Regulations regarding coal ash utilisation in Europe

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1. Introduction

Coal combustion product (CCPs), i.e. combustion residues such as boiler slag, bottom ash and fly ash from different types of boilers as well as desulphurisation products like SDA-product and FGD gypsum, are mainly utilised in the building material industry, in civil engineering, in road constructions, for construction work in underground coal mining as well as for recultivation and restoration purposes in open cast mining. By this, they are replacing natural materials and have to fulfil technical and environmental requirements in standards and regulations.

2. Technical regulations

The utilisation of coal ash across European countries is different and is mainly based on national experience and tradition. In 2003, about 21 million tonnes of fly ash were utilised in the construction industry and in underground mining. Most of the fly ash produced in 2003 was used as concrete addition, in road construction and as a raw material for cement clinker production. Fly ash was also utilised in blended cements, in concrete blocks and for infill (that means filling of voids, mine shafts and subsurface mine workings).

In 2003, 2.7 million tonnes of bottom ash were used in the construction industry. Out of this 48 % was used as a fine aggregate in concrete blocks and in concrete and 33 % in road construction. About 14 % of bottom ash was used for the production of cement and concrete.

Requirements and standards for the use of fly ash and bottom ash in cement and concrete

- as raw material for cement clinker production

There are no standards or directives for the use of coal ash as a raw material for cement clinker production. Nevertheless, the raw material situation of a cement plant, i.e. the composition of the limestone and marl resources and the plant technology cause specific requirements on fly ash quality. Furthermore, fly ash need to be licensed as a raw material component for the cement plant.

- as constituent of blended cement

The requirements for siliceous and calcareous fly ash for the use as a constituent of blended cements are defined in EN 197-1. Beside requirements for the basics composition in view to
reactivity limit values are defined for specific parameters (loss on ignition, sulphur, chlorine) to avoid unsoundness of or damaging reactions in concrete constructions. Over the last years about 2 million tonnes of fly ash per year have been used for this application. As the cement industry is obliged to reduce the CO₂ emission from cement production this amount is expected to increase.

- as addition to concrete

Fly ash has been successfully used in concrete around the world for more than 50 years. In Europe approximately 30 % of the fly ash produced is used as concrete addition and is replacing a part of the cement necessary for the production of concrete. Technical requirements for the use of fly ash for concrete are given with the European Standard EN 450 "Fly Ash for Concrete". The standard was first published in 1994 and the revised standards EN 450-1 "Fly ash for concrete – Part 1: Definition, specifications and conformity criteria" and EN 450-2 "Fly ash for concrete – Part 2: Conformity evaluation" will be published this year by the National Standardization Bodies in Europe. The standards refer to siliceous fly ash, only. Calcareous fly ash as mostly obtained from the combustion of lignite cannot be utilised as concrete addition according to the EN 450.

- in road construction

For the use of coal ashes in road construction bound and unbound applications have to be considered. Unbound applications cover the use e.g. in base layers as filling material, in dam construction or soil beneficiation. Bound applications cover the use in hydraulic road binders and in concrete for road construction. For these applications national and/or country specific regulations of road construction authorities have to be fulfilled. Furthermore, the European standards for soil beneficiation with fly ash (prEN 14227-13), fly ash bound mixtures (prEN 14227 – part 3) and for fly ash for hydraulically bound mixtures (prEN14227 – part 4) have to considered. The two last European standards refer to siliceous or calcareous fly ash which is produced from the combustion of pulverized coal or lignite in power plants. For the use in hydraulic road binders the requirements of the European standard prEN 13282, presently under revision, have to be considered. The requirements for fly ash are based on the definitions given in the cement standard EN 197-1.

