MANAGEMENT OF LIGNITE COMBUSTION WASTE FROM KOSOVA POWER PLANTS - FLY ASH USE POSIBILITIES

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Abstract: -The main purpose of this work was to analyze possibilities for application of lignite byproducts- fly ash from Kosova Power Plants in other industry branches and for filling of old underground mines and see the positive impact in environmental protection. The Kosova lignite-fired power generation industry produces millions tones of fly ash each year. Only small amount of this fly ash is used, with most being considered a waste. This waste must be disposed of in an environmentally acceptable way at a cost which is increasing as legislated requirements become more demanding. There is high potential, however, with improved technologies and a little more will, to increase the use of fly ash concrete industries and in the production of value-added products for the building and construction industry — with the bonus of major savings to greenhouse emissions. For investigation fly ash samples from the Kosova Power Plants were chosen and tested in laboratory as additive material in University of Freiberg, Germany. The results obtained show that it is possible to use lignite fly ash for the production of self – compacting materials and the same can be used for other industry branches.

Key-Words: Lignite, Fly ash, Environmental protection, Power plant, Waste, Mines

1 Introduction

Lignite and other coal types are minerals which have impacted largely the development and technological revolution of human society. If it was used in the ancient times for heating, as combustion means for transport and train circulation, now in modern time it has found a great use in energy industry, as basis of the energy production so necessary for progress of society.

During the coal use, there are mineralogical remains in the form of ashes and other wastes, which have different physical, chemical, mineralogical and morphological properties, which largely depend on the type of coal used, and technology in its combustion. This type of ashes is presented in thermal power plans in the form of dust or fly ash and inorganic remains, which are separated from the process by different methods.

In the whole world, more or less, these remains known as “puzzolanic” materials, are used as additional materials in producing cement, other construction materials, road materials, underground mine backfilling, agriculture, etc.

2 Problem Formulation

Every year around the world the huge amount of waste is obtained during the generation of electricity power from thermal power plants by lignite combustion processes. This potentially usable waste byproducts are one of the biggest environmental problems not just in Kosova. According to one crude estimation yearly are produced more than 300 billion tones of fly ash worldwide and these figures increases each year and is expected to grow up more rapidly in the next years according to the growing demand for energy production. For that reason management of lignite fly ash waste is one of the biggest problems in Kosova where millions of tones are produced each year from existing power plants. Older lignite power plants usually produce fly ash waste with high percentage of unburned coal, and in case of Kosova this is usual because all Power Plants are very old. This is very important parameter called Loss On Ignition (LOI) and according to chemical,

physical and mineralogical properties fly ash is being used differently in different cases.
According also to the fact that modern Power Plants are usually equipped with modern technologies which include low NOx burners in their boilers this has directly effect in the quality of fly ash waste, produced and brings the possibility to increase the use of this waste in several industry branches. In mean time management and use of fly ash waste has direct positive impact in environment protection and cost saving.

2.1 Types of lignite fly ashes and their classification

The coal ashes, as a pozzolanic material, were known in early times, but the first study on possibilities of its use in construction industry and other branches, dates from 1937 (Davis). Still, there is yet no unique classification of fly ashes and its types, and in general, there is an acceptance of division into two classes: Class F and Class C and this classification is based in the amount of Ca as component from fly ash. The C Class includes the ashes from the Kosovo lignite power plants. The content of ash in the Kosovo lignite is up to 43% of its total. A part below (tables 2 and 3) provides chemical quantitative analysis of lignite, while in graphs (1 and 2) there is the distribution and size of component particles.

2.1.1 Possibility for using lignite fly ash from TPP in Kosovo

Kosovo, in a relatively small territory, is one of the richest regions with lignite, and this resource serves as basis for generating the country's energy. In this process, the existing thermal power plans discharge extremely large ash amounts, deposited in landfills, which in turn largely pollute surface and underground waters and environment. Considering that Kosovo possesses an infrastructure not so modern, and a large demand for development of facilities and road infrastructure, there is quite a great opportunity for using ashes in many segments. As was stated, the Kosovar ashes pertains to the C class, and based on labor analysis, it complies with the majority of criteria of use in different manners and sectors, as an additive. Currently fly ash in Kosova has a big chance to take place in construction and building industry (as cement additive, lightweight aggregate), environmental rehabilitation, waste management (toxic element immobilization) and polymers(function filler).

