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ELECTRO - FILTER ASH USE IN THE UNDERGROUND COAL MINES

Abstract

Thermal power plants in the Republic of Serbia spend 35-40 million tons of coal annually, mostly lignite, with about 6 million tons of ash or slag as a by-product of electricity and heat production, deposited on the landfills. The Law on Waste Management defines the possibility of reusing of ash and slag. The Rulebook on categories, testing and classification of waste, as well as the Decree on technical and other requirements for ash, as building material intended for use in the construction, reconstruction, rehabilitation and maintenance of infrastructure facilities of public purpose, electro-filter ash and slag are characterized as the non-hazardous waste for a wide range of use. In recent decades, the electro-filter ash has been used in several fields in the coal mines, increasingly gaining in importance, and what is the subject of this work in order to demonstrate the efficiency of its use and at the same time contribute to the environmental protection.

Keywords: *mines, coal, electro-filter ash, fire insulation*

1 INTRODUCTION

Electro-filter ash and slag are the most commonly used secondary waste in the Republic of Serbia. About 200 million tons of ash and slag are deposited on the current landfills of over 1,600 ha of fertile land, located in the immediate vicinity of the thermal power plants, large river flows and settlements. This significantly affects the deterioration of environmental conditions and it is imperative to find a solution for using of this ash to meet both the environmental and economic parameters.

Ash consumption in construction grows increasingly, and ash is most commonly used in the industrialized countries as the Great Britain, the United States, France, the Netherlands, Czech Republic and Poland. There is no problem of disposal the electro-filter ash in the EU countries. The amount of generated electro-filter ash is insufficient to undermine the needs of an ever-increasing demand. According to data from developed countries of the European Union, 18 million tons of ash are used, primarily, in the construction industry and road construction.

In the mines of the Republic of Serbia, the electro-filter ash is now used to fill the excavated free space behind the fire isolation barriers, where it has a number of advantages compared to the other conventional ways of isolating the oxidation and fire processes. In the first place, it made the process of filling in the faster procedure, reduced the number of engaged workers and enabled continuous filling.

In some mines, filling of excavated empty spaces on a larger surface was done in order to prevent deformation of the surface of the terrain. Also, in some cases filling with electro-filter ash was carried out on the excavation fields where several cave rooms were made and through which the working

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front was passed from the mechanized long wall excavation, and these rooms had to be filled previously.

2 ELECTRO - FILTER ASH PROPERTIES

Electro-filter ash, which is obtained by combustion in the coal combustion boilers, is a finely ground, powdered material that is transferred by flue gas. The ash is usually collected by the electrostatic precipitators, dust collectors or mechanical collection devices, such as cyclones.

In the production of energy, three methods of ash removal from the boiler plant are applied: dry, wet and cyclone, where a dry process is most commonly used in thermo-objects in Serbia.

The ash consists of full or hollow particulate particles, mainly ball-shaped, and is mostly of glass (amorphous) nature. The specific gravity of electro-filter ash usually ranges from 2.1 to 3.0, while the specific area (measured by the Blaine's method of air permeability) can vary from 170 to 1000 m²/kg.

The chemical properties of electro-filter ash depend on coal composition, the methods of controlling the air pollution in the thermal power plants, and the techniques used for transport and storage on the landfills.

Lignite ash has a higher content of calcium oxide and a lower loss by ignition (LO1) than that from bituminous coal. Electro-filters ash from lignite and partially bituminous coal may have a higher amount of sulphate compounds compared to ash obtained from bituminous coal.

The ignition loss (LO1), which represents a measure of the amount of residual carbon retained in the electro-filter ash, is one of the most significant of its chemical properties.

In the classified ash, the loss of ignition can be from 5% to 6% according to the AASHTO or ASMT specifications. Loss by ignition indicates the similarity of using the ash as a substitute for cement in concrete, which is an important feature of it.

