Coal Combustion Products (CCPs)

Assessment Criteria for Use in Agricultural Applications

Ash Development Association

REFERENCE DATA SHEET No.8

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INTRODUCTION

The use of coal combustion products (CCPs), specifically fly ash and furnace bottom ash, for soil amendment has been an ongoing area of investigation by the Ash Development Association of Australia (ADAA) since the mid 1990's.

International research into the use of CCPs for soil amendment has grown markedly over the past few decades. This research has focused on identifying and determining the feasibility of using these products in agricultural, horticultural and forest ecosystems.

Australian interest in the use of CCPs for soil amendment has been driven by: (a) recent research findings demonstrating the improved growth of crops, pasture, forests and turf following the addition of CCPs;[1] and (b) the need for the development of sustainable utilisation options.

For example, a four year study supported by the ADAA at the University of Western Australia, which concluded in 2002, found that significant environmental and crop production benefits arise from CCP use in amending weak structural soils.[2]

The study assessed, amongst other things, the potential water saving (physical) and nutrient (chemical) benefits arising from the use of CCPs in local soils in certain areas in Western Australia. Other encouraging findings from this study included improvements in crop yields, growth, colour and general health of harvests, and increased turn around times for turf farming harvests. There was also improved water take-up resulting in a 30 percent reduction in watering requirements.[3]

In 2003, the ADAA commenced a four year research project with the University of Technology Sydney to assess the use of CCPs in various agricultural systems and with various soil types. The goal of this research is to gather additional information demonstrating the economic and agronomic benefits from the application of CCP in horticultural and agricultural systems.

Concurrent with the commencement of this research project, the ADAA commissioned an extensive investigation into associated environmental aspects of CCPs. This study specifically assessed trace element concentrations and the potential leachability of any undesirable elements. CCPs from across Australia were assessed against agreed criteria developed by the New South Wales Department of Environment and Conservation (DEC) specifically for agricultural applications.

The full report 'Coal Combustion Product (CCP) - Environmental Testing Programme 2003/2004'[4] and findings are available from the ADAA website: www.adaa.asn.au

The purpose of this reference data sheet is to provide guidance to producers, suppliers and users with industry agreed acceptance criteria and methodologies used to assess the suitability of CCPs prior to use in agricultural, horticultural and forest ecosystems.

MATERIAL PROPERTIES

CCPs, particularly fly ash and furnace bottom ash, are the solid particulates that remain after the combustion of coal in the furnaces of coal fired power stations.[5]

Australian coal-fired power station fly ashes are typically light to mid-grey in colour and have the physical appearance of fine powder. Particle sizes range from less than 1 μm (micrometre) to 200 μm and are irregular to spherical in shape. Furnace bottom ash can comprise 10 to 20 percent of the total CCPs produced and range in grain size from fine sand to coarse lumps. Chemically, CCPs are mainly silico-aluminate glasses, though some mineral materials may be present.[6]

Typical Oxide Analysis of Fly Ash by Percentage

Sample	Component								
	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	Na_2O	K_2O	SO_3	LO.I*
FA - 1	58.0	26.5	3.2	1.6	0.9	0.4	0.4	0.1	3.0
FA - 2	56.7	26.7	5.0	1.1	0.9	0.4	1.3	0.1	6.5
FA - 3	63.2	27.4	1.0	0.2	0.2	0.6	2.2	0.2	3.4
FA - 4	69.2	21.8	3.5	1.2	0.7	0.5	1.4	<0.1	1.3
FA - 5	58.6	28.5	6.3	1.6	1.0	0.3	1.2	0.7	1.25
FA - 6	71.0	24.9	0.7	0.1	0.2	0.1	0.4	0.0	1.1
FA - 7	65.0	23.0	5.0	0.2	0.3	0.4	1.8	0.2	1.3

*LO.I: Loss in Ignition

Table 1: Typical Oxide Analysis of Fly Ash

METHODOLOGY FOR ASSESSMENT

The procedures outlined below are for the testing of run-of-station CCPs to be distributed for agricultural applications.

Broadly, all samples are to be taken in accordance with the sampling procedures outlined below. These samples are then analysed, using the methodologies described, in a NATA accredited laboratory, for a range of total and leachable metals, dioxins and furans and conductivity.

Sampling Procedures

Fly ash samples are to be taken in accordance with the requirements of the following Australian Standards:

- AS 1199 – Sampling procedures and tables for inspection by attributes
- AS 1399 – Guide to AS 1199

Furnace bottom ash samples are to be taken in accordance with the requirements of the following Australian Standard:

- AS 1141.3.1 – Methods for Sampling and Testing Aggregates 1996 (Method 3.1-Sampling Aggregates: Section 6.9 - Sampling from Stockpiles)

Laboratory Procedures

Laboratory procedures for analysis of total metals, TCLP, dioxins and furans, electrical conductivity EC_{se} (dS/m) and water soluble boron using a calcium chloride extractable method must be conducted by a laboratory with NATA accreditation for the specified tests.