2.1.2. Possibilities of using coal-lignite ash - world experiences

Today byproducts of lignite are increasingly being used as basis or additives for other industrial sectors. In the world, there are different experiences which have shown achievements in this field. Knowing that utilization of ashes in substituting cement and its sub-products is much known, we will shortly hold on to other experiences which have shown the potentials of using ashes in an adequate manner. In the USA, apart from increasingly being used in construction material industry, ash is being used in paving roads, as a foundation or component of asphalt, in combination with other elements. Also, in Australia, India, China, Germany and other countries, utilization of ashes in such a manner is assuming pace. Since the eighties, when the Japanese found the formula of constructing self-compact concrete, the utilization of ashes has grown considerably as an additive or substitute of cement in many types of constructions, be that a building, a road, a bridge, etc.

3 3. Problem Solution

Fly ash waste management is first of all an economic and environmental problem. Disposal costs have been gradually increased in last years, while the share volume of fly ash being disposed of swelled too. As result of this the utilization of larger amounts of this waste and byproducts in the future is more than desirable.
Main goal of the study is to give a direction and ideas for establishing an integrated management of waste utilization in different industry branches in Kosova. In compliance with this purpose we are oriented to find a solution and achieve the recovery of fly ash and based on that our research activities has been addressed in various directions resulting in:
-tests concerning the use ogf fly ash as additive material in cement industry
-tests concerning possible use in construction industry, infrastructure, road building, ect.
-test for possible use in underground mine back filling
-and for surface old mine land filling

3.1.1 Production of self-compacting concrete based in lignite fly ash as additive

Knowing the importance of utilization of fly ash, which comes from generation processes, it was thought of stimulating its use in producing cement and its sub-products, namely in producing self-compressing concretes, then its use in larger projects of infrastructure (roads), and also the promotion of ideas for potential use in other sectors. Here, one must take into account that Kosovo imports large amounts of cement and its sub-products, and in this case it would be very profitable to stimulate a greater utilization in this sector, since productivity would grown at the one hand, import rates would diminish, and financial means would be saved, and invested in another sector, on the other hand. Another positive impact from this would be the decreased environmental pollution, which is a problem in itself in Kosovo.

3.1.2 The possibility of using Kosova's lignite fly ash in other industry branches

Apart from construction and construction materials, ash may be widely used in other sectors, such as road infrastructure, airport development, agriculture, etc. In the occasion of the development of the Highway which would link Kosovo with Albania, this would present another good case to being using it in the field of road construction, and later utilization would be extended to construction of internal national roads. In other countries such as USA, Britain, Australia, etc., ash has taken the role of a partial substitute of cement in large public facilities, airports (Heathrow – London, Amsterdam, etc.) and the same may be done in constructing Kosovar airports. In many countries of the world, ashes used also in improving land quality, and enhancing cultivated lands, while on its use as a material for land reclamation in depleted mines there is a great knowledge, and not more room shall be spent to clarify that.

Fly ash lately is being used for other means, like that of road construction, filling the open pits etc. The most recent requirements are related to filling the underground mines which utilize the "cut and fill" mining method, by hydraulically filling the empty gaps that have remained after the ore exploitation.

Such current requirements come from the Stanterg lead and zinc mine, which is going to use the fly ash as a filling to the old ore bodies, without mixing it with other material or as a replacement to cement, my mixing it with crashed stones or with hydraulic filling from the flotation plant, in order to give geo mechanical required properties to the filled materials. The other requirement is in the Belo Berdo mine, which uses mined stones to fill the empty areas in the mine. Fly ash in this case is planned to be used mainly as a material that replaces cement used in the past.

