SLAG AND ASH DEPOSITS. PAST, PRESENT AND FUTURE.

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Abstract

Romania's energy production is based largely on conventional power plants that use coal as main fuel from domestic production.. Basic coal combustion process used in power units is lignite, extracted from the Oltenia basin. (Popescu L.G., 2010)

Romanian's integration into the European Union has imposed environmental compliance by all large combustion plants in traditional power plants running on fossil fuels. (Popescu L.G., 2010)

The purpose of this paper is to highlight the evolution of slag and ash deposits used by power plants and heating plants in Romania, from the beginning until 2015.

It also presents current solutions for the storage of slag and ash resulted from coal combustion, solutions to reuse this slag and ash, the European directions on the reduction of greenhouse gas emissions, renewables energy and the improvements on energy efficiency.

Key words: slag and ash, power plant, environment protection.

INTRODUCTION

The electrical energy in Romania is created by Power Plants (they use different resources, such as, coal, marsh gas, oil fuel etc.), hydroelectrical Power Plants, Nuclear Plant and Plants that used renewable energies (wind, sun etc).

According to estimates, at least until 2020, coal will remain the main energy resource of the country, and consumption will be about 30 million tonnes of energy coal annually. Coal burned in power plants comes from domestic production and has the following structure: 90% lignite (poor quality coal) and 10% pit coal.

Because coal used in power plants is of lower quality (90% poor quality coal), the amount of slag and ash resulting from burning is about 28-35 % of the coal burned.

Since it is estimated a consumption of approximately 30 million tons / year, the quantity of slag and ash resulted is about 10 million tons / year. About 95% of the slag and ash is kept in industrial waste storages and the remaining 5% is used in different parts of the economy. The utilization of slag and ash in the economy is reduced due to poor economic concerns and mediocre quality of slag and ash resulted from coal burning in power plants. (Muntean M-D., 2014).

MATERIAL AND METHOD

The evacuation of slag and ash resulted from coal combustion in power plants and heating plants in Romania is done through one of two methods:

- In classical solution (dilution 1/8 ÷1/10, slag and ash/wather);
- Using dense slurry technology (slag and ash/wather =1/1);

To underline the the difference between these two methods, I presented in this paper, as a case study, two thermoelectric power plants; one which is discharging the slag and ash using classical solution (CET Drobeta-Turnu Severin), and the other one using dense slurry technology (CET Turceni).

A. The Power Plant from Drobeta-Turnu Severin was used for first time in 1985. It is now equipped with:

- 6 steam boilers of 420 t/h
- 4 turbo aggregates of 50 MW
- 1 turbogenerator of 25 MW
- 1 turbogenerator of 22 MW, powered by coal.

The Power Plant from Drobeta-Turnu Severin is located aproximatly 6 km from Drobeta-Turnu Severin, and the ash and slag deposit is located to about 1.50 km from the power plant, on Trestelnic valley around the Halânga village.

In order to reach the destination from Drobeta-Turnu Severin you must follow the DN 67 which connect Drobeta-Turnu Severin and Târgu-Jiu, and from the power plant to the slag and ash deposit you have to follow a road used in exploitation of the deposit.

The slag and ash deposit has two compartments and it was created by barring of the Trestelnic creek valley. The Trestelnic creek is located at aproximatly 5 km upstream from the interconnection with the Danube River.

The base of dam was created from local materials, it is 5,5 m tall, the slopes upstream and downstream are 1:3. Through the achievement of the base dam, Trestelnic creek is blocked at aproximatly 2,5 km downstream from the springs that are a 2 km away.

Once filled with slag and ash the deposit was raised with 8 more dams, made with material from the deposit in the "upstream" system. These dams have a height of 5,50 m, upstream and downstream embankment slopes are 1:3.

The left over slag from the 6 steam boilers is crushed and then mixed with the ash from electro filters and with water in a mixing tank. The mixed percentage is 1:10 (slag and ash/water). Through pumping the mix is carried through a pipe that has a 400 mm diameter to the slag and ash deposit.

