Alternative monitoring procedures for coal ash and criteria for land use

Introduction

The environmental conditions for use of coal ash[1] that were formulated by the National Coal Ash Board (NCAB) are based on knowledge accumulated through research initiated by the NCAB over the years. The NCAB's scientific-professional team also recommended procedures and methods for monitoring the ash as well as parameters and criteria to evaluate the extent to which the ash is suitable for its designated uses, in particular concerning its use in infrastructures and agriculture (as well as construction products containing more than 50 percent ash). The formulated conditions apply to ash defined as "usable", i.e. ash that meets the standards based on the criterion defined by the European directive EN-12457-2 for non-hazardous waste. Tests conducted recently indicate deviations from this criterion, some of these deviations being significant, in the ash originating from certain sources.

The problem

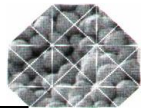
The European directive sets conditions for landfill disposal assuming the landfill is exposed to rain water, either through runoff over its surface, percolation through it or capillary rise from its base. The behavior of coal ash under the conditions that characterize its applications in soils (structural filler in roads infrastructure[2,3]; improvement of structure of soils for agricultural and conservation purposes[4]; stabilization of sewage sludge used as a supplement to agricultural soils[5]) is fundamentally different from its expected behavior as a filler in a landfill as per the definitions of the directive. Consequently, the results of the tests prescribed by the directive do not reflect the anticipated situation when the ash is used for soil applications.

The most significant differences are expressed by the following indicators:

Mode of application – The directive assumes a massive, regular fill exposed to the environment, whereas the applications of ash in soils or as road infrastructure are characterized by its insulation from the environment and by different conditions from those the directive envisioned. This is mainly due to the dispersion of the ash and its mixing with the soil in various proportions in applications in agriculture and infrastructure stabilization.

Changes over time – The directive assumes extraction of chemical elements under unchanging conditions, whereas the extractability of elements from coal ash actually varies (lessens) over time as a result of chemical processes that occur on the ash's surface (aging).

[1] Proposal for environmental conditions and monitoring, October 2010.
[2] Ten years of monitoring at Jisr-El-Zarqa coal ash embankment. Yaacov Nathan and Yoetz Deutsch, Geological Survey of Israel, July 2008.
[3] Permeability of a fly Ash layer in Highway 6 road embankment. Rami Keren, Volcani Center, 2009.
[4] Soil amendment for agriculture using fly ash. Pinchas Fine, Uri Mingelgrin, Shai Bartal et al., Volcani Center, September 2010.
[5] Stabilization of sewage sludge as an additive to soil using fly ash. Pinchas Fine, Uri Mingelgrin et al., Volcani Center, 2008.



Environmental characteristics -

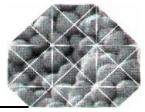
Reaction of the ash – The directive assumes an unchanging contact between the ash and its surroundings as well as infiltration of water through the ash layer, whereas the exposure of coal ash to the environment in road applications following compaction results in a crust that is impervious to water.

Acidity – The directive assumes that the pH level will rise due to the addition of the coal ash, whereas the pH in the soil following ash applications is (after a relatively short time for adjustment) at the range of 7-8, (the soil serves as a buffer that keeps the pH level close to neutral).

Reaction of the soil – The directive assumes an unhindered transport of solutes to the groundwater, whereas following contact of the soil with the added coal ash, various adsorption and uptake processes occur, depending on the characteristics of the soil.

Alternatives for monitoring procedures and criteria for maximum values

1. Characterization curve procedure – A characterization curve is to be constructed for every ash (namely, one curve for all ashes from a given source) for the release of elements into solution as a function of pH. The concentrations that will be obtained in the extraction solution in the compatibility test for a given use of the ash will be compared to the values obtained at the same pH level in the characterization curve of ash from the same source. In case the concentrations measured in the compatibility test are around the concentrations given in the characterization curve for the relevant pH, the concentration in the characterization curve at neutral pH will be compared with the value of the European standard. In case there is a significant discrepancy between the concentrations measured in the compatibility test and in the characterization curve, the ash will have to be extracted at a neutral pH and the obtained concentrations compared to the European standards.
2. Application-dependent procedure
    a. Road Paving – Transition coefficients from powdered ash to compacted granular (monolith) ash will be determined at the end of the ash's aging process for the following situations:
        i. If the methodological problems associated with leaching from a compacted granular material are solved – the ratio of the concentrations of the elements in the solutions in contact with the ash in a powdered structure and with that ash in the compacted-monolithic structure (if obtained in both cases for the same amount of ash per unit volume of liquid) will enable the determination of transition coefficients for the evaluation of the release of trace elements from the coal ash to the surrounding soil for structural filling in road construction using the relatively simple procedure of leaching from powdered ash.
        ii. Otherwise (as a default) – the ratio between the values given in the European standards for the powdered ash (EN 12457/2) and for monolithic structures (maximum values in



Landfill Regulations 2005 – England and Wales, obtained by the Netherlands extraction procedure – EA NEN 7375:2004) will be used.

A. Agriculture

i. Transfer coefficients will be determined for the transition from fresh ash to a reference ash (that has undergone aging)[6].

ii. The ash will be examined as is or in its application mixture at the application pH value (pH=7-8 for soils).

3. Criteria for maximum values

Criteria for maximum allowed values of trace elements were defined for paving and for soil amendment as follows.

a. Paving – The scientific-professional team proposal, October 2010.

b. Soil amendment – Based on the proposal above. Strict thresholds will be determined (floor criteria) adopting the assumption of a high hydraulic conductivity and a low sorption capacity for the elements released from the ash (e.g., sandy soils). Relaxation from the strict values to be defined will be allowed for soils that display a high adsorption capacity for some, according to Keren's formula[7].

For stabilization of sewage sludge – Data collected worldwide will be examined regarding standards for concentration of trace pollutants in sludge extracts with regard to sludge application to soils as a basis for formulating criteria for maximum allowed values.

[6] Oxyanions release from alkaline fly ash to water. Rami Keren and Ludmila Tsehanski, Volcani Center, May 2008.
[7] Keren's model to estimate the release of trace elements from fly ash in soil. Rami Keren and Sigal Tzaidi-Nativ, Volcani Center 2004.