In the Stantërg underground mine, about 100.000 m3 fly ash can be deposited per annum, whereas in the Belo Berdo mine 20.000 m3 per annum will be used.

3.1.3 The experimental part of work

First of all our preliminary stusy has been carried out consisting in the analysisn of chemical,physical,mineralogical characteristics of fly ash and lignite.In our experimental work, the main aim was to see the possibilities of using Kosovo ash in mortar materials and cement mixtures industrie, underground mine filling, agronomie, infrastructure and other branches of industrie. For the laboratory work, ash samples from different TPP locations in Kosovo were taken to be analyzed and identified untill the best peformance has been achieved.

3.1.4 Chemical, physical, mineralogical analysis and structure of the Kosovo lignite fly ash

Usually, an important role in the chemical and mineralogical structure of ash is assigned to the coal genesis, while conditions of coal combustion and granule distribution are important in the puzzolanic ash activity. The largest difference in chemical structure between different types of coal ashes is in the content of CaO and SO_3, and also depends on the type of coal used for combustion (Fig.1 and Fig.3).

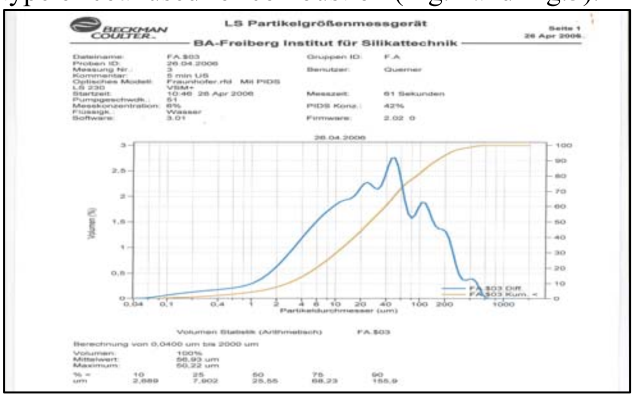

Fig.1

In the concrete case, for experiments of this paper, the ash of TPP Kosovo was used, which has a relatively high content of CaO and is sorted at the C class. Its chemical content was analyzed in the lab and has resulted in the data below (and also in Table.1):

1.SiO2...... 21,96 .
2.Al2O3... 6,07
3.Fe2O3... 7,8
4.CaO.......45,62
5.MgO.........4,23
6.K2O.........0,47
7.Na2O.......1,43
8.SiO3........ 9,03
9.P2O5..... 0,29

10.BaO..... 0,09
11,MnO.......0,24
12. Loss in combustion.2,46

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ANALYSENAUFTRAG FÜR QUANTITATIVE CHEMISCHE ANALYSEN

Auftragsnummer: 28106

Auftraggeber: Dr. Krasnici

Art des analysierenden Materials: Flugasche

ANALYSENWERTE (Angabe in %)

Bestimmung von	Probenbezeichnung					
SiO_2	21.96					
Na_2O	1.43					
MgO	4.23					
Al_2O_3	6.07					
K_2O	0.47					
CaO	45.62					
TiO_2	0.27					
Fe_2O_3	7.89					
P_2O_5	0.25					
BaO	0.09					
MnO	0.24					
SO_3	8.03					
GV	2.46					

Bemerkungen:

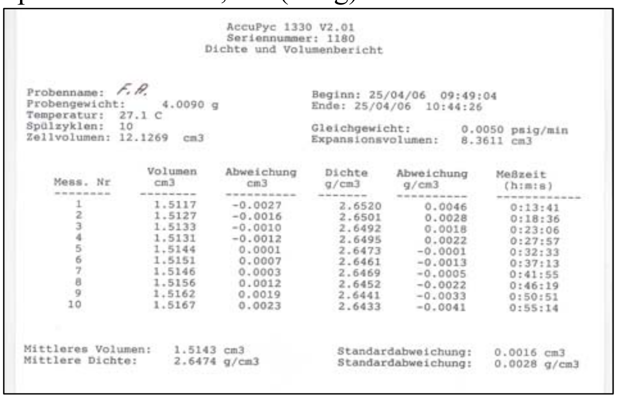
Datum: 16.05.06 Unterschrift:

Table.1

The chemical composition is entirely dependant on the coal genesis but for physical attributes, great importance is assigned to the manner of combustion, and the manner of dividing ashes from the process. In this case, we will explain some of the most important physical attributes which have an impact on using ashes as additive material.

