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Part 3

ASH AND SLAG HANDLING

3.7. Analytics

3.7.8. Utilization of coal combastion by-products in Poland

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ABSTRACT

In Poland, on the significant effects of the utilization of 80 % of fly ash and slags from combustion of hard coal and lignite, had implementation and observance of the environmental law, principles of free market, tightening of the requirements of work safety and exploitation of coal mines, rules of limiting the use of mineral resources and CO_2 emissions to the atmosphere. At the same time the intensive work were carried out on developing and implementing national and European standards for the use of combustion by-products as ingredients and construction products and others.

These factors have contributed to improving the environment not only in power plants, but also by users of CCPs and also helped to reduce the cost of ash management in power plants and obtaining additional profits for users.

All these actions and their effectiveness to a large extent are the result of activities of the Association of producers and users of fly ash and slags Polish Coal Combustion By-Products Union.

1. FACTORS AFFECTING MANAGEMNT OF COAL COMBUSTION BY-PRODUCTS

Poland is one of the few countries where more than 90 % of the electricity is produced from burning of coal (65 %) and lignite (35 %). In the past 15 years, in addition to modernization of existing technology of energy generation, followed by reconstruction of the power plant capacity by the construction of new power units with fluidized bed combustion boilers and for supercritical parameters. This state of energy, allowing also the burning of the mining waste and biomass, have a significant impact on the amount and types of coal combustion by-products (CCPs) and their management – table 1[1].

A significant impact, on a way of management and utilization of coal combustion by-products, in this time horizon, had the implementation of:

- principles of a free market
- stricter requirements in the exploitation of mining excavations
- limiting rules of the use of natural resources
- limiting rules of the CO_2 emission

The list of coal combustion by-products has been enlarged by the gypsum from flue gas desulphurization, fly and bottom ashes from fluidized bed combustion boilers and cenospheres. At the same time, the increase of utilization of fly ash cause decreased need of placement of coal combustion by-products in a landfill. Currently hydro-transportation and wet landfilling of ash and slags, has been replaced in most power stations by transport, storage and release of fly ash in a dry method.

As far as security requirements increase in coal mines, from a level of placement of excess of coal combustion by-products in mining excavations, currently fly ash, slag and compositions based on CCPs are an indispensable means of strengthening and isolation in mines.

Main changes in the management of coal combustion by-products were caused by organizational changes in the energy sector, entrusting management and utilization of combustion by-products to the companies specially set up (internal and external, including foreign – e.g. Knauf). The choice, more and more frequently is based on economic criteria, taking into account the costs of deposit and use of fly ash and slags. In the most recent period there is a strong impact of free market on a trade of fly ash of siliceous type. The implementation of obligation of CO_2 limiting, resulted in great interest of the cement plants of the supplies of ashes from energy. While earlier, most of the supplies of ash to the cement power plants required surcharges from the power plants, currently cement plants, normally purchase fly ash from power plants. It is obvious that these ashes must meet the strict requirements of the valid standards.

In these conditions, were created in Poland few very professional companies that not only deal with the distribution of ash from power plants to customers but also have their own means of transport and technologies and processing installations of CCPs into a products of high commercial value (Dalia, EFS, EKOTECH, UTEX, VKN etc.).

A large contribution to the development of ideas and rational management of CCPs has a non-governmental association POLISH COAL COMBUSTION BY-PRODUCTS UNION, created by agreement of the companies involved in the development and utilization of CCPs. The basic tasks of the UNION is, inter alia:

- aid to its Members in promotion of the economic use of CCPs
- creation of new and support of existing research, education and information programs,
- work for the establishment and development of legal basis of CCPs management
- contributing the economic development of its Members by supporting their initiatives and promotion of innovative technical, organizational and economic solutions.

Membership of Polish Union to European Coal Combustion By-Products Association (ECOBA) and organizing national and international conferences allowed to share the foreign achievements and to present of Polish achievements.