From the transfer pipes the mix reaches the distribution tubes (D= 400 mm) inside of the deposit. There is one distribution pipe in each compartment and extends over three sides of the compartment (figure no.1).

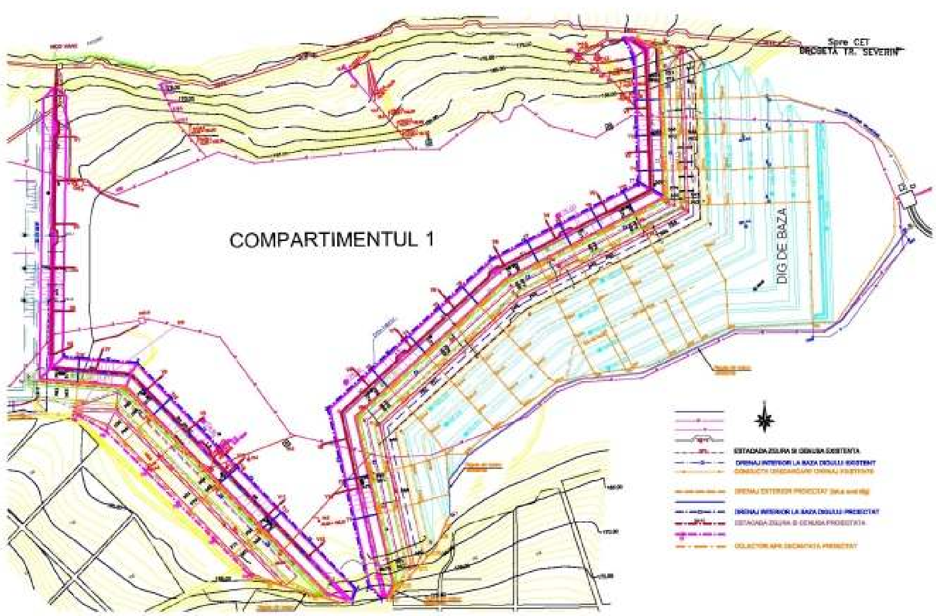

Figure no.1. Overview of slag and ash deposit.

From the distribution pipes, the mix reaches the deposit using discharge pipes (D= 250 mm) provided with valves. A couple of those pipes are always open in a aleatory way in order to achieve uniform filling of the compartments.

A part of the decanted water from the deposit is evacuated in the exterior through wells and spillway collections and the other part through the interior and exterior drainage systems.

The water from the deposit, that originated from slag and ash mixture, the water drained from the Trestelnic valley to the storage area and the one from precipitations is ejected onto the exterior of the storage through a collection of spillways and wells (3 pieces in each compartment) and a drainage system. Through the evacuation system of the water from the storage, the discharge over the top part of the dams is avoided and also their stability is ensured.

A part of the water from the deposit is collected through wells and ejected onto the exterior through the pipes that pass under the dam. The spillway collection are made out of a prefabricated reinforced concrete (D= 1.000 mm, h=0,15 m). These rings allow to rise the wells with increasing amount of slag and ash deposited and also raising the water level in the deposit. The exhaust pipes of the water collected in the collection wells are made of steel (D= 700 mm).

The interior drainage of the deposit is made at the upstream foot of the embankment on all its length. The water is collected through PVC pipes with 110 mm diameter, provided with gaps of 0,5x10,0 cm. These drains discharge from place to place in the concrete manholes (D= 1.000 mm), and from here, through PVC pipes with 150 mm diameter, without gaps, these pipes cross through the dam and the water is ejected in exterior drainage.

The distance between the evacuation tubes is approximately 35 m. The exterior drainage is comprised out of concrete manholes (D= 1.000 mm), and corrugated pipes with 110 mm diameter located downstream at the bottom of the dams. The drainage pipes are placed in the trenches with 0,85 m depth at the interior drainage and 0,70 m at the exterior drainage. The drain filter is made out of geosynthetic filter material, the drain material (stone 30-70 mm) and ballast or gravel protection of 0,2-70 mm. The execution of the interior drain and the evacuation pipes is made before the start of the over height dam, and the exterior drainage after the execution of the new dam.