Below (Table.2) are the most important physical attributes of lignite fly ash investigated in labor:

Particle size: 50,22 (µm); Density: 2,6474 (g/cm3) ; Specific surface: 5,937 (m2/g)



AccuPyc 1330 V2.01
Seriennummer: 1180
Dichte und Volumenbericht

Probenname: F.A.
Probengewicht: 4.0090 g
Temperatur: 27.1 C
Spülzyklen: 10
Zellvolumen: 12.1269 cm3

Beginn: 25/04/06 09:49:04
Ende: 25/04/06 10:44:26

Gleichgewicht: 0.0050 psig/min
Expansionsvolumen: 8.3611 cm3

Mess. Nr	Volumen cm3	Abweichung cm3	Dichte g/cm3	Abweichung g/cm3	Meßzeit (h:m:s)
1	1.5117	-0.0027	2.6520	0.0046	0:13:41
2	1.5127	-0.0016	2.6501	0.0028	0:18:36
3	1.5133	-0.0010	2.6492	0.0018	0:23:06
4	1.5131	-0.0012	2.6495	0.0022	0:27:57
5	1.5144	0.0001	2.6473	-0.0001	0:32:33
6	1.5151	0.0007	2.6461	-0.0013	0:37:13
7	1.5146	0.0003	2.6469	-0.0005	0:41:55
8	1.5156	0.0012	2.6452	-0.0022	0:46:19
9	1.5162	0.0019	2.6441	-0.0033	0:50:51
10	1.5167	0.0023	2.6433	-0.0041	0:55:14

Mittleres Volumen: 1.5143 cm3 Standardabweichung: 0.0016 cm3
Mittlere Dichte: 2.6474 g/cm3 Standardabweichung: 0.0028 g/cm3

Table.2

The mineralogical content of ash is affected by the

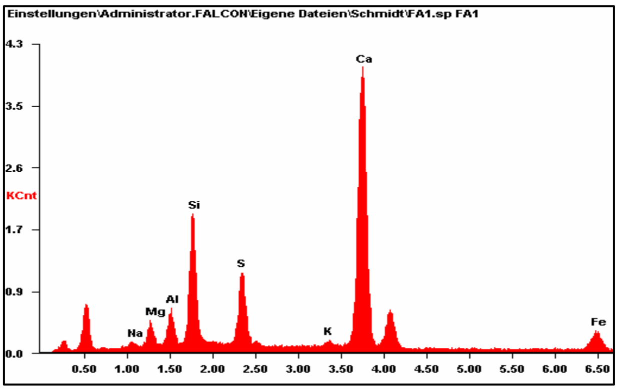


Fig.2

type of coal and usually they are comprised of hyaline phases which possess a structure of well formed spherical particles. Also in a majority of ash types, spherical particles of other minerals may be found, such as iron and magnesium oxides, etc.

A great role is also played by the technology of coal combustion and the temperature of such combustion, since the transformation of the mineralogical composition is a result of this (Fig.3). In the lignite ash used for the paper, we saw that some of the particles do not have a spherical form, and are damaged, and in some cases there are also cenospheres, thus a set of particles laced in a single one. Also, due to a rather non-modern technology,

