RECYCLING OF FLY ASH AS RAW MATERIAL FOR BRICKS MANUFACTURING

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Abstract: Production of electricity by thermodynamic conversion of thermal energy resulting from coal combustion still remains in the forefront of attention in terms of reduced costs, especially when achieved in large scale industrial plants in areas with direct access to primary energy source, such as units operating within Oltenia Energy Complex. Economic advantage are however in contradiction to environmental aspects emission of pollutants derived from coal combustion such as ash. If ash entrained in the flue gas (fly ash) is recovered in the cement industry, heavy ash (from the boiler bottom), more important in terms of quantity, poses considerable problems regarding the disposal and, moreover, remains a constant problem in terms of deposits generated over time. This paper presents the results of experiments carried out on recovery of heavy ash deposit Ceplea Valley (Turceni) as auxiliary material in brick manufacturing process obtained from the clays stripping Rovinari. The positive and negative effects involved the addition of ash manufacturing recipes (variation of density, apparent porosity and mechanical resistance), up to an addition of 10 to 30% by mass. The results indicated that use of the material as fly ash can be effective, especially since, as the source of origin is a local industrial waste. The paper is developed based on activities performed within the project LIFE10 ENV/RO/729.

Key words:
Coal, ash, building bricks, clay.

1. INTRODUCTION

Industrial development has been, is and will remain the main mode of expression and practical application of knowledge gained in the processing of material, from natural resource exploration technology base to state of the art. It is known, however, that industrial activity in continuous development involves drawbacks, among which the most important can be seen accelerated growth of primary energy consumption and waste generation. In the last two decades we witness the increasingly strong contradiction between the trend of development, modernization and improvement of all economic activities and the desire to conserve the environment: air, water and soil "clean" the threat of the greenhouse effect and accelerate global warming.

The energy industry can be considered the main responsible of the effects of environmental pollution and increased risk factors, particularly by large power plants that use coal as fuel and nuclear plants as well. Oltenia region (particularly the Gorj county), where production is concentrated heavily on coal power, becomes for Romania, which represents the energy industry as a whole in the world: a great principal factor generating waste and pollution. Hence, the need to pay greater attention to waste management activity, and if their production can not be avoided, identifying ways to reduce accumulation in deposits.

2. PROBLEM FORMULATION

Power plants fired by coal generate significant amounts of ash, of which only a small part (fly ash) are recovered and used in the cement industry. Heavy ash (boiler bottom ash) deposit on the ground, estimated that for every million tons of ash an area of roughly 1.2 acres in the environment is taken out of the economic circuit, accumulation so far at the country level (108 stacks of ashes) occupying roughly 2,800 acres, with the largest share in Gorj (about 800 acres) and Dolj (about 400 acres). Obviously, in such a situation the problem of investigating the possibilities of recovery of such waste cannot miss industrial concerns in the area of technological research on this line settling the topics addressed in the project "New materials obtained from recycled eco-sustainable industrial waste - EcoWASTES "(" New eco-sustainable building materials by recycling of industrial wastes "), co-funded from grants by LIFE 10 ENV/RO/729 grant agreement by the European Commission, DG Environment project conducted under the supervision of the Faculty of Engineering of the University "Constantin Brancusi" Targu Jiu. The literature provides multiple examples feasibility study on the use of power plant ash in manufacturing technologies of building materials, both for concrete with hydraulic binder and burnt products (bricks). The ash is used as granular aggregate (from 0.7 to 1.2 g/cm3 bulk density) to obtain prefabricated construction volume of approx. 16 dm3 and weighing up to 15 kg, characterized by relatively high compressive strength in the class of density of around 7 MPa. Considered to belong to the category of structural lightweight aggregates, ASTM C 330 classification, the ash is used in the form of pellets or extruded obtained in autoclaved aerated concrete, compaction tables with low cement and sprayed concrete for construction. It is also referred to as a raw material of interest to obtain the composite used in the manufacture of concrete elements pavement. Another important category of applications is indicated for brick manufacturing technologies and is based on compositional similarity with silico-calcareous clays and presented positive results by including ash as a raw material in plastic molding mixtures with a mass weight of 15 - 20% / 5,6,7 /. Internally, SC FIBROCIM SA in collaboration with the Polytechnic University of Timisoara, studied the possibility of using coal plant ash as aggregate manufacturing recipes tiles, presenting results in variations in the ash replaces 5%, 10% and 15% sand of classic recipes / 8 /. LIFE project has been addressed 10 ENV/RO/729 recovery power plant ash accumulated in Section 1 of Warehouse Ceplea Valley and part Turceni. The deposit covers an area of 52.64 hectares and contains approx. 13 million cubic meters of ash (about 18 million tons) / 9 /. To test the ash characteristics 14 incremental 4-5 kg samples were taken from equidistant points (approximately 100 m) located in the four areas on the surface of the deposit (marked A, B, C and D) amounting to approx. 10% of the total. Determinations were performed in laboratory characteristics of the Metallurgical Research Institute of Bucharest and University "Constantin Brancusi" University of Targu Jiu, results of tests on samples corresponding average areas mentioned are presented in Tables 1 and 2.