The water collected in the manholes executed on the exterior part of each dam, water collected by the drainage system inside and outside the dams, is discharged through pipes having 150 mm diameter to the perimetral channel located at the base of the dam.

The water evacuated through the interior and exterior drainage system of these dams with the water from the collection wells is directed towards the slag and ash chamber. In this way, it is recycled in the hydro mechanincal transport system. (Muntean M-D., 2014)

B. Dense sludge discharge technology and storage represents an environmentally friendly technology, that coal combustion wastes (slag, ash, desulphurisation byproducts) are discharged and stored as a slurry (dens fluid), uniform without the excess water with an average dilution (solid / liquid) 1 / 1, from which chemical reactions occur between components of ash transport water activated resulting novel compounds, leading to insoluble strengthening (strengthening) of sludge in place of deposit.

Laboratory studies and tests performed on rock made from ordinary clay, ash and desulphurisation by-products (gypsum), was meant to demonstrate that the rock that will keep the inert waste category.

Test results confirm this, because the additional intake of calcium ion made of gypsum results in obtaining a more compact rocks with low permeability and where all the pollutants will be held without possibility of further migration.

Dense slurry technology is not only a process for discharge of slag and ash mixed with water, but is a technology transformation and environmental unfriendly technologies enabling the transformation of these wastes in inert waste. These hazardous substances, such as slag, or ash desulphurisation by-products are processed in an inert waste, such as ash rock. (figure no. 2).

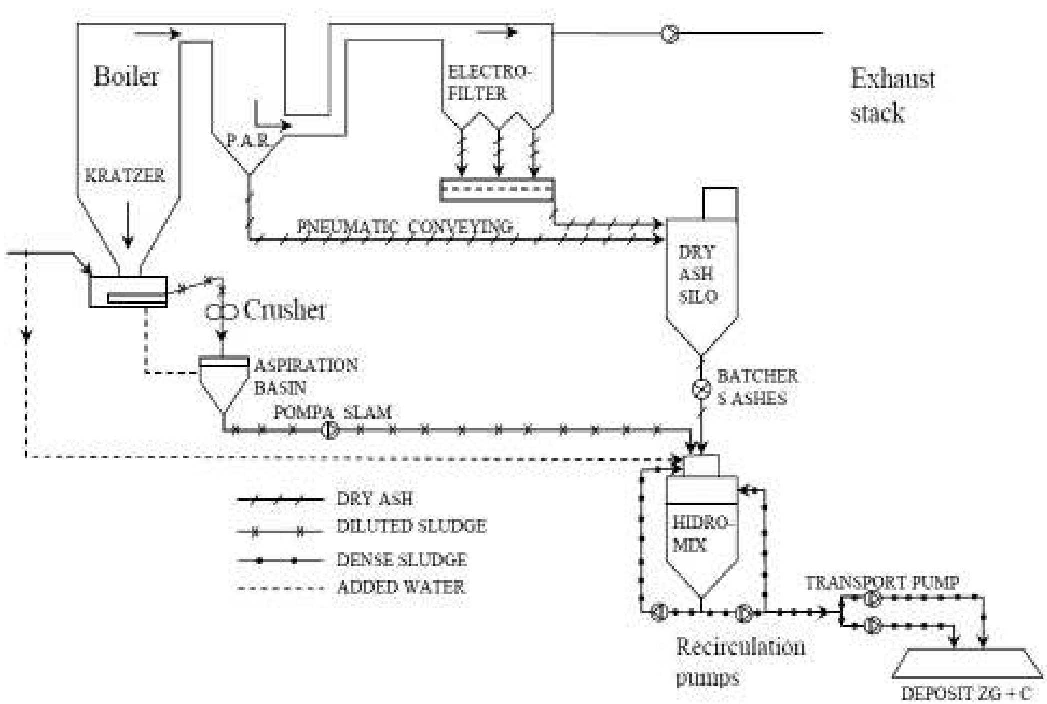

Figure no.2. Block diagram of slag and ash dense fluid discharge method.

Preparation, transport and storage technology of fluid hardener by slag and ash, is a green technology that will lead to increased stability of lag and ash deposits, and reducing environmental impact.