It has to be noted that these European standards, by now, are not harmonized. They can be used in addition to or instead of national regulations. In Germany, national regulations to be considered for road construction are i.a. the regulations of the Road and Transport Research Society (“FGSV - Forschungsgesellschaft für Straßen- und Verkehrswesen”), in the Netherlands those based on the “Building Materials Decree” (Boustoff-Besluiten

- as aggregates

On June 1, 2004 new harmonized European Standards for for heavy aggregates for concrete (EN 12620) and for lightweight aggregates for concrete, mortar and grout (EN 13055-1) were introduced. These standards contain requirements regarding the characteristics of aggregates and the conformity crietria. The standards have a common structure in view to the definition of categories, as in European countries different climate cause different requirements. National authorities have to introduce the relevant categories in their country by e.g. national application documents. In Germany, the application document DIN V 2000-
103 for aggregates for concrete and DIN V 2000-104 for lightweight aggregates defined in clauses 1 “area of application” the types of industrially manufactured aggregates that may be used in concrete in accordance with the technical standards are given, i.e. bottom ash.

3. Environmental regulations

Being many environmental benefits connected with the use of CCPs, also the environmental impact of the use of CCPs has to be considered in any application. Fly ash and bottom ash as any natural mineral contain a certain amount of trace elements. For some of the trace elements, concentrations may be higher in fly ash than in natural minerals or products used for a certain application. In order to avoid any negative impact on the environment or even on human health, regulations have been developed for the different uses of industrial by-products at a national level in the European member states. As a result of the environmental regulations no negative impact on the environment or on human health by the utilisation of CCPs has been reported so far.

The European Construction Products Directive (CPD) from 1988 deals with the subject of emission of dangerous substances from construction products that may have harmful impacts on human health and the environment. The European Commission has mandated the European Standardization Organization CEN/CENELEC to develop harmonised assessment methods and harmonised approaches related to dangerous substances (emissions to indoor air, surface water and ground water). In parallel to this approach on European level, the national authorities in several EU member states are developing or have already developed test methods and environmental requirements. With regard to CCPs the requirements related to content and leaching of trace elements and (sometimes) organic matter are of importance. Requirements in some countries exclude the use of unbound fly ash or bottom ash e.g. in road construction or for filling and grouting purposes. As the requirements are not harmonised across Europe different limits exist in neighbouring countries. Because of this situation export and import of fly ash between EU member states is increasing. There is a thread that the utilization of fly ash and bottom could be excluded at least for certain applications because of requirements related to environmental considerations.

Selected environmental regulations from single European countries for CCPs in road construction, for concrete in contact with soil and groundwater, and for concrete in contact with drinking water are as follows:

- in road construction / in contact with soil and ground water

The “Building Materials Decree” of the Netherlands (Boustoff-Besluiten) contains rules relating to the use of building materials and earth in construction and other works. The aim of the Decree is to establish a general level of protection for soil and surface waters. Pollution can be caused by harmful substances leaching from building materials and other materials or contaminated earth. These materials and earth therefore have to be tested regarding their possible harmfulness to the environment before they may be used.
The Building Material Decree accords the reuse of materials such as construction and
demolition waste and residues recovered from industrial processes a full place in the building
industry by setting clear conditions on which their use is permitted.

The decree divides in bound and unbound utilisation only. The limit values of single elements
with regard to the test methods (unbound utilisation: percolations (column) test according
NEN 7343, percolation at L/S = 10 in mg/kg; bound utilisation with diffusion test (stand test)
according NEN 7345, immission in mg/m²) have to calculated in a special way.

In Germany, quality control criterias were established by the German federal states working
group of waste (LAGA). The working group established guidelines consisting general
principals of utilisation regardless of the type of residue/waste, technical regulations for
utilisation and requirements for sampling and analysis. The guidelines serve the requirement
to avoid unacceptable environmental damages. With respect to the waste definition of the
European Commission the guidelines treats waste for utilisation, only.
The technical regulations are elaborated for single types of residues, i.a. fly ash from wet and
dry bottom boilers, FBC ash, bottom ash and boiler slag. The classification values fixed in the
regulation are precaution values for different classes of utilisation (Z 0 to Z 2) defined for
protection of soil and groundwater. The precaution values are based on the German leaching
test (DEV-S4). The leachate has to be tested on the parameters ph-value, conductivity, As,
Pb, Cd, Cr, Cu, Ni, Hg, Zn, Cl and SO₃.