Table 1
The chemical composition of samples oxidized average fly ash / 10 /

Average sample	SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	MnO	Na_2O	K_2O	SO_3	PC
A	49.7	0.77	20.95	8.96	2.48	9.25	0.08	0.21	1.55	0.59	5.06
B	40.8	0.67	15.7	8.4	2.36	13.75	0.08	0.19	1.35	4.6	11.69
C	45.24	0.76	19.15	8.65	2.35	9.45	0.07	0.2	1.44	1.52	10.73
D	46.8	0.68	19.4	8.9	2.42	9.35	0.08	0.25	1.42	1.38	8.88

Table 2
The physical characteristics of the sample medium fly ash / 10 /

Sample	Moisture	Size composition Remainder (%) on the mesh (mm)										Bulk density g/cm^3	
	%	4	3	2	1	0.5	0.2	0.09	0.06	<0.06	Unsettled	Tamping
A	25.47	1.84	1.06	2.55	7.19	10.44	24.35	28.35	7.81	16.41	0.74	0.90
B	26.78	1.43	0.93	2.43	5.08	8.32	19.24	26.35	8.88	27.34	0.71	0.88
C	25.83	2.25	0.86	2.62	7.81	11.89	26.60	27.70	6.36	13.91	0.70	0.86
D	25.88	0.51	0.62	2.07	7.72	10.89	22.97	28.38	7.18	19.67	0.73	0.92

From the data presented it appears that in terms of fly ash composition Ceplea Valley can be compared to a ferruginous clay, calcium silicate, while the light falls into the category of physical light granular aggregates.

In order to investigate the possibilities of recovery of power plant ash was studied variant used as raw material manufacturing flow burnt bricks for building, using as a reference the industrial flow SC MACOFIL SA Targu Jiu. In this company, the basic raw material used is the feldspathic clay derived from work performed in the Rovinari stripping, coal exploitation career. The chemical composition of the clay is given in Table 3.

Table 3
The chemical composition of the feldspathic clay Rovinari / 11 /

Basic oxide compounds (% mass)										P.C.
SiO_2	TiO_2	Al_2O_3	Fe_2O_3	MnO	MgO	CaO	Na_2O	K_2O	P_2O_5	
65,80	0,68	15,97	5,40	0,11	1,64	0,85	1,86	2,37	0,12	5,35

In order to verify the compatibility with the of combustion process flow melting points of the power plant ashes and feldspathic clay were determined by the sintering and, using high-temperature microscope, as shown in Figure 1 taken during the test image.