In addition to the chemical composition and loss of ignition, the quality of electro-filter ash is primarily determined by fineness and consistency. Fineness affects the reactivity of ash, as well as the levels of carbon content. The electro-filter ash has a greater fineness than the Portland cement and lime, and its grain size ranges between 10 and 100 microns. Ashes used for the production of concrete and solid mass for filling should be consistent, respectively resistant to the changes allowing the mixture to be tested.

Previous research on the use of electro-filter ash in Serbia has been almost exclusively related to the field of construction. It has been established that, as a raw material for the production of building materials, the electro-filter ash has application inproduction: building elements - blocks of brick, ceramics, concrete prefabricates, light concrete, light aggregates, pucolan - metallurgical cements, hydraulic lime and cement.

As a material that is directly installed at the locations of application, it is used for: masses for stabilization the pavement structures; as a filler in the asphalt mixtures and bitumen masses, for mechanical and chemical stabilization in the construction of roads, as a filler for asphalt, in the embankment, etc.

Electro-filter ash is useful for a wide variety of applications, because it is a pucolan, or silicate or alumina-silicate material that in isolated form and in the presence of water, combined with calcium hydroxide (from lime, Portland cement or dust from an annealing furnace) and forms mixtures with the characteristics of binder.

3 EXTINGUISHING OF MINE FIELD FIRES WITH THE SYSTEM FOR FILLING WITH ELECTRO-FILTER ASH

Endogenous oxidation processes and jam fires are a specific phenomenon in the underground coal mining and often follow the mining processes. Namely, endogenous fires are created by the joint operation of natural - geological and technical - technolo-

gical conditions in a particular cave object. From the natural-geological conditions, the most influential are: propensity of coal to self-ignition, thickness of the coal layers that are mined, tectonics in the excavation area, inclination and depth of recovery, characteristics of the accompanying rocks and presence of water.

The second group of conditions, i.e. technical and technological are: inadequate preparation and elaboration, applied excavation system, losses of coal during excavation, poor untimely isolation of excavated areas, inadequate rate of progress of excavation works, irregular ventilation scheme, high depression of the excavation field and pits, air flow losses, poorly defined location of tubular sewage fans and others.

The occurrence of an endogenous fire in a mining cave usually endangers the employees and equipment and leads to a temporary interruption of mining operations until it is eliminated.

Experience has shown that the excavation system, no matter how efficient and economical is, make conditions for development the oxidation processes that can turn into open fires.

Prevention of oxidation processes enters the technological system of underground coal mining and affects all its stages of work from: opening, preparation, excavation, ventilation, drainage and maintenance.

The first degree of protection against oxidation processes and cave fires are preventive measures. If the preventive measures are not adequate and sufficient, as the second level of protection, the measures of remediation or liquidation the occurrence can be used.

Recovery itself includes active and ventilation methods. Active methods include all active fire extinguishing operations with water and removal of heated and ignited coal, isolation of the fire endangered areas by temporary and permanent bulkheads, injection and interventions with inert gases.

The most commonly applied method of active procedures is the isolation of oxidation or fire area, and its goal is to stop the oxygen supply to the fire source, and the success of extinguishing depends on the isolation quality. Isolation barriers must meet a range of conditions to be effective: to be impermeable, to be able to withstand any additional water inlet, to be heat-resistant and resistant to the aggressive environmental performance, easy to maintain, to have as long life as possible, and to be able to be quickly and efficiently to built-in.

The aforementioned conditions are mostly satisfied by the so-called "sludge plugs", i.e. barrier with electro-filter ash which are in practice proven as efficient.

Also, special attention is required, which must be applied in the case of fire isolation of the area in the so-called methane conditions when there is a potential risk of ignition and explosion of methane.

The electro-filter ash filling system can be applied after the preparatory work has been carried out which fit into a further concept of exploration work in the mining cave.

At the preparatory stage, on the surface area near one of the cavities, a working plate has to be built and silos to be mounted (usually two blocks) so that the ash dispensing valve is at a height of 1.5-2.5 m in order to ash flow by gravity through the length of pipe. Below the silo, a mixer connected to both silos has to be installed, as well as and the water inlet pipe connected to the bottom of the ash inlet valve. The ash and water flow gravitating through the tube into a mixer for making a mixture of water and ash. At the outlet pipe from the mixer, a pump for transporting a mixture of water and ash is installed, and the main pipeline for the pit is installed behind it.