As the LAGA-criterias are most important for earth works, additional regulations of the Road
and Transport Research Society (“FGSV - Forschungsgesellschaft für Straßen- und
Verkehrswesen”), have to be considered for road construction projects.

The “Regulations for environmental friendly use of industrial by-products and recycling
materials in road construction” (RuA-StB 01) deal with the environmental conditions to be
considered when by-products will be used in road construction. The limit values for the water
management characteristics of certain industrial by-products were adjusted to the LAGA-
values. The conditions for use refer to the permeability of the base layers and the
construction material themselves, the hydrogeological conditions (level of ground water, area
of drinking water, ..) and hight of the cover to protect ground water.

For concrete in contact with soil and groundwater

For concrete in contact with soil and ground water national regulations on the basis of
leaching tests have to be considered. In the Netherlands the limits based on “Building
Materials Decree” have to be met (Test procedure: NEN 7345).

In Germany, the environmental compatibility of concrete used in contact with groundwater is
evaluated with a defined evaluation concept. This concept is based on threshold
insignificance values. A groundwater with pollutant concentrations below the limit values is
defined as “insignificantly polluted”. The limit insignificance values are defined for
groundwater, they are not connected to a specific test. Leaching tests, e.g. the long-term
tank test according to the German draft standard (DAfStb, 2002) that is comparable to the
Netherlands standard NEN 7345 provide the discharge of pollutants under the defined
boundary conditions of the experiment. The concentrations in the groundwater have to be
calculated with a defined routine from the leaching test data. The evaluation considers the
boundary condition (e.g. groundwater flow, soil quality) at a certain level. The concept is applied for technical approvals.

On European level a new European Technical Committee will be installed for “Development of horizontal standardized assessment methods for harmonized approaches relating to dangerous substances under the construction products directive”.

- for concrete in contact with drinking water

In UK, BS 6920 prescribes test methods for materials in contact with drinking water. The materials has to be tested on their effects on odour and flavour, on appearance, on the growth of aquatic micro-organisms, on of cytoxicity and on extraction of metals.

In Germany, a certificate for materials to be used for concrete in contact with drinking water will be granted by certified bodies based on test procedures of the German Technical and Scientific Association of Gas and Water (DVGW). The hygienic requirements for cement bound materials are defined in the working paper W 347 of the association. By this, organoleptic parameters (colour, odour) as well as the leaching of As, Pb and Cr and the migration of TOC has to be tested. Furthermore, microbiological growth behaviour has to be tested according to working paper W 270 if organic additives will be used.

The DVGW working paper is presently being revised implementing the essential requirements of the amendment of the EC drinking water ordonance. The new working paper will become binding in 2005.

On European level a regulators group installed by EU member states is working on the development of a “European Acceptance Scheme” (EAS). The EAS will form the basis of approving all materials (plastics, metals, cement bound materials etc.) in contact with drinking water. In subgroups proposals for evaluation criteria’s, application of test procedures and test parameters will be formulated. Principals as follows will be recognized:

- Preservation of existing national levels of consumer protection
- Warranty of usability of all common materials
- Formulation of a complete certification system
- Warranty of transparency and confidentiality

The existing national requirements will be replaced by the harmonised standards resulting from the EAS.

4. Conclusions

Political intentions and legislation are influencing the utilisation of coal combustion products and are very important to power producers. Based on technical benefits the use of CCPs has developed over the last years or even decades with coal ash. By now, environmental testing have to be considered based on national regulations in single European countries. With the new generation of harmonized European product standards also environmental and health aspects will be addressed. The experience gained with existing regulations regarding environmental and health aspects of construction products will be considered in the new generation of harmonized standards.