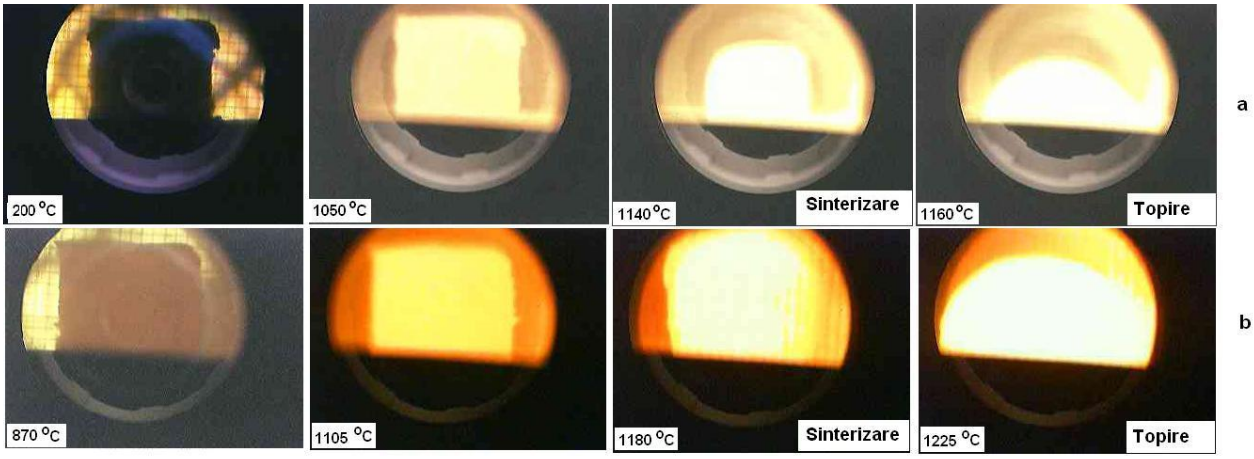


Figure 1. Images taken during the determination points sintering and melting fly ash (a) and clay Rovinari (b) / 11 /

The results indicate that the two types of materials have similar behavior in the heat treatment process, are compatible in terms of the maximum temperature reached by the feed industry tunnel reference furnace (about 1000 ° C).

3. EXPERIMENTAL WORK AND RESULTS ACHIEVED

In experimental work aimed to study the influence of the addition of fly ash on main characteristics of Rovinari natural feldspathic clay-based products. For this purpose, plastic mixtures were manufactured for pressing the clay, or clay with addition of 10%, 12%, 15%, 18%, 20%, 30%, 50%, 55% and 60% fly ash.

The mixture was moistened with water and then shaped by pressing the metal mold at the maximum pressure of 50 MPa and second deaeration steps of approx. 5 MPa to give cylindrical specimens with dimensions Ø 50 mm, h 50 mm. After standing for 3 days in the normal atmosphere, the samples were subjected to drying in an oven at 105 ° C, and then firing the electric furnace to temperatures of 970 ° C, 1000 ° C to 1030 ° C, the gradient of temperature rise of 5 ° C / minute, hold for 4 hours at maximum temperature plateau and slow cooling (closed oven) for 12-14 hours Figure 2).

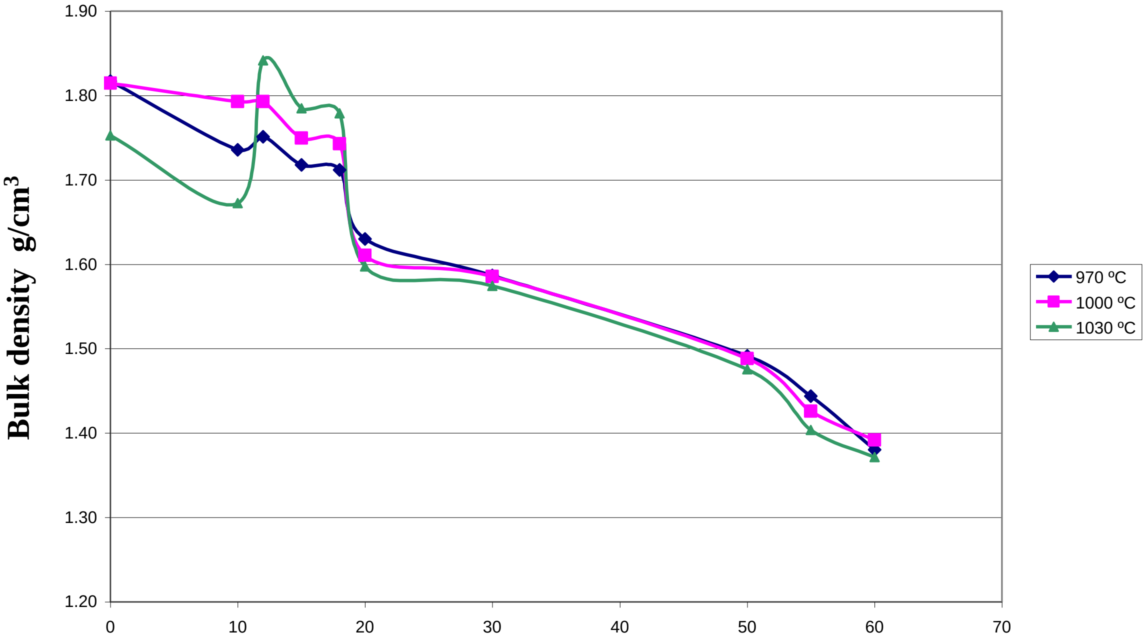
Figure 2. Set of cylindrical specimens heat treated