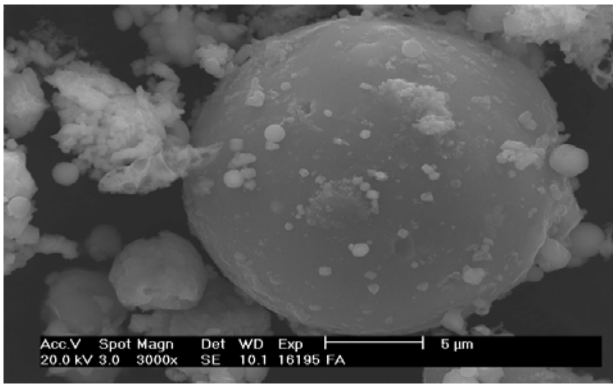


Fig.3

remnants of unburned carbon are found, and they have a role later in attributes of materials, where ash is used as a mineral increment for producing these materials

3.1.5 Microscopical analysis and morphology of the Kosovo lignite fly ash

To have a clear idea on the microscopicall characteristics of Kosovo ashes and its morphology, samples of this fly ash are investigated in a scanning electron microscope (Fig.4) and this is made for

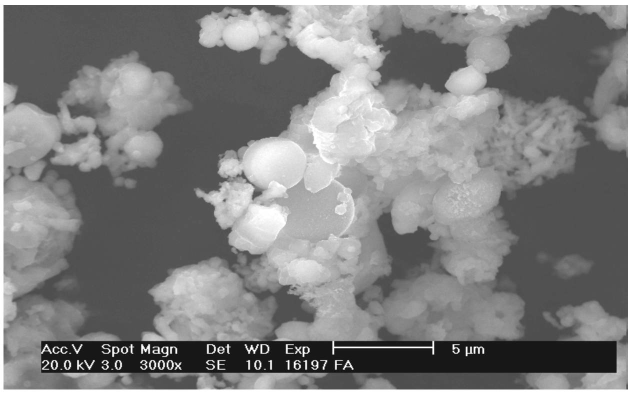


Fig.4

different samples of lignite ash and lignite itself. It was spotted that Kosovo lignite ashes has a rather not a uniform particle composition, and with a relatively large size of composing particles. Also, in its composition it has an amount of carbon remnants (Fig.5), and the particle shape, although spherical, in certain cases they have shown to be broken or damaged. This may be explained as consequence of technological processes which are at the function of Power generation industries in Kosovo. Such a thing, the particle shape, has a rather great role in processes and reactions in composing self-compressing materials, where ash shall be used as additive. Following chemical, physical, microscopic

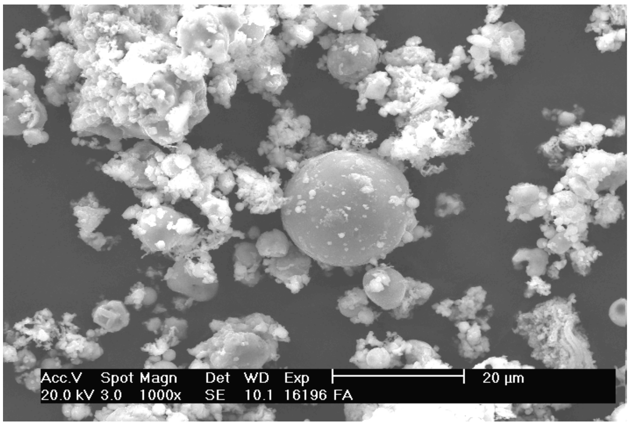


Fig.5

and other analysis, fly ash was used preparing samples, and in a voluminous work, different mixtures were tried for analysis, with different percentages and ratios, which have contained different ash amounts to evaluate the effect of lignite as additive to these materials.

3.1.6 Research methods

These mixtures have been analyzed in an experimental way, in the Vicat device where the initial and final setting time were determined. In devices Schwindkegel and Schwindrinne the volume changes and exothermal behavior of materials were determined, which represents also the subject of works. For this, the measurement of material distribution was made, mainly its viscosity in their respective device. Also in the Schwindkegel device, the direct measurement of temperature change in the experiment was made, while in Schwindrinne overture was measured with another efficient tool, called "Testo".

Results obtained have been processed in an analytical manner, and their presentation was made through graphs(Graf.1), always providing a scientific comparison between results obtained in experiments, and data from scientific literature, although in certain cases, in our research, reactions and phenomena have shown quite some originality.