2. COAL COMBUSTION BY-PROUCTS MANAGEMENT

The use of CCPs in Poland has a 100 years tradition, when for the first time the slags from grade firing boilers with an addition of lime has been used in the construction of family houses. With a development of the energy and accumulation of the problems of combustion wastes, the interest of economic management of CCPs has been increasing. Directions and quantity of utilized CCPs, with laps of time evolved and more often are the results of functioning of the free market. Currently, the use of CCPs for the production of traditional

materials, performance of civil engineering works and reclamation or revitalization of degraded fields is based on strict control of their physicochemical properties and established technologies and applications. For the development of utilization of CCPs significant meaning have works on developing and implementing national and European technical standards for the use of CCPs as ingredients and construction products and others (including: EN450, EN206, EN 13 283, EN 14 227).

At the direction of the management of fly ash and slag, important impact have their composition and physicochemical properties. The current classification in Poland distinguishes three types of fly ashes: siliceous, aluminous and calcareous. This classification requires a new treatise, in order to take into account all CCPs and to refer in a greater extent to the foreign practice [2]. A brief overview of the main ways of the utilization of CCPs has been based on the data given in Table 2 [1, 3].

Traditionally, a large recipient of fly ash is cement industry. Fly ashes of siliceous type are used in the production of clinker and cement. In certain periods, the high-ash cements also were produced, in which the proportion of clinker accounted only 30 %. The application of calcareous ash to the production of cement and clinker is the subject of many studies, the results of which indicate the possibility and usefulness of their use. Currently, the use of ashes in cement plants exceeds 1 million tonnes/year. Taking into account the need to reduce CO_2 emissions by the cement industry, should expect the increase of fly ash utilization in order to reduce a rate of materials that require decarbonisation.

Significant quantities of fly ash, especially the siliceous type are used besides cement industry, for the production of cement binders, by their joint grinding with clinker. Widely practised is also production of adhesives not only on the basis of siliceous and aluminous ashes but also calcareous and FBC ashes by their possible mechanical activation and revise by traditional binders (cement, lime, gypsum). The largest quantities of binders and binding mixtures are used for road construction and mining. Currently, most cement centers are not only equipped with tanks to ash but also have the software to fly ash dosage, in order to minimize addition of cement and to ensure the supply of concrete with required parameters.

Fly ashes from coal combustion are also used for the production of sintered aggregates. However, fly ash and slags from the coal combustion are used in a production of construction ceramics and slag aggregates. The fly ashes of aluminous type are used in the production of special ceramics.

In recent years, there is growing interest in the use of fly ash, slag and their mixtures (from landfills), and sets with other wastes (e.g. mining waste) in road construction. If the ambitious plan for the construction of motorways in Poland will realize, with a simultaneous shortage of construction materials, we will be the observers of the increase of use all types of wastes, including CCPs.

In a group of these uses it is necessary to remind the Polish achievements in the field of application of calcareous ash in the road construction and the creation of the system of testing and qualification of ash to road construction [4].

The largest quantitative use of CCPs is observed in the mining of coal and lignite, in excess of 4 million tonnes/year.

Today the CCPs are mainly used in underground mining to increase the work and exploitation safety of mines, particularly to: matage, filling in the redundant excavation tunnels, filling in the old shallow voids, elimination of shafts, fire prevention or fire-fighting [5].

In case of ash-slags mixtures from lignite combustion they are used in lignite mines to the formation of transport arteries.

The CCPs are also used in reclamation, macrolevelling of degraded fields and fertilization and drainage of soils, etc.

Most of the cited studies and ways of management and utilization of CCPs was presented in the speeches of our specialists on the EUROCOALASH International Conference 2008 [6].

Inspired and supported by the Polish CCP Union, research, implementation and preparation works on the principles of REACH Regulation, with international cooperation, should in the coming years enhance achievements in the field of rational management of CCPs.