After the thermal treatment, the samples were subjected to laboratory tests in order to determine the main physical characteristics: bulk density, water absorption capacity, the open porosity (tests carried out by means of boiling water and weighing head) and compression strength. Laboratory test results are shown in Table 4 and in Figures 3-6 are shown graphically the values of the physical parameters based on the weight of the mass of power plant ash mixtures of bending and the maximum combustion temperature of the test specimens. Following the results obtained, it was observed that the addition of ash mixtures of bending results in lower density products, the fact that it acts as an easy granular components. Positive side effect is of course that of open porosity increase, leading to increased thermal insulation ability of the product, but also appears to reduce the negative effect of compressive strength, all effects referred varying constant with increasing ash content in the mixture of trimming.

Table 4

Ash content, burning temperature and the results Laboratory tests performed on cylindrical specimens burned

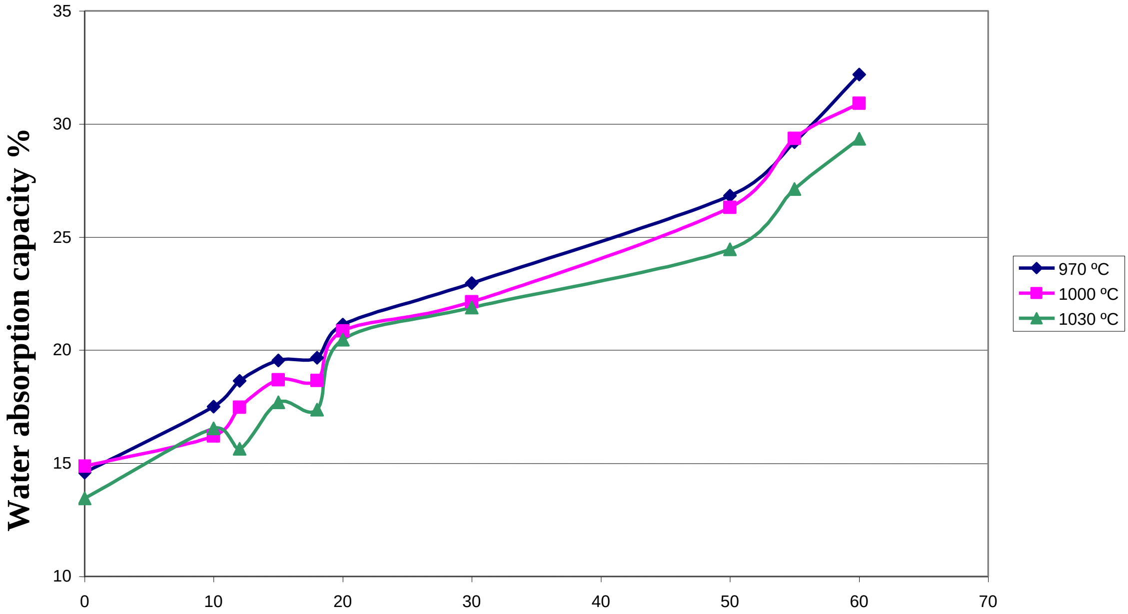
Nr. crt.	Ash content %	Firing temperature °C	Bulk density g/cm^3	Water absorption %	Open porosity %	Compressive strength MPa
1	0	970	1.82	14.60	26.52	27.3
2	10	970	1.74	17.50	30.37	33.6
3	12	970	1.75	18.65	32.66	26.7
4	15	970	1.72	19.55	33.59	24.9
5	18	970	1.71	19.67	33.66	28.2
6	20	970	1.63	21.13	34.43	25.4
7	30	970	1.59	22.97	36.44	20.7
8	50	970	1.49	26.84	40.02	16.7
9	55	970	1.44	29.20	42.15	13.4
10	60	970	1.38	32.19	44.43	11.9
11	0	1000	1.81	14.86	26.97	26.5
12	10	1000	1.79	16.20	29.05	24.2
13	12	1000	1.79	17.48	31.34	28.2
14	15	1000	1.75	18.69	32.70	26.6
15	18	1000	1.74	18.65	32.51	29.0
16	20	1000	1.61	20.85	33.57	28.3
17	30	1000	1.59	22.13	35.09	23.0
18	50	1000	1.49	26.31	39.15	19.9
19	55	1000	1.43	29.36	41.88	15.7
20	60	1000	1.39	30.92	43.03	15.6
21	0	1030	1.75	13.45	23.57	4.0
22	10	1030	1.67	16.54	27.66	5.0
23	12	1030	1.84	15.64	28.81	27.5
24	15	1030	1.78	17.69	31.58	26.8
25	18	1030	1.78	17.37	30.90	30.5
26	20	1030	1.60	20.47	32.69	17.5
27	30	1030	1.57	21.88	34.45	19.3
28	50	1030	1.48	24.46	36.08	21.0
29	55	1030	1.40	27.13	38.08	21.5
30	60	1030	1.37	29.35	40.26	20.5