ASSESSMENT CRITERIA

Table 2 sets out the relevant criteria, procedure and frequency required for each of the test procedures.

Elements	Procedure	Criteria	Reference	Frequency
Total Metals- M17 Metals[1]	USEPA 200.2	Cd (10mg/kg) Pb (100 mg/kg) Hg (5mg/kg)	Fertilisers Act 1985 (NSW)	Annually
Leachable TCLP Metals- M17 Metals[1]	USEPA 1311	Various	Environmental Guidlines:Assesssment Classification and Management of Liquid and Non -liquid Wastes, DEC 1999	Annually
Boron	CaCl2 Extraction Method	60 mg/kg	The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006 (NSW), Table 2	<1000 tonnes,three (3) times per annum (minimum)[2]
Electrical Conductivity ECse	Method 104, Guidlines on Laboratory Analysis of Potentially Contaminated Soils NEPM 1999	4 dS/m	The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006 (NSW), Table 2	<1000 tonnes,three (3) times per annum (minimum)[2]
Dioxin and Furans	USEPA 1613B	100ng/kg	Referenced from limits for the land application of biosolids in Europe	Annually[3]
Chemical Oxides	XRF	Report		Every 3 years[4]

1 M17 metals: Ag, As, Ba, Be, Cd, Cr, Cu, Ni, Pb, Sb, Tl, Zn, Se, Hg.

2 Where more than 1000 tonnes of ash is provided to processors or consumers in total, suppliers must test at least three times a year plus once every 1000 tonnes (See s 11.5.2 of the Exemption).

3 Annually for first 3 years and subsequently, once every 3 years.

4 Or on a change of input that is likely to affect the components in the ash (see s 11.1.3 of The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006 (NSW)

Table 2: Assessment Criteria and Procedures for Analyses.

COMPLIANCE WITH ACCEPTANCE CRITERIA

For compliance to be achieved, the analytical results for all tests must be below the threshold limits set out in the assessment criteria in Table 2.

Where the analytical results are below the thresholds specified and there are feasible beneficial opportunities identified, the use of CCPs to amend soils in agricultural systems may be justified.

Beneficial opportunities would include (a) sustainable utilisation options for the CCPs, and (b) improvement in growth for crops, pasture, forestry or turf species.

Special conditions for NSW suppliers, processors and consumers which are outlined in the exemption, *The fly ash and bottom ash from burning NSW or Queensland coal exemption 2006* (NSW), must be also met in conjunction with the above criteria.

SUMMARY

CCP use in agriculture offers both potential chemical (nutrient) and physical (structural) benefits for users, as well as environmental benefits through resource reuse instead of landfill emplacement.

Much of the literature regarding the beneficial use of CCPs in agricultural applications describes application rates at levels of 5 to 20 percent.[7] Application rates are typically modified according to soil type and the physical or chemical characteristic being modified (e.g. pH modification, drainage etc).

It is advisable to consult appropriate agronomy experts to determine appropriate soil application rates.

REFERENCES

[1] S. M. Pathan, ***Fly Ash Amendment of Sandy Soils To Improve Water and Nutrient Use in Turf Thesis, Agriculture and Plant Sciences,*** University of Western Australia, 2003. / [2] Ibid. / [3] C. Heidrich, ***Ash Utilisation - a perspective on coal use in Australia – 12th International Conference on Coal Science***, Cairns, Australia, International Coal Science Forum, 2003. / [4] D. Aynsley and M. Porteous, ***Coal Combustion Product (CCP) - Environmental Testing Programme*** 2003/2004, Ash Development Association of Australia, Wollongong, NSW, 2004, 53. / [5] ADAA, ***A Guide to the Use of Fly Ash & Bottom Ash in Roads and Embankments***, Ash Association of Australia, Sydney, Australia, 1997, 33. / [6] C. Heidrich and I. Hinczak et al., ***Case study: CCPs potential to lower Greenhouse Gas emissions for Australia, World of Coal Ash 2005***, Lexington, USA, 2005. / [7] S. Pathan and T Colmer et al., ***Fly Ash Amendment of Sandy Soils to Improve Water and Nutrient Use Efficiency in Turf Grass Systems***, Faculty of Agriculture, University of Western Australia, 1999. / Fertilisers Act 1985 (NSW) (Order No 2001/02 or 2001/07). / NSW Department of Environment and Conservation, ***The fly ash and bottom ash from burning NSW or Queensland coal exemption*** 2006 (NSW). / G.E Rayment and F.R. Higginson, Australian Laboratory Handbook of Soil and Water Chemical Methods, Inkata Press, 1992, pp. 115-9. / Commonwealth, ***'Electrical Conductivity', Schedule B (3), Guidelines on Laboratory Analysis of Potentially Contaminated Soils,*** National Environment Protection (Assessment of Site Contamination) Measure 1999 (Cth). / Commonwealth, Fertilisers Act 1985 (NSW). / DEC, ***Environmental Guidelines: Assessment, Classification and Management of Liquid and Non-Liquid Wastes***, 1999.

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