As already mentioned, the water used in hidromechanical transportation of dense sludge will be embedded in the ash rock, which is formed from chemical processes after the deposit of sludge in storage and a small part of this water (losses) will be found in water eliminated to the atmosphere due to evaporation process (estimated at about 3%).

Considering the above, it is expected that the process of depositing dense sludge deposit will not result in wastewater. (Popescu L. G., 2010)

RESULTS AND DISSCUSIONS

During the process of joining to the European Union, Romania has completed negotiations for "Chapter 14 - Energy" and "Chapter 22 - Environment".

For this purpose Romania had to implement EU directives on waste disposal, concerning the limitation of emissions of certain pollutants into the air from large combustion plants and directive for integrated pollution prevention and control.

As a result of environmental agreements achieved and approvals of the water management, some ash and slag deposits may operate using classical solution (dilution 1/8 to 1/10, slag and ash / water) until the end of 2015. After this date these deposits will have to be closed and Power Plants (electrical and thermal) will have to operate on gas or to adopt another solution using dense slurry technology (slag and ash / water = 1/1). (Muntean M-D., 2014)

In past few years various studies have been made on slag and ash to find new opportunities to use this slag and ash, and also to release the land surfaces currently occupied by slag and ash deposits.

The ways of fly ash utilization includ (approximately in order of decreasing importance):

- additive in cement;
- earthworks and other structural fills (usually for road construction);
- mortar and filling fluids;
- waste stabilization and solidification;
- clinker in cement production;
- soft soil stabilization;
- road construction;
- the substitute material (eg brick production);
- mineral filler in asphaltic concrete;
- agricultural uses: changing the acidity of soil, fertilizer, livestock feeders, soil stabilization in stock feed yards;
- applied to road surface to control ice formation;
- Structural insulated panels, for abrasive blasting operations, utility poles, railway sleepers, sound barriers for highways, marine fittings, doors, window frames, scaffolding, columns, paving stones.

Recently concrete mix design for partial cement replacement with High Volume Fly Ash (50% cement replacement) has been developed.

The replacement of Portland cement with fly ash is considered by its promoters an alternative to reduce the greenhouse gas effect, considering that to produce one ton of Portland cement it also results approximately one ton of CO_2 produced. (Anghelescu L., Diaconu B., 2012)

CONCLUSIONS

The evolution of slag and ash deposits can be evidenced both by technological progress achieved over the years (switching from classic solution of discharging the fluid mixture to dense slurry technology), and also in economic terms (by finding alternatives to recover and reuse this slag and ash in different economic fields).

The increase in industrial and domestic waste raises special problems, both by occupying an important land area and for human and animal health. Operating decantation ponds may affect the surrounding lands if retention dams are broken and dissipation of ash from the coal power plants dumps pollute the air, are deposited on soils "enriching them" in alkali and alkaline earth that can reach groundwater if they are located on land with low level in these.

Within the research thematic approached, determinations of the physical and chemical features have been made in the last few years for the soils in the area of influence of some thermal power plants, the following elements being highlighted:

- early soil pollution with low-moderate amounts of heavy metals;
- a weak acidification of soils under the impact of low SO2 emission, as a result of using lignite, less rich in sulphur;
- heat plants pollution effects extend over a wide area, but the most affected is that around the unit, and the heaps of sterile area, located on land depression, bearing the risk of allowing access into groundwater of heavy metals and acid pollutants, which have a higher concentration in the stored materials; for example, in the influence area of CET Mintia and Paroseni, 3.500 ha of agricultural lands are moderately affected and in the influence area of CET Rovinari and Turceni, about 30.000 hectares are weakly affected and 25.000 ha are moderately affected.

Although apparently less polluting than the non-ferrous metallurgy, the coal thermal power plants impose a series of actions to be taken, such as:

- continuous surveillance of the state of pollution of soils and vegetation in the affected area

- a re-technologization of the units in cause, by replacing used filters, desulphuring coals, especially in the case of those rich in sulphur, refilling the lands, etc.. (National report on the state of environment in 2013. Bucharest, 2014)

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