Ash content %

Figure 3

Variation of bulk density based on ash content and combustion temperature



Ash content %

Figure 4

Variation of water absorption capacity depending on ash content and combustion temperature

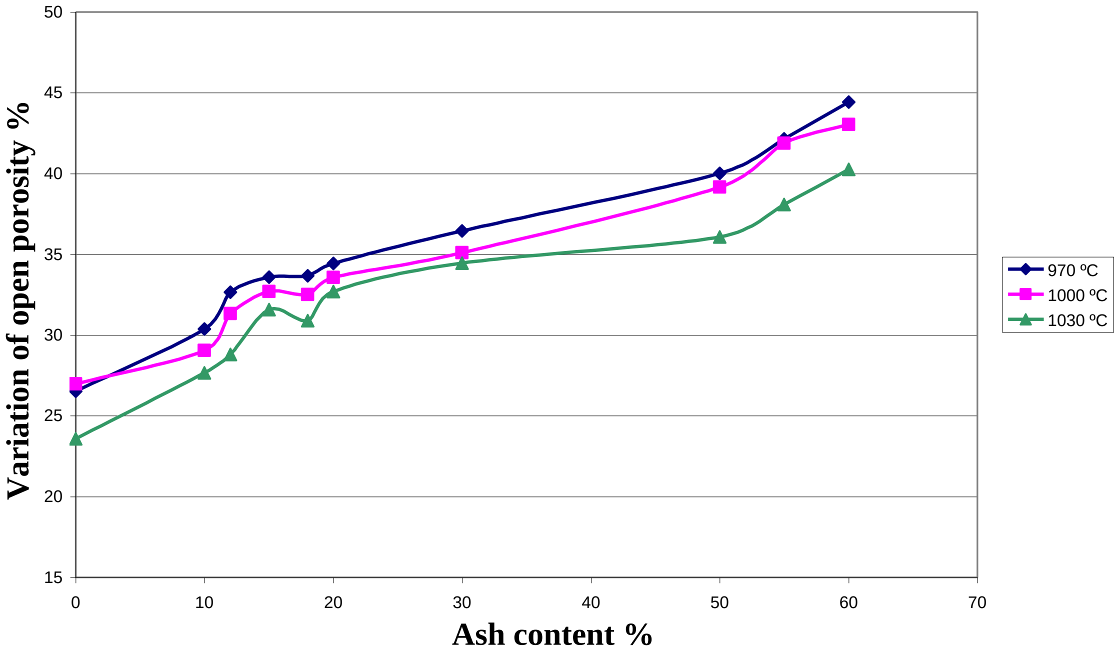


Figure 5
Variation of open porosity depending on ash content and combustion temperature