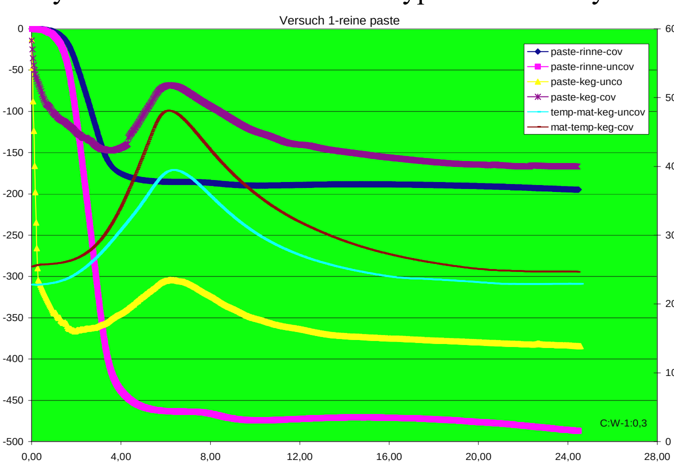
Water Demand and setting times of self-compacting materials-Experiments in the VICAT Device

The method used to determine the water demand and start and end times of solidification, is widely known as the Vicat Method. This is one of the oldest methods, which is still used widely today. This is a relatively simple device, in which fresh samples and determination of parameters required is made through penetration of the Vicat needle in the sample. The sample prepared is placed in Vicat circles, which are placed in a glass plate and four minutes from the time of mixing the sample, the test which determines water demand is done. In these experiments, the water demand has been determined accurately in these mixtures as were the times of initial and final solidification prepared for the sample. It may be seen that the fly ash addition has resulted in a longer time of initial and final solidification, while indirectly this has reflected in volume changes and processes of hydratization developed

According to Literature and different authors there are allegations that there is a difference between measurement of volume changes from one device to the other, since according to them, in Schwind kegel the measurement is three dimensional because of the form of the device.

4. Conclusions

Researches made, have shown that in analysis made in different samples and mixtures (Graf.1), different conditions and devices, results gathered are rather diverse, and in general it can be concluded that the utilization of Kosovo lignite fly ash in self-compact materials and building industries is possible, and may turn useful in many aspects. In this direction, it may be concluded also that this type of ashes may be



Graf.1

used as a connecting material, and as a substitute of cement, and also as an additive.

The use of lignite fly ash in materials of construction industry has a positive impact not only in improving hydraulic attributes, but also in improving rheological attributes, as a consequence of its regular particle shape. Based on the increased demand for construction and other materials in general, the importance of using lignite ash additives in production of these materials increases. This is specifically important in the aspect of energy saving, since the production of each cement ton spends a certain energy amount, and substitution of any amount of cement with fly ash directly saves the amount of that energy which would be spend. Hence, the greater the utilization of lignite ash as a substitute, the greater the energy saving is.

Again more sever approach concerning landfill is coming on (specially in Kosova case because of small territory) and many restrictions keep up with it. Consequently, in order to reduce and prevent landfill burden as well as to increase the use and value of fly ash related to various applications, a beneficiation process becomes more than necessary.

Also it has been proved that management of this kind of waste has very high positive environmental protection impact and also according to obtained results it shows the possibility for use in different other industry branches.

To this and of the study the aim was to find the possibilities and develop a cheap and high capacity technology for the achievement of goal that means that in future Kosova has to increase rapidly the overall recovery of beneficiated fly ash waste, as well as to obtain a byproducts rich in carbon te be recycled to the boiler for other applications.

In principle, many authors (Malhotra, Mehta etc) think that in the 21st century, none of the connecting construction materials and other fields should not be produced without including ashes and other secondary materials in their structure. This is best described with the statement of a known technologist of these materials from the USA, Abdun-Nur, who says that "*In a real modern construction material world, the fly ash is an essential component of mixtures, the same with cement, water and other chemical components, hence concrete without ashes would only find a place in museums and exhibitions* ".

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