The description of a caving plant for filling with electro-filter ash is given below. On the plateau next to the cave entrance, the following equipment was installed:

- Two silos volumes of 20 m^3 and 18 m^3;
- For the water supply to the silos, a plastic tube diameter of 75 mm is used, and the valves of 75 mm for flow control of water filling;
- For dosing of oven ash, 200 mm ovals are installed;

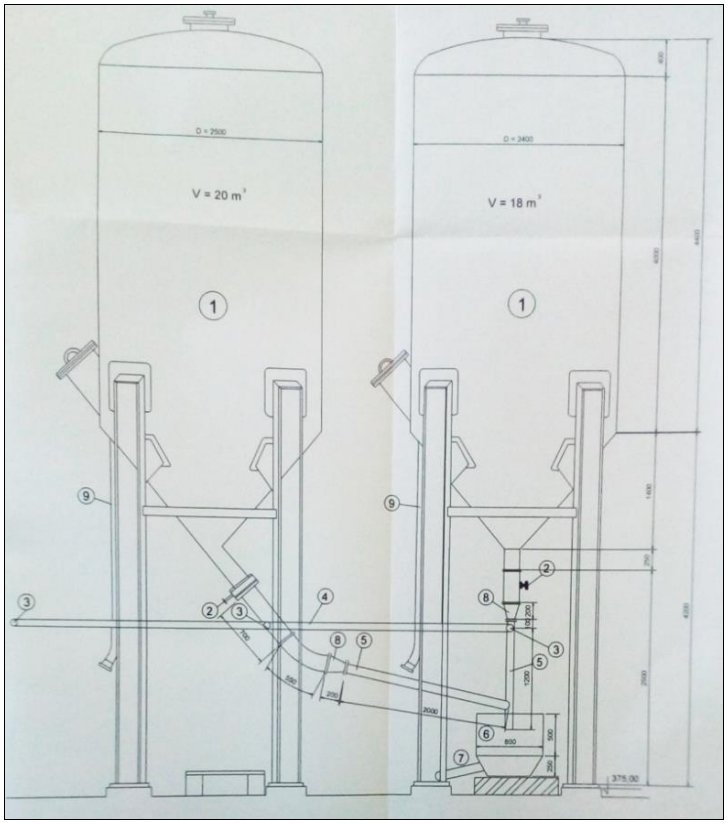
- For acceptance the sludge, a mixer - tank was built - with dimensions of 1.0 x 0.8 x 0.8 m;
- Pump for suppression of the mixture;
- Water supply, from the water supply network to the silos through a distribution for each silo.
- For controlling of water consumption, the water meter is installed in the water supply connection.

The appearance of the filling station with equipment availability is shown in Figure 1.

A plastic pipeline is used for the hydraulic transport of sludge from the tank at the surface to the production part of the cave, or to the objects that being built. At the site of the construction of the isolation facility, a prefabricated filter barrier is made and the part of the pipeline is installed behind it. The appearance of a typical solution of an isolating object from electro-filter ash is shown in Figure 2.

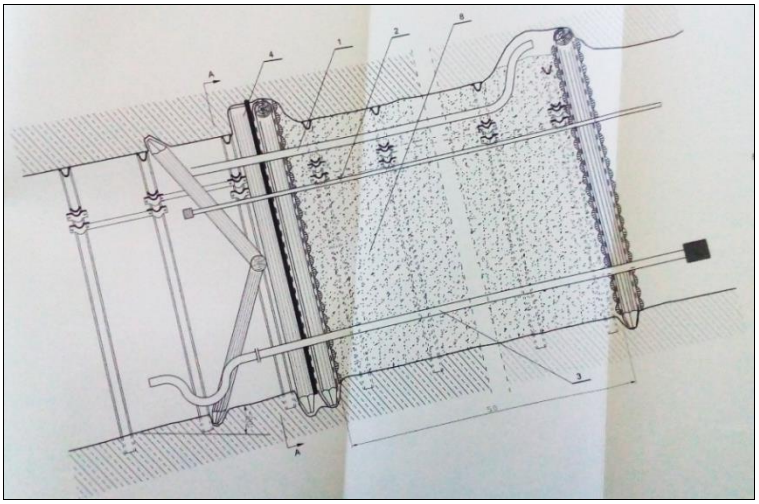
The construction of a sludge barrier must be well-done and thus ensured that there is no relaxation. The filling in the initial phase is carried out gradually with certain breaks necessary for water discharge.