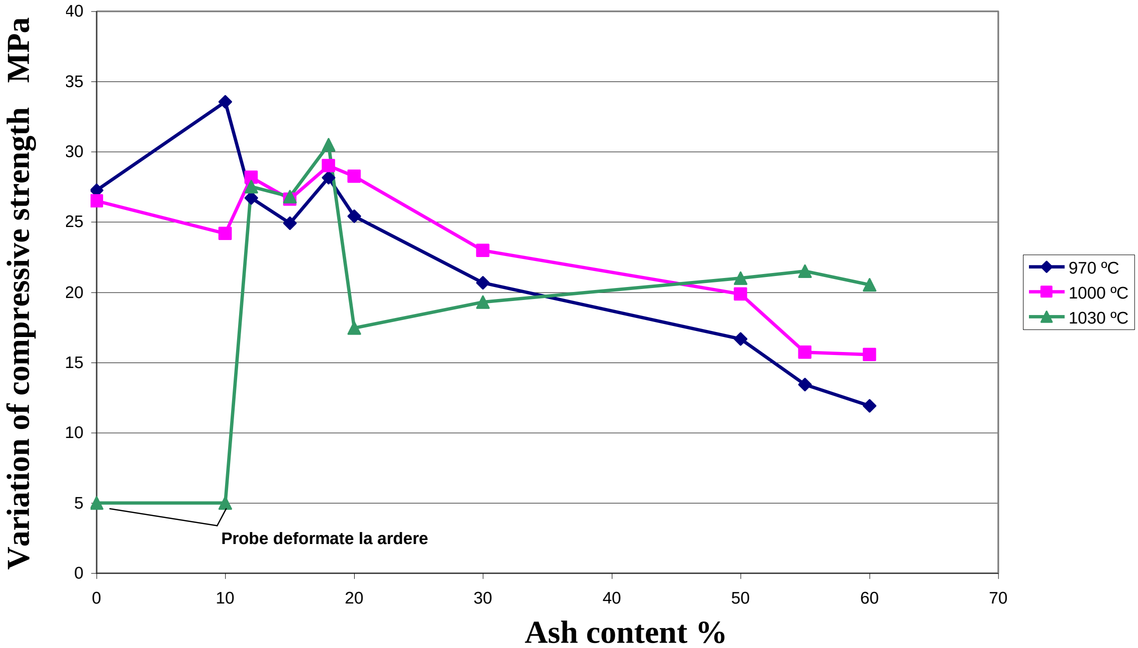


Figure 6
Variation of compressive strength depending on ash content and combustion temperature

It is also noted that in the case of specimens thermally treated at 1030 ° C abnormal changes occurred in physical parameters investigated, and in the case of two types of recipes studied, the resistance to compression cannot be determined correctly, due to the strains arising due to major deformations (temperature maximum treatment too high). It appears, however, that the adverse effects of ash additions of over 20% significantly decrease hence the conclusion that this component is likely to increase product stability at high combustion temperature.

4. CONCLUSIONS

- Large amounts of ash resulting from coal combustion in high capacity power plants require studying the possibilities of recovery, in order to reduce the effects of environmental pollution. This applies also to ash deposits accumulated over time, especially for the county, holding this point of view a "first" nationally disadvantageous;
- Fly ash accumulated in compartment no. 1 of Valley Ceplea Repository (CET Turceni) has a constant deposit characteristics and overall physical properties recommended for use as a granular aggregate density class easy and relatively fine grained;
- Usage of power plant ash for preparation for trimming brick building leads to lower their apparent density and open porosity increase (increased thermal insulation ability). At the same time it leads to a reduction of the compressive strength, hence the need to consider the effects of favorable and unfavorable, respectively ashes mixed weighting according to the desired goal;
- At the same time lead to a reduction in compressive strength, hence the necessity of analyzing the effects of favorable and unfavorable, respectively ashes mixed weighting according to the desired goal;
- Using power plant ash mixed with clay stripping feldspathic Rovinari area is likely to increase the stability of products under high temperature afterburner, but was recommended a maximum of 990 - 1010 ^{o}C.

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