ECOLOGICAL AND ECONOMIC EFFECTS OF DEVELOPMENT OF CCPS UTILIZAION

Limiting of landfilling of CCPs in favor of their use provides a lot of benefits to the power plants and users in particular ecological, economic and social.

The primary environmental benefit is the elimination of landfilling of fly ash and slags and reduction of the surface of existing landfills, inter alia, the source of air, water and soil pollution. Each 1 million tonnes deposited in the environment needs safeguard of 33 to 62 ha and in case of hydrotransportation of wastes the loss of approximately 0.3 million tons of water.

The management of CCPs allows to reduce the use of traditional raw materials, often to reduce the length of routes and the mass of transported raw materials and products.

Today, one of the most important arguments for the application of CCPs, is the possibility of reduction of CO_2 emissions in the production of clinker and cement and reduction of consumption of materials, which production is connected with the emission of CO_2. Depending on rang of CCPs utilization in the production of cement reduction of CO_2 emissions can be up to 35 %. In production of high-ash cement binders reduction in emissions may occur up to 60 %.

These ecological effects are closely related to economic effects. Currently built landfill must not only meet the requirements of the hydraulic structures but also to guarantee the neutrality for the environment. These requirements and the cost of the land under their building, indicate that the construction costs of landfills may grow even more than dozen times up to a range of 1000 to 3000 PLN/m^2. To these costs it is necessary to add the costs of maintaining of hydrotransportation, anti dusting of landfills and fees for landfilling of wastes in environment, that are systematically increasing. In 2000, the cost of landfilling of fly ashes and slags on existing landfills ranged from 30 to 51 PLN/ton [7].

At the same time, due to the transmission of CCPs to customers (directly and through intermediaries), a number of power plants obtained significant cost reductions of ash and slags management as shown by the data in Table 3.

Most often, the largest economic effects receive users of CCPs, which replace traditional materials and technology and develop new products and applications of CCPs.

On the choice of solution and development of utilization of CCPs have significant impact, a social factor. Today it is difficult to imagine obtaining social acceptance for the acquisition of land for new landfills. The quantitative and qualita-

tive development of CCPs utilization allows increase employment and access to a range of goods.

All these achievements have become possible through the ability to a joint effort of many experts and organization by Polish CCP Union to eliminate the negative thinking about ashes and slags as waste and the creation of proper evaluation as a coal combustion by-products, with a very rich physicochemical and raw materials properties.

Table 1. **The amount of CCPs in professional power generation [1].**

Year	Fly ash, thousand tonnes		Slag, thousand tonnes	
	from lignite	from coal	from lignite	from coal
1985	18 074,5		3 335,0	
1995	12 763,4		1 792,5	
2000	5 646,85	7 718,32	144,65	1 718,99
2005	5 955,00	6 755,00	170,00	1 886,00
2006	6 157,00	7 156,00	188,00	2 126,00

Table 2. **Utilization of CCPs from professional power generation [1].**

Year	Fly ash and slag thousand tonnes						
	Construction materials	Cement	Road construction	Mining	Other	Industrial use	Management, %
1985	1556	504,8	143,3	481,5	326,9	3 012,5	14,1
1995	1 346,1	837,6	280,7	4 524,7	868,5	7 857,6	54,0
2000	2 194,7	712,8	229,1	3 391,1	4 906,5	11 434,2	75,1
2005	1 724,0	961,0	581,0	4 848,0	4 120,0	12 234,0	82,9
2006	1 907,0	1 095,0	576,0	4 616,0	4 214,0	12 408,0	79,4

Table 3. **Comparison of CCPs management incurred by power plants, heat and power plants, and heat plants in 2000. [7].**

Specification	Costs PLN/Mg
Landfilling of ash and slag	30,00 – 51,00
slags	0 – 16,90
ash	12,00 – 25,00
slags-ash mixture	- 6,50* do + 22,00
gypsum	- 3,80 do – 5,00*
DAR	12,00 – 28,00
DSR	14,00 – 39,00
FBR	13,70 – 31,20

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