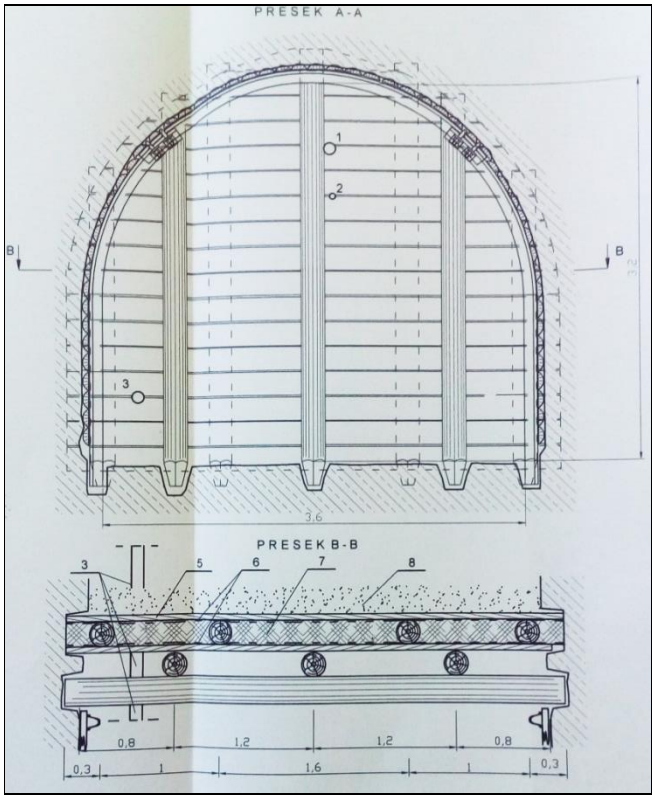
In sludge treatment, the most important is the good ratio of water and ash, because in the case of higher mixture density, there is the possibility of clogging the pipeline, while too sparse mixture extend the time of buckling and water clearing. The most common mixing ratio of water and ash is 1: 2 and 1: 4 by weight.



Legend: 1. Ash storage silos, 2. Ash dosing valve Ø 200 mm, 3. Dosing valve Ø 75 mm, 4. Water supply tube Ø 75 mm, 5. Tube for finished mass drainage of Ø 75 mm, 6. Mixer - sludge reservoir, 7. Slit tube for Ø 75 mm, 8. Transition to tube Ø 200/100 x 200 mm, 9. Silage filling tube Ø 90 mm

Figure 1 *Filling station with equipment availability*





Legend: 1. Lifting pipe Ø 100 mm, 2. Sampling tube Ø 20 mm, 3. Drainage pipe Ø 100 mm - 150 mm, 4. Wooden columns for reinforcement, 5. Wooden partitions, 6. Jut, 7. Glass wool, 8. Filter ash

Figure 2 *Isolation object of filter ash*

CONCLUSION

The use of electro-filter ash and slag is an example of sustainable development. Waste that burdens the operation of thermal power plants is now becoming useful and gaining the usable value. The use of ash generates savings, increases profits and removes substantially negative effects on the environment.

In the underground coal mines, the use of electro-filter ash, in the first place for the construction of stable isolation facilities and for filling up the excavated areas, becomes increasingly widespread, according to the demonstrated efficiency in application.

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