by-products. However, the heat generated during the curing of concrete and, to a much greater extent, the preparation of wallboard, could lead to significant amounts of Hg being released. The Hg released will depend on the concentration in the ash or gypsum as well as the temperatures reached and the type of process used. It will be possible for plants either to adjust their processes or switch to alternative methods if the Hg release should be considered of concern.

The total trace element content of a coal combustion by-product material does not give a valid indication of the quantity of any trace element which will leach from the ash during utilisation or storage. For this, specific leaching tests are required to emulate the conditions the material will encounter in the field. Currently, most published research on leach tests includes caveats on the applicability of the results obtained from such studies. In most instances, the tests will overestimate the potential for trace element leaching in the short-term but may underestimate the potential for relatively major changes in the mineralogy of the ash and subsequent increase in leaching over extended periods (years) of time.

Other than standard legislation relating to common work place environments, there do not seem to be any specific limits or guidelines relating specifically to those working in the transport and storage of fly ash at or from coal-fired plants as fly ash is not considered a significant threat to human health in these situations. There are only a few legislated limits for cement and concrete which relate to trace elements. In Europe and the USA, the level of Cr(VI) is limited to reduce the occupational risk of skin irritation. Although this standard does not pose a problem for most fly ashes, it has resulted in a significant change to the



Incremental cost of 70% Hg control using activated carbon

market with cement and concrete now having a set, and very much shortened, shelf life. In cases where the Cr (VI) exceeds the limit, treatments are available, such as with ferrous sulphate, which can reduce the chromium to a less harmful form.

The radioactivity of building materials is regulated in many countries. Most countries accept that the minimal increase in radiation from trace elements in fly ash is insignificant enough to be ignored. However in Israel, despite the fly ash being of average radioactivity, the proposed legislation is so strict that fly ashes could be excluded from certain construction applications. Israel seems to be unique in this situation as few if any other countries have such concerns with radioactivity in fly ash.

Fly ashes and related by-products are often used for soil amendment and backfill type applications due to their physical and chemical properties. The trace elements in the ash can actually be beneficial to certain soils. Although elevated concentrations of some trace elements can occur in some soils they generally do not pose a threat.

Fly ash in ash dams may pose the greatest threat to the local environment due to the large amount of water available and the constant leaching activity. Treatments for ash dams based on metal oxides are being proposed to reduce the potential for trace element leaching.

Legislation in the USA is evolving to promote the dry handling of ash at coal-fired plants. This will mean greater quantities of ash in a saleable form and less to be disposed of in ash dams and landfill. It is believed that other countries may follow this lead which could significantly reduce the concern over the environmental effects of ash dams whilst simultaneously producing more readily marketable ash products.

Each issue of *Profiles* is based on a detailed study undertaken by IEA Clean Coal Centre, the full report of which is available separately. This particular issue of *Profiles* is based on the report:

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